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ABSTRACT

This yearbook consists of two distinct parts. In part one, Concepts and Techniques in Geography, eight academic geographers review the thrust of recent research in the branches of the discipline with little or no reference made to the implications of these developments to elementary and secondary education. Two essays deal with man/land relationships: Cultural Ecology, and Environmental Perception. One is on regional economic development. Three focus on spatial analysis: Spatial Interaction, Changing Urban Spatial Patterns, and Location Theory. Two deal with teachniques of abstraction and symbolism: Systems, Model Building, and Quantitative Methods; and Trends in Cartography. Part two consists of nine essays on teaching and learning, all but the first of which related to geography subject matter, geography instruction or geography teachers: 1) Cognitive and Affective Learning; 2) Children's Spatial Visualization; 3) Developing and Using Behavioral Objectives; 4) Building and Using Inquiry Models in Teaching; 5) Educational Simulations in School Geography; 6) Evaluating Geographic Learning; 7) Emerging Social Studies Curricula: Implications; 8) An Analysis of Teaching Strategies; and, 9) The Preparation of Geography Teachers. Many of the essays are well documented with references although the entries are generally not annotated. (NH)

Focus on Geography

Key Concepts and Teaching Strategies

The National Council for the Social Studies is a national affiliate of the National Education Association of the United States. It is the professional organization of educators at all levels — elementary, secondary, college, and university — who are interested in the teaching of social studies. Membership in the National Council for the Social Studies includes a subscription to the Council's official journal, SOCIAL EDUCATION, and a copy of the Yearbook. In addition, the Council publishes bulletins, curriculum studies, pamphlets, and other materials of practical use for teachers of the social studies. Membership dues are $12.00 a year. Applications for membership and orders for the purchase of publications should be sent to the Executive Secretary, 1201 Sixteenth Street, N.W., Washington, D.C. 20036.

Focus on Geography

Key Concepts and Teaching Strategies

Phillip Bacon, Editor

40th Yearbook 1970

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Foreword

Strong and prevailing winds of change, from both geography and education, are clearly with us and, as a consequence, there is good reason for a Yearbook focusing on geography to usher in the decade of the 1970's. Geography as a field of inquiry is probably undergoing as dynamic a change at this moment in time as at any period in its long history. There is a contagious atmosphere of excitement in graduate departments these days as young scholars struggle to secure a functional stance on the threshold of significant theoretical work. As a result of their efforts, rigorous analytic approaches are rapidly opening new perspectives on the geographer's traditional interests in the man-natural environment system.

Part I of this Yearbook represents an attempt to capture some of this excitement, in midstream, so to speak, for much of the work is still very much in the developmental stage. This sense of evolution places a special burden on both authors and readers. It has forced the authors (and editor) to try especially hard to make their theoretical, and often highly abstract, notions intelligible to the non-geographer. And, obviously, it requires the reader to stop and ponder, rather than to race through, or skip over, complex phrases and references. It is our fond hope, however, that readers will, indeed, ponder these ideas for they do, we believe, have unique value for the social studies of the 1970's.

The mission of Part II is to open doors to important ideas about learning and teaching. It represents a serious effort on the part of learning theorists and social studies educators to find ways of focusing on geography content that will have genuine relevance for children and youth in this new decade.

Yearbooks do not just happen, as anyone who has participated in their development is well aware. They are, in fact, born out of the combined efforts of a great many people, too many, unhappily, to be acknowledged here by name. However, the editor has accumulated some special debts enroute to the publication of this Yearbook that he does wish to acknowledge publicly.

Certainly to the authors of the chapters that follow, he has lasting obligation. They responded to his calls to action with uncommon alacrity. He is appreciative, too, of the help that several of his graduate students, especially Dennis Asmussen, Joe Decaroli, and Arthur Nichols, gave to him in final preparation of the manuscript for production. Finally, the editor must express appreciation to the Publications Committee, to the NCSS headquarters staff, and particularly to Daniel Roselle, Willadene Price, and Carolyn Larson, who had the singularly difficult task of making this manuscript intelligible to the printer.

PHILLIP BACON, *Editor*

Preface

From the National Council for the Social Studies

The world is not what it used to be. Not that the oceans have dried up in the decade since we last issued a Yearbook concerning geography but the ways we are using and looking at our world have changed significantly and in startling opposite directions.

On the one hand, the jet age has became a habit. Distances have lost their magic, and acculturation has become an international factor of our times. With the excitement of exploring the moon and snapping pictures of Mars, the earth has, at times, seemed no more than man's springboard into the universe.

On the other hand, we have suddenly remembered that this old earth is vitally important if man is to survive at all. In our concentration on scientific and technological progress, we have somehow overlooked that we humans must still live on earth. Human behavior in the world and toward the world has loomed up in its full significance. The renewed attention with regard to our own environment has startled us all out of our lethargy. The black smog clogging the air not only of the cities but for thousands of miles of countryside, the scum of our rivers, the depletion of all those resources which made the earth inhabitable for man have finally made their impression. What is frightening is that the realization may have come too late.

Geography and human behavior have become vital partners. The 40th Yearbook is a renewed assertion and recognition of this partner-

ship as well as an effort to deal with educational approaches that will make the study of geography more effective for our young.

The National Council for the Social Studies is indebted to Dr. Phillip Bacon and the group of able contributors whose efforts made this Yearbook possible.

SHIRLEY H. ENGLE, *President*
National Council for the Social Studies

From the National Council for Geographic Education

It is my pleasure to add to the Preface of this volume the endorsement of the National Council for Geographic Education. For the fourth time in somewhat less than forty years, the Council notes with commendation the initiative taken by another organization, through a Yearbook, to keep America's educational readership abreast of developments in geography. All who believe in the peculiar virtues of the geographic point of view have reason to be grateful for such positive sharing of responsibility.

Change in the rationale behind the successive Yearbooks constitutes an interesting expression of educational history in twentieth-century America, and at the same time testifies to the vitality of the field concerned. In 1933, the Yearbook of the National Society for the Study of Education (Guy M. Whipple, editor, *The Teaching of Geography*) took up the cause of geography as a field on the defensive against the "iconoclastic destruction of subject structures"—that is, against the claims of the social studies as a new master category in the school curriculum. At the same time, consistent with prevailing views, the book presented geography as a study of the relationships between man and his earth environment.

In 1948, the Yearbook of the National Council for the Social Studies (Clyde F. Kohn, editor, *Geographic Approaches to Social Education*) accepted the demands of social education as a control over geographic learning. The editor, in keeping with the times, asked how these demands could be met through "learning about geographic phenomena—the development of differences from place to place." In 1959, the Yearbook of the National Council for the Social Studies (Preston E. James, editor, *New Viewpoints in Geography*), while representing the

same general interpretation of education and geography as its immediate predecessor, expressed contemporary trends by appealing to the university discipline of geography as a source of new wisdom for the schools.

The present Yearbook fulfills its commitment to the 1970's by reflecting two broadly significant developments in geography. Part I speaks for a university discipline that has experienced a pronounced widening and diversification of research activity in recent years. A result, evident in the chapters of Part I, is a release of authors from previously effective philosophical restrictions. Part II communicates the excitement of a field that is rediscovering itself through involvement in new thinking about teaching and learning, at all levels of education from the primary grades to graduate school. One consequence of this reconsideration, to be found in the pages of Part II, is a reduction of anxiety over the "correct" relationship between geography and the social studies. The National Council for Geographic Education wishes to make known its complete approval of the alleviation.

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Contents

PART ONE
Concepts and Techniques in Geography

Foreword		v
Preface		vii
Contributors' Who's Who		x
1	Location Theory *Günter Krumme*	3
2	Cultural Ecology *Marvin W. Mikesell*	39
3	Environmental Perception *Thomas F. Saarinen*	63
4	Changing Urban Spatial Patterns *Arthur Getis*	101
5	Regional Development *John B. Parr*	121
6	Spatial Interaction *Douglas K. Fleming*	147
7	Systems, Model Building, and Quantitative Methods *George W. Carey*	173
8	Trends in Cartography *Philip C. Muehrcke*	197

PART TWO
Teaching and Learning: Applications to Geography

9 The Cognitive and Affective Learning of Children *Rosemarie McCartin* 229

10 Children's Spatial Visualization *John Eliot* 263

11 Developing and Using Behavioral Objectives in Geography *Ambrose A. Clegg, Jr.* 291

12 Building and Using Inquiry Models in the Teaching of Geography *James L. Hills* 305

13 Educational Simulations in School Geography *Angus M. Gunn* 337

14 Evaluating Geographic Learning *Dana G. Kurfman* 355

15 Emerging Social Studies Curricula: Implications for Geography *Lorrin Kennamer, Jr.* 379

16 An Analysis of Teaching Strategies in Emerging Geography *Theodore Kaltsounis* 407

17 The Preparation of Geography Teachers *John Jarolimek* 423

PART ONE

Concepts and Techniques in Geography

Chapter 1

Location Theory

Günter Krumme

Location Theory* has, at various times, been the umbrella for a large number of different theoretical directions, particularly in the fields of economic geography and spatial economics. It has been narrowly defined as a normative theory of optimal locations of individual manufacturing plants or, quite broadly, as a body of theory aimed at explaining individual locations as well as location and land use patterns of all human activities.[1] A variety of specific dichotomies could be identified in the definitions of Location Theory, the most significant being the contrast between *micro* and *macro*-theories (referring to the analysis of individual or group behavior versus the analysis of aggregate spatial patterns), and *static* versus *dynamic* theories (depending on whether or not the passing of time is allowed and accounted for by the theory).[2]

Specific reference shall be made to two recent approaches by an economist and a geographer respectively. Martin Beckmann[3] maintains that "in location theory, economic analysis is used to study the geography of man's economic activities. Location theory raises the question of 'where' and adds it to those of 'what,' 'from whom,' 'how,' and

* *The author wishes to thank Drs. William B. Beyers, Michael R. Greenberg, Guy P. Steed and Morgan D. Thomas for their helpful comments.*

'when,' which the student of economic theory encounters in the discussion of the functions of an economic system. We may say that location theory is also the study of the effects of space on the organization of economic activities." Clearly, Beckmann includes a wide range of problems in his definition and, though his emphasis is on individual or micro location analysis, considers also more aggregate spatial phenomena. The restrictions of the definition lie in the "economic analysis," by which he means the micro-economic study of resource allocation as achieved by a price system operating under the assumption of profit maximization.

Allan Pred,[4] on the other hand, makes a plea for a "geographical location theory." He presents a strictly behavioral approach toward the locational problem, emphasizing the significance of information and the ability to use information as constraints in location decision-making. Pred's extensive references to the more behavioral literature in economics indicates, however, that a distinction between an economic and a geographic location theory is hardly valid. However, this is not to say that geographers such as Julian Wolpert, Peter Gould, and Pred have not contributed to the development of this highly interdisciplinary field of location theory by introducing behavioral concepts developed largely by other disciplines.[5] These efforts should be seen in light of the fact that, in economics, location theory still occupies a basically peripheral position; on the other hand, pragmatically-oriented economists and regional planners seem to be highly dissatisfied with the abstract state of largely transport-cost oriented location theory,[6] and have taken up the task to formulate "theories of the 'middle-range' to explain, at a lower level of abstraction, the multi-faceted reality that surrounds us. . . ."[7]

Historical Aspects

A brief and necessarily oversimplified account of the development of location theory will, nevertheless, show that its roots are distinctly not to be found in geography. While economic geography, *alias* commercial geography, evolved as a rather descriptive, fact-finding discipline serving Europe's business schools, the origins of today's core areas of interest in economic geography can be largely traced to a small number of European location economists, some of whom have been — *post mortem* — declared geographers *honoris causa*.

Reflecting on the more recent history of location theory, it seems convenient to distinguish three periods:

(1) The period ending during the 1940's (perhaps with the untimely death of August Lösch in 1945) was dominated by normative partial equilibrium models, the development of which had been initially started by von Thünen and Launhardt.[8] The rather abstractly handled distance factor, in addition to the normative and static character of this body of location theory, strongly suggests a "Germanic Bias" in the development of location theory analogous to Isard's "Anglo-Saxon Bias" in the evolution of general economic theory.[9]

(2) The second period coincided with the evolution of "Regional Science" as an interdisciplinary field during the 1950's.[10] It is characterized by attempts to integrate location theory more thoroughly into existing micro-economic theory.[11] Following initial steps to introduce more realistic objective functions into economic analysis, and encouraged by corresponding empirical findings, location theorists slowly accepted the challenge to make conceptual and analytical provisions for a realistic and differentiated repertoire of locational behavior.[12]

(3) It is more difficult to isolate specific trends within the third period, which has been under way since about 1960. The research frontier indicates a number of mostly interdisciplinary directions integrating concepts and tools drawn from systems theory, information and learning theory, game theory, as well as mathematical statistics and econometrics, and traditional economic theory.[13] Substantive advances are highly interrelated with the development of model building technology, ranging from "hill climbing algorithms for the classic Weber problem to complex land use models in transportation studies." [14] The most general trend — namely, that of a behavioral orientation — is based on the widely accepted notion that individual location decisions should be properly analyzed in a more comprehensive spatial, temporal, and behavioral context. Simulation analysis may well be the suitable frame for a reunification of the more narrowly conceived Location Theory with aggregate (settlement-, location-, and network-) *pattern* analysis.[15]

Locational Decision-Making

This chapter is concerned with the locational behavior of individuals, groups, and organizations. Its focus is based on the "revelation" that location decisions are made on the micro-level. It seems highly unsatisfactory to deal with individuals en masse only and to assume that "individual behavior is unpredictable in much the same way as the behavior of individual molecules." [16] Aggregate, deterministic interaction

and location models, such as the gravity and potential models of social physics, "are often, perhaps mostly, presented without explicit statements about assumed social organization and technology at the micro-level from which the individual tries to handle his situation." [17]

The individual location decision is recognized as having "forward" and "backward" linkages to other decisions; "a location decision is no longer the last act in the decision-making process," [18] and it is "not necessarily the key decision when viewed in a larger context." [19] A location decision is one of a large number of decisions which arise during a period of time or a life cycle. Some of these other decisions (e.g., investment decisions of firms) are intimately intertwined with the actual location decision; others are independent and often of considerably greater significance for the life pattern of a household or the survival of a firm than the location decision.

It is proposed that location decisions made by individuals, households, farmers, manufacturers, retailers, or government institutions have more in common than the occurrence of transport costs and more than the separate development of, for instance, industrial and agricultural location theory would indicate. The introduction of externalities, uncertainty, or group decision-making into location theory does not require entirely different approaches for food processing "manufacturers" or highly intensive glasshouse "farming" operations. Developments in the fields of decision theory (allowing for more operational concepts and locational strategies), organization theory (focussing on institutional relationships), and small-group social psychology (defining communication patterns within the group), provoke a reconsideration of the boundaries of theoretical compartments.

In this necessarily brief survey, the locational problem is presented in four frameworks, within which a larger number of concepts have been summarized. The first framework focusses upon the locational implications of the traditional analytical optimization method known as marginal or substitution analysis. Whereas this substitution analysis is primarily concerned with variables *external* to the specific decision-making unit, the second framework emphasizes the impact of *internal* factors, specifically organizational aspects, on location decisions which are here interpreted as locational adjustments. The third framework is more explicit about the spatial and temporal conditions which bear upon and constrain such adjustment processes, while the final approach focusses

upon a few analytical procedures for simulating the actual process of locational decision-making.

Substitution Approach

The first framework is designed to shed some light on the impact of traditional production and price theory on the development of location theory;[20] more specifically, it is believed that substitution analysis best illustrates the fundamental principles at work in processes of optimization. For reasons of historical interests, let us begin with Alfred Marshall's definition of the substitution principle:

> As far as the knowledge and business enterprise of the producers reach, they in each case choose those factors of production which are best for their purpose; the sum of the supply prices of those factors which are used is, as a rule, less than the sum of the supply prices of any other set of factors which could be substituted for them; and whenever it appears to the producers that this is not the case, they will, as a rule, set to work to substitute the less expensive method. . . . We may call this, for convenience of reference, *The principle of substitution*.[21]

The most explicit and inclusive formulation applying the substitution principle to the sphere of location can be found in Isard: [22]

> Formal location theory may be viewed as treating an elaborate substitution problem. . . . Since prices of inputs and outputs vary with location, and since transport (transfer) and communication costs are involved especially when the sources of inputs, the sites of production and other activities, and markets do not coincide, the substitution problem breaks down into a number of partial substitution problems many of which have spatial aspects. . . . Optimization principles govern the paths of substitution.

The fundamental purpose of substitution analysis is to attain an optimum constellation of a set of variables by incrementally changing the values of individual variables whenever such a change supports the objective of coming closer to the optimum. The neglect of variables related to the production process and to the market mechanism, and the overwhelming emphasis on transport costs delayed the formal introduction of the substitution principle into location theory until Isard created the concept of transport input (which he defined as "the movement of a unit of weight over a unit of distance").[23] Having made this formal step, Isard was then able to treat economic distance as any other input of a production process which allows for substitutability.

How the substitution principle can be applied to solving a locational optimization problem may be demonstrated by the same simple, triangular location constellation used by Alfred Weber.[24] Weber's solution minimizes total transport costs for the shipment of inputs and outputs to and from the site of production. It is most significant to note that in Weber's model substitution is not permitted to take place among inputs; the production recipe is given and assumed to be independent of location, as well as of the size of operation. Under these conditions, substitution can take place only between transport inputs, since economic distance is the only parameter to vary in the process of optimization.[25]

Suppose we wish to find the minimum transport cost point within a triangle A,B,C to and from which three sets of goods have to be transported (Figure 1). We proceed by successively searching for partial equilibrium solutions, partial in the sense that we try to find cost minima

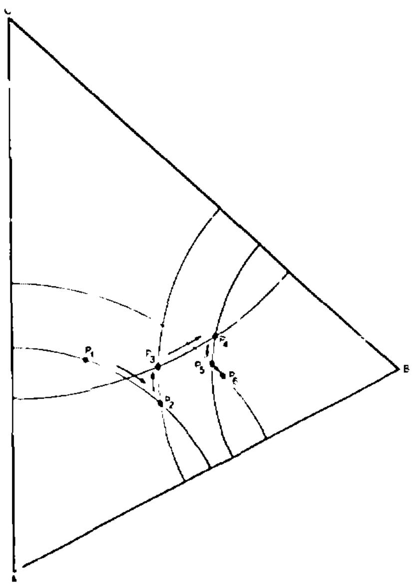

FIGURE 1

Iterative approximation of the Weberian optimum

for two points while holding the transport costs to the third point constant. We begin with any one point P_1 within the triangle as the first approximation. Drawing a circle around A with the radius AP_1 will enable us to operate (or substitute) on the arc of this circle without changing the distance to A. Moving along the arc we continuously change the distance to B and C, i.e., we are substituting between two transport inputs until any further move cannot decrease the combined transport costs any longer. This is our first partial equilibrium point P_2. Now we hold the distance, e.g., to B, constant by drawing a circle around B with the radius BP_2, and proceed correspondingly along the newly determined arc until we find P_3, our partial equilibrium point for the distance to A and C. By continuing this process of freezing and defreezing distances, and finding partial equilibria in a sequence of iterations, we approach P_n, the point which combines the last partial equilibrium with the overall optimum.[26] We have reached the bottom of the transport cost valley; a step in any direction will result in an increase in total transport cost. Such an increase, however, may be justified if the additional transport inputs substitute for other inputs. Weber introduced the concept of *isodapanes* to tackle the analysis of other input costs (land, labor, taxes, utilities, etc.). Isodapanes are defined as lines connecting all points around the transport cost minimum with equal transport cost increases. On each isodapane, there will be a point with an overall cost minimum. Comparing all of these cost minima we will find the overall minimum of the whole system of isodapanes.

This cumbersome inspection method can also be applied to the selection of residential locations. Suppose we have three reference points: A (husband's job), B (wife's job), and C (nursery school for daughter). Suppose we assign weights to the respective distances according to the number of trips required per week and the travel time per trip. For simplicity, we assume that the reference points have been chosen prior to this selection process, that they cannot be adjusted afterwards, and that travel time is equally "dear" to all three commuters. Before the iterative procedure is applied, it may be useful to define the actual "substitution region," i.e., that area within which the final solution has to be located. This is done by defining "critical isovectors" around the individual reference points beyond which a residence would be either physically or economically inaccessible and thus unacceptable for the family member concerned. After the optimum commuting location has been found, a successive isodapane analysis enables the household to

weigh additional commuting costs and inconvenience against possible savings in rent or satisfaction gained from living in a different neighborhood.

Realistically, reference points differ with respect to the degree to which they "dominate" the location selection procedure or are subordinate to other reference locations. An elimination procedure may commence by finding the best solution for a relatively small number of dominant points (e.g., job of husband) and then proceed to determine other, either less significant or more ubiquitous, reference locations (e.g., job location for wife, cultural center, church, etc.) which then become part of a second round of iterations on a smaller scale. Other reference points (possibly nursery school or shopping center) may not attain the degree of significance to be included in the initial selection process, but *are selected* once the residential location has been chosen.

Isard's classical treatment of substitution between transport inputs has been extended by Leon Moses [27] to include the problem of interdependence of location and the internal workings of the production system. Weber avoided this question by implicitly assuming that all production-related decisions had been finalized prior to the actual location decision. However, optimal proportions of inputs (such as coal and oil in a reduction process) may change with changing levels of operation (size of blast furnace) due to the nature of the production process. They may also depend on characteristics of the input markets and on transport costs as they affect delivered relative prices of inputs. Thus, Moses concludes that an optimal location cannot be found without determining simultaneously optimal input proportions and the optimal size of operation.[28] While Moses also uses Isard's arc-method to analyze the impact of transport costs on location by substituting among material as well as transport inputs, he does not go beyond the first (rather arbitrary) arc and, thus, does not arrive at the actual optimum. The reader will realize that an iteration procedure similar to the one employed in the Weberian context would not only have to iterate locations but input coefficients as well. Thus, we alternatively hold either locations or input coefficients constant and successively adjust the variable values.

There seems to be no reason why Moses' analysis could not equally be applied to the "other side" of the production process. Instead of transforming two or more inputs into one output, one could assume to produce two or more final products (with spatially separated markets) out of one localized input. Most industries supply examples of multi-product

production processes subject to substitutability. Relative costs of shipping these outputs to their respective markets, and relative market prices, will determine the optimal location as well as optimal product mix and level of operation.

Substitution analysis is not only applicable to the monetary sphere of life. The payoff of an action or the utility of an experience may include non-monetary values such as individual satisfaction. In the process of maximizing his personal utility function, the individual may, for example, substitute between time and space variables. In the search for his optimal recreation location, he may be able to identify combinations of *places* at varying distances and recreation *periods* of varying lengths of time which would be equally "dear" to him. Sets of other combinations of places and periods would, correspondingly, specify other, higher or lower, levels of equal satisfaction. With a given vacation budget, the individual will choose that combination of vacation length and location which will reach the highest of these utility levels.[29] Households selecting residential sites may substitute between proximity to the city center and residential density.[30] A more realistic model would take into account that a constantly growing share of households are "liberated" from simple "job-of-husband-determinism" and the traditional downtown orientation in their choice of residential locations due to earlier retirement, higher standard of living, extended weekends, longer bearable commuting distances, general improvement of communication, increasing significance of continuous education, and other economic and sociological factors. In fact, for an increasing part of the population the residential location decision seems to become dominant over many aspects of job selection.

Realizing that the recreational component of the residential function is increasing, one may search for an analytical continuum along which the household chooses individual locations or systems of residential and recreational locations which are best suited for its collective monetary means, professional and educational activities, preference functions, and the household's collective position in the life cycle. Clearly, under such conditions, the pluralistic characteristics of a household in terms of age, sex, and preference patterns would also call for something more than a mono-objective decision-making model. Finally, farmers and most other individuals are continuously substituting between increases in leisure time and increases in monetary income since mere maximization

of either one does generally not lead to an overall maximization of satisfaction.

SCALE ECONOMIES AND "EXTERNAL SAVINGS." One of the most influential, but least understood phenomena in location theory, is the locational impact of *size,* or in specifically spatial terms, *agglomeration* and *juxtaposition*. Generally, a distinction is made between advantages *(economies)* and disadvantages *(diseconomies)* generated by size, agglomeration, or juxtaposition. A large commercial establishment or public utility, or a large household (cheaper by the dozen!), may be able to secure significant savings from operating on a large scale in one or more spheres of its operations. Other functions may be detrimentally affected by their large scale. Such "internal" economies or diseconomies may be contrasted with equivalent "external" savings. Independent of its own size, the individual production plant, administrative office, or household may benefit or suffer from the actions of other units in relative proximity. External economies of agglomeration and juxtaposition may accrue to the individual unit, either by the ease of interaction with other firms or households, or by the more efficient joint use of facilities, such as public utilities or business services.

However, an overload of natural or man-made capacities may turn agglomeration economies into diseconomies.[31] Such diseconomies may have relatively short-term characteristics and be eliminated by appropriate adjustments, for example, by removing a bottleneck in the transportation system. Others, particularly those caused by unwise, long-term utilization of land in the past, can be overcome only in the long-run, or perhaps not at all. In their attempts to overcome these locational frictions, and to adjust efficiently to their external environment, individual decision-makers are assisted by a certain degree of substitutability of internal and external economies and diseconomies. Striving for high or sufficient profits or incomes, low costs or high levels of personal satisfaction, individuals or organizations may achieve necessary economies either internally or externally. A small commercial outfit may do well in a large city, but would not survive in a small village. Large corporations often have the ability to split their functions into more or less independent parts and stages. Such bundles of functions may then be individually large enough to achieve internal scale economies and, simultaneously, can make use of agglomeration economies by locating in Manhattan, or avoid congestion and other locational strains by locating in the suburbs or rural areas.[32] Households located on an isolated Pacific

island, or in the center of New York, *may* be able to compensate for the lack or oversupply of agglomeration effects by "temporal substitution" of their locations, such as appropriately timed relocations or recreational periods.

The foregoing discussion has made it clear that the significance of the substitution principle in the sphere of location theory is not limited to the day-to-day consumption and commuting pattern of the household or the production process of the manufacturing plant. Practically all functions performed by an individual or an organization have some inherent flexibility and are subject to structural change during processes of internal growth or decline or external change. This may be particularly relevant for the organizational level; there is an infinite number of ways in which a corporation, a shopping center, a fire station or even a household, can be organized and managed; many of the relevant variables are spatially sensitive. Substitution may, finally, also occur in the determination of an optimal set of other external relationships of an individual unit — outside the immediate consumption and input-output sphere. A wide range of cooperative and "quasi-integrative" linkages between individuals or organizations may be open as (partial) alternatives to corresponding independent actions.[33]

DYNAMIC INTERPRETATION. The extent to which substitution processes and various iterative procedures can actually be interpreted as successive steps of locational adjustment largely depends on the adaptability and mobility of the individual or firm, for instance, in terms of relocation costs. The tramp looking for a semi-permanent residence may actually try successive locations suggested by his iterating mind, whereas a less mobile person, or the location decision-maker for a new steel plant, may precalculate some or all moves and then "skip" to an intermediate or final location. It is difficult to visualize that these and other actual adjustments occur in a time-less setting. An inclusion of a time dimension would, in turn, be realistic only by allowing other variables to change over time, particularly externally controlled variables such as the state of technology and market conditions. Pursuing such extensions further, one not only appreciates the beneficial simplicity of static analysis and its static optimum, but also realizes its limitations, and rather opts for an "optimum path of locational adjustment through time."[34] The following framework more specifically investigates some of the factors which characterize the internal mechanism of such adjustment processes.

Internal Factors in Locational Adjustment Processes

In addition to many other biases in the development of location theory, the almost exclusive consideration of "external location factors," such as transport and labor costs, has been particularly detrimental to successive theoretical sophistication. "Internal location factors," that is, spatially sensitive components of the decision-making system such as preference patterns, organization, or investment structure, have been — in good Weberian tradition — largely neglected. Acknowledging the significance of the internal workings of the production process had been a major breakthrough; however, a modern corporation is still not adequately represented by an oversimplified production function.

A fairly large number of empirical location studies has become available in recent years which explore factors responsible for location decisions of manufacturing firms.[35] Most of these studies were designed to assign *ex-post* priorities or ranks to external rather than internal factors. Thus, "labor costs," "market advantages," "availability of suitable plant site or building," "reasonable or low taxes," and "industrial climate," were factors often mentioned. Among the factors which could be interpreted as "internal" were "integration of several offices," "difficulty of expanding parent plant," and, what seemed to have been a surprising finding at the time of the first of these studies, "personal reasons." Since then, "personal reasons" have appeared and been assessed in a variety of investigations, particularly in view of their implications for regional planning.[36] How should the significance of "personal reasons" behind location decisions be evaluated, if such findings result from large surveys and relatively little is known about the particular circumstances? The following is a summary of propositions:

(1) The "reasons" and ranks stated in these investigations should be considered only as one type of evidence. They must be supplemented by empirical scrutinization of the actual choices and of the individuals who make these choices in order to judge "just what his choices mean relative to his true values." [37] The motives are not precise representations of causes and are themselves intertwined with each other in a rather complicated fashion. They overlap, diverge, cross and merge and it seems hardly possible to separate "personal" distinctly from "economic" motives. There is a dynamic process preceding any location decision which involves the personal life of the decision-maker and his family and their residential location, a process "in which are merged known facts, supposed facts, acknowledged goals, dreamed goals, experience and expectations" about material (in-) conveniences, social and physical amenities and social and economic pressures and ambitions — "all weighted ac-

cording to some secret coefficient. These personal equations . . . may never become accessible to direct study."[38]

(2) Personal preferences may influence the location decision, but other decision variables (such as type of activity) may be less subject to personal constraints.

(3) Personal preferences may influence a location decision on a regional level; the specific sub-region, the locality, and the site may still be selected on appropriate economic grounds.

(4) "Personal factors" may well be quite profit-oriented, particularly if they involve existing friendships, local contacts, or the proximity to a golf course or night club.

(5) Personal preferences of the individual "entrepreneur" may more or less be equivalent to those of middle- and high-level management personnel and R & D engineers in large firms whose "personal" wishes have to be increasingly taken into account in location decisions in terms of availability of educational, cultural, and recreational facilities as well as climatic conditions.[39]

(6) If one concedes that entrepreneurs make location decisions under non-economic constraints, one may wonder how they survive. It has been suggested that a "range of tolerance" may exist in the form of a scope of entrepreneurial actions or locations which are not exactly optimal but which are covered by an existing profit margin.[40]

(7) Tiebout[41] interpreted this locational tolerance as a dynamic process. Firms may or may not start out in an optimal location. The survivors of a subsequent economic selection process then are those firms which have either actively tried to adapt themselves to the economic environment or have been successively adopted by it, possibly by a subsidizing government. This process of environmental adoption may or may not result from the existence of the firm and may or may not have been anticipated by the decision-maker.

(8) Finally, entrepreneurial perceptive and interpretive abilities may fail when questions are related to "personal factors." At least, it seems reasonable to suggest that the individual's *ex post* evaluation of factors responsible for a past location decision may also have been adapted or adopted in the interim.[42]

INTERNAL INVESTMENT CONSIDERATIONS. It has been repeatedly pointed out that the majority of today's non-residential location decisions do not involve *new* locations but are, in fact, "in-site" decisions.[43] In addition, they are undertaken by large multi-branch corporate systems rather than by new and single-establishment organizations.[44] Both aspects justify, if not require, approaching location decisions as special cases of investment decisions by which the firm adjusts quantitatively, qualita-

tively, and possibly spatially to some exogenous change or some endogenous stimulus. More specifically, such adjustments may be motivated by the wish or necessity to *expand* (which may or may not be possible at the old location), to *consolidate* (e.g., a number of small plants into one large one), to *relocate per se*, or to *change, reduce*, or *diversify* the production program or its markets. Thus, not only does an expansion investment contain locational decision components, but so does a rationalization investment, a re-investment, or a failure to re-invest at a specific location.[45] From a spatial point of view, investment decisions of all possible spatial shades may take positions along a continuum between two poles: the traditional "actual-location-and-nothing-else decision" (Weber-type) at one end; the nonspatial, in-site decision (Thünen-type adjustment to a location) at the other.

For manufacturing firms, it is generally assumed that spatial adjustments in terms of relocation have more long-run characteristics than most forms of in-site adjustments. To what extent this is actually the case will depend on the life periods of buildings and machinery, their economic mobility and degree of specialization, the marketing and research planning periods for new production programs, and many other factors. An important aspect, then, is the initial consideration of future short-run adjustment ability for any long-run location decision. In less esoteric terms, we are interested in "flexibility" as a location factor. Fleming, in his classic article on European coastal steelworks, was primarily interested in this "adaptability to change" once an integrated steel complex has been established:

> The individual plant must react to changing conditions that constantly alter supply and market areas. No plant is perfectly situated in this respect. . . . However, many permissive locational factors have emerged in modern times . . . the development of a wider geographical range of input sources and market outlets, the development of substitute outputs, an increase in the variety of feasible production processes, and improvement in transport connections, labor mobility, and financing possibilities.[46]

Fleming concluded that this higher successive flexibility in the choice between alternative reactions to environmental change was one of the primary factors for the initial location decision.

Individuals, as well as firms, have more or less distinct notions about their future in terms of status, income, profits, or size of operation. Whether and how rapidly these plans will be implemented will depend to a large extent upon the path taken toward such goals. This path has,

among others, a distinct spatial dimension, since optimal locations for young, low-income families, or small, inexperienced firms, may not coincide with those of higher-income families, or larger firms in other stages of their life cycles or expansion paths. Speculative location decisions which neglect the necessity of optimal intermediate steps, for instance, the accumulation of knowledge, contacts, and capital, may lead to growth rates which are smaller than those required for reaching the initial long-term objectives.[47]

Thus, it seems not to be sufficient to strive for either short- or long-run, basically static, locational optima, but for procedures which lead to successive optimal locational adjustment capabilities through time. The individual or firm, while striving for short-run flexibility, is nevertheless — in intervals — forced to enter long-run commitments. Strategies with different time horizons assist the individual decision-maker to tune his locational adjustment policy accordingly. For manufacturing firms with relatively immobile capital investments, for example, spatial adjustments would be assumed to be impossible in the short-run, at least for the one-plant firm. Multi-plant firms may achieve spatial adjustments by changing type and intensity of use of existing capital goods differently at different locations. The *medium-run* can be characterized by the firm's ability to change capacities at existing locations. Again, multi-plant corporations can pursue a spatially discriminating investment policy. The *long-run* type then refers to the actual determination of a new location (long-run due to the long planning period required and the long capital commitment). However, there are numerous ways to reduce the long-run consequences of such decisions, for example, by following a relocation policy of small steps. Small workshops may be acquired and successively expanded into a branch plant, possibly absorbing the parent plant in subsequent steps if the particular location has proven successful.

The foregoing discussion demonstrates some of the advantages which (a) expanding or consolidating firms and (b) multi-locational (multi-regional, possibly multi-national) corporations enjoy with respect to a continuing, relatively short-run flexibility in their locational policy. With a reasonable divisibility of capital goods, and a relatively small minimum-efficient plant size, such firms may — possibly without actually reducing their activities at established locations — shift their locational center of gravity [48] into more favorable directions, or withdraw from less favorable corners of the corporate region. Less rapidly growing, or stagnating,

firms achieve locational change by shifting necessary re-investments to other locations.[49] Such shifts are greatly facilitated by the (possibly planned) existence of groups of capital goods which need replacement roughly at the same time. The occurrence of such favorable moments for relocation can generally be quite accurately forecasted. Households are subject to similar "special occasions" during their life-cycle, most of which are, at least, in a probabilistic sense, predictable: marriage, or the necessity to enlarge the home to accommodate the offspring, offers opportunities to change the residential location, as does a corresponding contraction of the household, the event of a fire, an eviction, or a sudden loss of income.[50] It is suggested to explore such time-space fields within which adjustments take place in some more detail.

Location and Individual Action Spaces

This third framework more specifically recognizes the individual in a time-space continuum. It focusses on networks of technological, financial, and personal contacts of individuals, possibly as representatives of households, firms, and other organizations. The links in such a network may refer to: (1) physical transportation of goods and persons such as commuting, shopping, or input-output relationships; or they may (2) refer to patterns of influence in terms of managerial, administrative, ownership, and other control functions; and finally, (3) may involve links within fields of information from which the individual or firm draws information about the state of the environment in general and locationally relevant information in particular. The actual manifestation of the links may take the form of a ride on an overloaded commuter train, the exchange of messages via a satellite relay, or actual face-to-face negotiations between individuals. Urban and regional economists and economic geographers have used a variety of regional and interregional input-output models and other flow-analytic methods, as well as network models, to investigate flows of goods and services. Less literature is available on financial flows, and considerably less on the spatial aspects of interpersonal communication patterns.[51]

Linkages differ in their sensitivity to physical distance which has to be overcome. Economic distance in terms of transport costs as a barrier for the shipment of goods and persons has received wide attention in terms of theoretical deduction, empirical verification, as well as inductive generalizations.[52] While there seems to be a general trend toward decreasing significance of *transport costs* for location decisions, this

trend is highly differentiated among industries, different competitive situations, transport modes, types and size of load, as well as transport services with different time constraints.[53] Changes in transport cost patterns, and inter- as well as intra-modal substitution processes, thus result from changes in the time constraint (e.g., due to interest rate changes), changes in the intra- and inter-modal competitive situation (e.g., based on a merger of railway companies), and a variety of other economic and technological forces. In passenger transportation, the increasing differentiation of transport modes and networks with respect to speed seems to be the most significant trend. This applies to intercontinental transportation as well as to intra-urban commuting, and has been most markedly affected by technological developments and rather controversial public investment decisions in favor of freeway constructions and development of supersonic planes. However, there is a social and economic premium on speed which is largely responsible for preventing outright substitution of slower media by speedier ones. Consequently, distance is becoming a less absolute barrier to commuting and travel, but one which is heavily dependent on incomes, preference schedules, family structure, and roles performed.

Communication costs, on the other hand, have been widely neglected, even though, as a Dutch study showed, they seem to be considerably more effective as constraints for actual action spaces than physical transportation costs.[54] Many types of personal contacts can be maintained effectively by ever improving means of telecommunication and are, therefore, unlikely to influence location decisions. Indeed, Webber [55] suggested that "never before have men been able to maintain intimate and continuing contact with others across thousands of miles; never has intimacy been so independent of spatial propinquity." However, there are contacts which can be cultivated only by face-to-face communication of individuals. In the case of manufacturing firms, "these contacts demand the personal attendance of often highly expert personnel," which probably is "bound up with the fact that the contacts in many cases involve considerable elements of what we might call problem-solving, planning, keeping an eye on the course of events, pulse-feeling, and reconnaissance." [56] More specifically, personal communication with other producers, consumers, financial institutions, and local governments may result in faster service and deliveries, easier contact on special requirements, the possibility of holding smaller stocks, better knowledge of population characteristics in terms of habits, language, special tastes,

speedier information about and more efficient reaction to changes in the market place, better mutual understanding through frequent visits, and fewer misunderstandings.[57]

For convenience, the concept of action space shall be divided into three stages of analysis: (1) the individual or organization has a potential, a perceived, and an actual action space; (2) there is a location or home base within the action space; and (3) locations and action spaces may be subject to change and adjustment.

(1) ACTION SPACE. The potential action space is limited by financial, technological, institutional, and biological constraints. The person restricted to moving around in his private automobile can define a radius around his residential home which he can reach within a certain time; so can the truck driver performing a delivery function for his firm define a maximum radius around his home-base, independent of whether he actually covers this distance or not. Highly paid and mobile executives define their weekly action radii in terms of flying time. The average person, such as the undistinguished college professor, has a rather simply defined "daily prism" for his potential action space with few or no prospects of breaking out.[58]

Let us follow Webber's [59] proposition and disaggregate action spaces further by identifying spatial mobility and circulation patterns in terms of the specific roles which the individual performs, for example, as an internationally known scholar, college teacher, grocery shopper, service club member, parent, husband, relative, or friend. "Each of the many

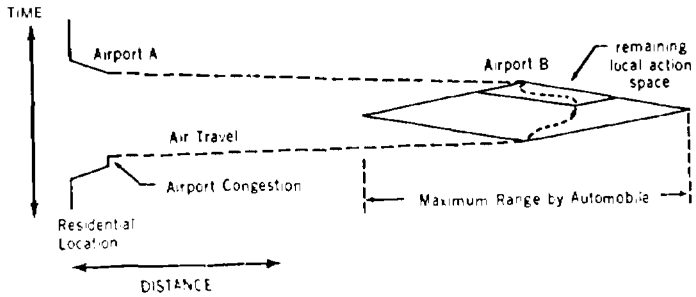

FIGURE 2

Potential and Actual Daily Action Space for Corporate Manager with Time- and Location-Constraints (after Hagerstrand, 1970)

communities to which he belongs has his own set of peers, each set distributed within spatial realms somewhat different from each of the others." [60] Thus, the individual may have a spatially extensive, cosmopolitan action space for some or all of his occupational pursuits, while maintaining a "place-based," spatially-constrained private action space at home.

In making decisions for actions or paths within his potential action space, the individual is constrained by (a) his *perception* of his possibilities and (b) his *preferences* both constraints have space and time dimensions. It appears that there are wide variations in potential and perceived action spaces of individuals, and Isard [61] suggests a high degree of substitutability between time and space preferences, resulting in a wide variety of actual or revealed action spaces. However, it seems equally accepted (although empirically not yet systematically tested) that regularities do exist within socio-economic groups of individuals.[62] It is suggested that these regularities are primarily based on what Hägerstrand calls "coupling constraints" which limit the "where, when and for how long time the individual has to join other individuals, tools and materials in order to produce, consume or transact." [63]

Social, cultural, technological, and economic complementarities incite individuals to form "bundles" with other individuals and material goods to jointly walk along time-space paths in car pools, lecture classes, conferences, and moon capsules. Clearly, there are corresponding constraints which make it opportune for the individual to bundle some of his roles along his time-space path like visiting relatives while on a business trip.[64] The design of transport links can similarly be interpreted as a more complex case of bundling future movements on the bases of efficiency criteria and spatial constraints, since "bundling reduces total length of required network links, thereby reducing construction costs." [65]

(2) LOCATIONS. The individual household or firm occupies a residential, office, or plant-*location* which ideally represents a weighted center of his multi-level, multi-dimensional network of technological, financial, and human ties. Some of these ties are highly sensitive to distance and, thus, constitute traditional "location factors" even though some of them may have been established long after the location had been initially selected. Home base locations have to be found for stationary as well as for mobile activities. For mobile shops or travelling salesmen, for example, optimal home locations are selected on the basis of efficient routing possibilities and, thus, are highly dependent on the distribution

of markets within a transport network.[66] More generally, residents of highly nodal areas have the advantage of relatively great "exposure to information covering relatively more extensive area of choice." Their contacts and interaction reach potentially further and "the likelihood of an unbiased and representative action space is greater." [67]

Large organizations, such as multi-plant and multi-warehouse corporations, or multi-hospital medical service systems, assemble "bundles" of individuals and material goods with changing composition at different locations. The optimal size, structure, spacing, and specific location of "bundles" is determined by the characteristics of the interaction patterns within and between bundles of any one system, and between systems, as well as by the state of the technological, institutional, socio-economic, demographic, and political environment.[68]

(3) CHANGE AND ADJUSTMENT. Networks of linkages and contacts change through time due to (a) "internal" changes on the part of the individual (e.g., changing preferences, changing evaluation of and response to unchanged opportunities, inconsistent behavior, changing budget constraints, or physical fitness), or changes within an organization such as change of objectives, or due to (b) changes in the external environment such as changes in the distribution of opportunities.[69] Correspondingly, individuals or organizations may find themselves outside their networks of spatially sensitive links, or find their web of ties "shrivelling away" when friends have moved out of town, business friends have died, gone bankrupt, or been indicted as Mafiosi, newspapers have ceased publication, government agencies or corporate headquarters have consolidated or relocated.

Adjustments may take the form of a locational change within the network (relocation), or of a change in the capacity or type of network links. This adjustment process — whether it takes place incrementally and continuously or abruptly and in large steps — is itself dependent on the individual's communication network or information field: sufficient information for planning a change must be gathered. More drastic changes involving uncertainty about other places and about the future may overburden the private, day-to-day information field of the individual or firm; it may be decided to make use of the specialized information fields of travel or real estate agents, location consultants, or trusted friends with wider or different locational horizons. Such information is not always free, but the expense of a location survey can be weighted against the opportunity costs resulting from having to make a "safe" location decision in a possibly high state of uncertainty. It would be

naive to assume that flows of information are free of exerted or subtle pressures to conform to accepted social rules or to cooperate with the distributor of information such as the real estate developer or the regional planning authority in the pursuit of his own goals.[70] It therefore follows, as Pred has suggested,[71] that private information fields may not just be a source of information, but a more or less significant determinant of the use of information in choosing among alternative options.

Once the relocation has taken effect, the often painful process of breaking off old ties and establishing a new web of contacts and technological linkages may initially be postponed due to human inertia, the existence of friendships, and environmental familiarity with the old location. A second stage may involve the adjustment to "the accepted way of doing things" in the new environment, that is, the creation of ties and the cultivation of contacts under the rules of the local customs. And, possibly as a third stage, one may recognize attempts of the newcomer to break out of the established set of rules and channels of communication in order to introduce new patterns that have proved to be more efficient in the old environment and may be adapted to the new one. However, due to substitutability between internal and external economies, other strategies are conceivable which are less dependent on external communication and technological ties. Large corporations may be able to overcome adjustment frictions of new branch plants by a massive initial injection of internal economies on the plant and interplant level, thus exempting them from immediate external economic adaptation. A still different, more Darwinian, strategy would be that of a firm which sends a large number of small branch outfits into foreign territory, quasi behind the lines, to let them struggle by themselves for viability prior to being organizationally integrated into the corporate empire. Here, no doubt, the highest demands are placed on the pioneering abilities of the individual branch manager, mainly in terms of establishing the initial local and regional communication networks required for successive survival.

Similarities between changes of communication networks of individuals and firms, as well as between different locational behavior, arise from common sex, age, social and economic organization, profession, and type of activity. Aggregate surveys in demography and industrial sociology have shown that technological linkages and fields of human contact, as well as the locational behavior of individuals, households, and firms, depend to a certain extent on their position in the human, organizational, or material life cycle in terms of age, years of marriage,

state of depreciation of buildings or machinery.[72] Children, for example, establish personal networks, or change their locations, entirely dependent on their parents, at least in their early ages. This dependence decreases with age, and it does so faster for the field of contacts than for locational choices.[73] Although life cycles are obviously less compelling for organizations than for human beings, manufacturing firms, for instance, have, particularly in their early ages, certain empirically established age- and size- specific growth-, mortality-, and relocation probabilities.[74]

Locational Decision-Making Processes

Finally, this last framework makes selective attempts to place earlier considerations into a more operational setting and to draw the procedural consequences from the repeated call for more dynamic and decision-oriented location models.

Since location decisions usually have a time dimension and "involve many people, it appears meaningful to talk of a decision-making process." [75] It also has been suggested that such processes and final decisions show significant differences for individuals and organizations; one is inclined to agree with Cyert and March [76] that it is naive "to assume that organizations go through the same process of learning as do individual human beings." Two characteristics of organizational decision-making seem to stand out: (a) It is more likely that, in an organization, a compromise is reached rather than a narrowly determined, "most efficient" decision due to the differences in goals and available information of individuals in different positions within the decision-making hierarchy. (b) On the other hand, patterns of individual preference or locational idiosyncracies are less likely to encroach upon a location decision of an organization; it "maintains its role structure amid a flow of constantly changing individual persons occupying these roles. Men are continually hired, fired, promoted, and demoted. They join and resign." [77] Corporations can adapt by exchanging decision-makers who, in turn, can make "personal" location decisions without affecting the location of the organization.

For analytical purposes, it seems appropriate to distinguish between the following three levels of locational decision processes: (a) the *simultaneous*, analytical solution which has the image of an instantaneous decision; (b) the "lengthy, *complex process* of alerting, exploring, and analyzing that precedes that final moment"; [78] and (c) the *sequence* of decisions leading "to processes of adaptation and/or learning which give

a particularly faithful reflection of human behavior in an evolutionary milieu." [79]

The instantaneous decision may be, quite unrealistically, represented by the "aye" of the eleventh member of the Board in a 6:5 majority decision on the location of a branch plant, or by the phone call to the mother-in-law "breaking the news" of the forthcoming "locational adjustment" of the family size to the suburban multi-children-family neighborhood. Analytically, it refers to the equilibrium solution of traditional location models à la Thünen and Weber. All the information required for the decision is assumed to be collected and the constraints have been established and are inflexible. Processes of information collection and evaluation as well as sub-decisions which resulted in the constraints for the final "aye" are not considered.

Alonso has provided this analytical equilibrium with a real-world image. Individuals and firms "searching" for their intra-urban optimal locations make "bids" for land (at different locations) on the basis of their individual utility and budget functions, and "landlords will sell or rent the land to the highest bidder." [80] Thus, not only will the location of the individual firm or household be determined, but also the land use *pattern* within the city.

A more concrete bidding procedure is described by Stevens who — in a game-theoretic setting — presents two competitors who are allowed to submit simultaneous bids for three turnpike service franchises. Having equal bidding funds, but no knowledge about the other competitor's allocation plans, the individual bidder is left with the "choice of bidding on any one, any two, or all three locations." [81]

Hotelling's classic ice-cream-vendor-on-the-beach model supplies a further example for the uncertainty a location decision-maker may face in view of the existence of a non-cooperating competitor as well as for a simultaneous, game-theoretical solution. However, the model can also be interpreted as a process of successive adjustments. Suppose that 40 customers are distributed along the beach, each buying one cone per day (Figure 3). Seller I enters at a, seller II subsequently at b, I moves

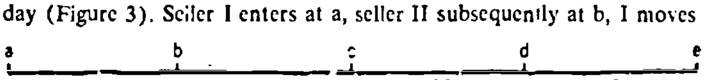

FIGURE 3

Linear Market (Beach) with evenly distributed demand and five potential locations (see text)

to c, and II finally follows there (Tables I and II). By then, all advantages will have vanished.[82] Modifying this basic procedure, one could assume that seller I has a distinct lead time during which he accumulates

TABLE I

Combined Payoff Matrix for Sellers I and II. (With Inelastic Demand)

SELLER I \ SELLER II	a	(2) b	(4) c	d	e
(1) a	20 / 20	35 / 5	30 / 10	25 / 15	20 / 20
b	5 / 35	20 / 20	25 / 15	20 / 20	15 / 25
(3) c	10 / 30	15 / 25	20 / 20	15 / 25	10 / 30
d	15 / 25	20 / 20	25 / 15	20 / 20	5 / 35
e	[illegible] / 20	25 / 15	30 / 10	35 / 5	20 / 20

TABLE II

Distribution of Payoffs during 4 Periods

	Location and Payoff	
	Seller I	Seller II
1. period	(a) 40	—
2.	(a) 5	(b) 35
3.	(c) 25	(b) 15
4.	(c) 20	(c) 20

profits before seller II arrives. Plausibly, seller I could use his profits to try to squeeze II out of the market by undercutting his price, improving his own product quality, or, more interestingly, by establishing a branch-ice-cream cart.[83] Alternatively, we could assume that all these adjustment procedures are unavailable, and that the funds accumulated by sellers I and II can only be used to finance relocations, which, in turn, would then be constrained accordingly.

Another set of location problems which lends itself to the application of game-theoretical procedures is characterized by the following situation. Two or more individuals, firms, or community governments have a common interest in achieving scale or agglomeration economies by a specific joint action, such as establishing a cooperative laundry or a large-scale waste-disposal plant, but have different ideas about the best location of such a facility. Each participant would prefer the new location as close to his own home base as possible; however, he is prepared to yield proximity, in order to maintain the cooperative spirit, as long as his savings from cooperation still outweigh the costs resulting from the additional distance. The critical boundaries thus defined delimit the participants' "joint action space." The spatial configuration of the participants' initial location, their size and corresponding ability to achieve internal scale economies without cooperation, the availability of alternative cooperative opportunities (namely, to agglomerate in other directions from their initial location), and a number of other factors will determine the power structure among the participants.[84] To solve this bargaining problem within the joint action space, several gaming strategies have been suggested by Isard [85] with such pragmatic labels as "split-the-difference incremax procedure," "distance-decrement concession procedure," or, simply, "distance compromise procedure."

More complex situations arise where participants attempt to share in the scale economies of a joint action without being affected by the actual or perceived external diseconomies of close proximity to this type of operation, be it a supersonic airport or an atomic power plant. In order to avoid inconsistent bargaining, resulting from their "split personalities," the gaming participants may have to supervise simultaneously sub-games among the different interest groups within their respective communities.

A similar situation could be identified where the agglomeration project is designed after individual locations have already been separately established. The individual may then have the alternative either to shut down

or relocate his operations, or to participate in the project in addition to continuing his separate establishment. In the event he decides for relocation, his strategy would be aimed at minimizing the distance to his old location in order to disturb as little as possible his established interaction network. Conversely, should he decide for a second plant or store, he may be interested in locating the cooperative undertakings as far away as possible from his first location in order to establish a new and independent network and to avoid competing with himself. Such a situation is likely to occur when retail stores wish to participate in a shopping center or neighboring metropolitan cities build their second or third airport in cooperation. In both cases, it may happen that the individual participant in the locational bargaining process alternates in the course of the negotiations between his two strategies, namely, either minimizing distance and giving up the old operations, or maximizing distance to the initial location.

For a discussion of household location decisions a situation could arise which is similar to the one discussed in Framework I. Major constraints for the game between husband and wife are likely to be set by the characteristics of the husband's occupation and by the demographic characteristics of the household.[66] However, the possibility that the wife's work may also be a significant factor, and that the wife's interest may not be adequately represented by the slogan "I am happy wherever my husband will be happy," and, finally, that both, either alternatively or consistently may not follow their own preference function but try to perceive and follow the one of the partner, would make the gaming process more interesting but also more complex.

Uncertainty about the future state of the economic and physical environment is caused by a diversity of factors and affects individual decision-makers in many ways. Uncertainty, lack of experience, and inability to bear risks may make it unfeasible for the young farmer to cultivate crops which are profitable in the long-run but highly speculative in the short-run; a young firm will, correspondingly, prefer not to operate immediately on a multi-plant, multi-product level; instead, it will "put in a small amount of capital, and then, as it gains experience and becomes better informed, gradually invest more capital."[67] The accumulation of experience, information, business and market connections, reputation, profits, and capital does not occur in a world without dimensions: changes take time and proceed over space. The literature supplies ample evidence that both processes can occur in an orderly, predictable fashion.

Gould's [88] now classic model of the Ghanaian farmer dueling with nature represents a convenient starting point of a dynamic behavioral model in which these considerations could be meaningfully incorporated.[89] Changing weather conditions represent a major source of uncertainty to which the farmer has to adjust in some measure. Gould's "maximin" solution is clearly based on the assumption that the farmer — entirely independent of his information level and intellectual abilities — is forced to organize his farming activities in a short-run fashion. Unless he is absolutely certain that there will be no unfavorable season in the future, he has to "play safe" and decide on a pattern of cultivation which guarantees the subsistence level for his family whatever weather conditions will prevail. A subsistence farmer, similar to a firm operating with substantial amounts of short-term, borrowed capital, cannot, at a sufficiently low level of income, "accept a higher, but less stable income except where it would necessarily always be above his subsistence level." [90]

A dynamic modification of Gould's model would begin with making provisions for breaking out of this "low-level-equilibrium trap." Two conditions need to be successively fulfilled before the farmer would be in a position to alter his previous pattern of cultivation. First, he has to have or gain some notion of the probability of the occurrence of certain weather conditions; and second, he has to have or accumulate the economic means, in terms of material stocks or monetary funds, to make long-run plans and be independent of nature's short-term irrationality. In addition, one may wish to know how much information and reserves farmers, in specific cultural environments, tend to accumulate before they actually change their production schedules.

In a normatively-oriented model one could assume that objective rain probabilities have been determined from the historical meteorological record.[91] The effectiveness of these external probabilities could be enhanced by more or less reliable weather forecasts, as well as by certain "internal" information. For example, "by measuring the amount of moisture in the soil the farmer greatly reduces the risks he takes when he decides what to plant. He still can't be sure of the other part of the equation — the rainfall — but he knows that the wetter the soil is at planting time, the heavier are the odds for a good cash crop." [92]

In a more behavioristic approach it could be assumed that the farmer relies on his father's and grandfather's experience. Instead — or in addition — one could let the farmer "take account of actual occurrences ... updating the initial conditions each time on the basis of the previous

observations."[93] There are two ways to let this happen. A more behavioral path would be based on subjective generalizations made by the farmer on the basis of successively increasing information. Such subjective probabilities are then based on a variety of (e.g., personality) factors and will result in a variety of individual behavior. In a more normative approach, one could generate internal, increasingly denser probabilities based on objective statistical procedures. Such a model would be a more profound normative model, compared with the probability model using the "objective" historical record, since it would reflect the cognitive limitations under which a farmer has to act in a real situation.

The successive accumulation of reserves, which are the prerequisite for the ability to make use of these probabilities and to "speculate" on higher future incomes, depends on such factors as: the farmer's preference for leisure; changes in this preference pattern; the saving, consumption, and investment (storage facilities) propensities; the farmer's initial ability to "take-off" from the level of subsistence by accumulating a very basic stock which would not disappear again; and, last but not least, the behavior of the market in terms of price fluctuations. So far, it had been implicitly assumed that the farmer had proceeded through a process of improving the subsistence life for himself and his — most likely steadily increasing — family by short-term stockpiling or by increasing his productivity via self-produced capital goods and substituting his increased time by leisure activities or by improving his diet. At what stage he will actually enter an exchange relationship with a market, and subject himself to price fluctuations, will depend on numerous additional factors, many of which are of a spatial nature such as transport costs, diffusion of market information, and the activities of agents. Suppose empirical findings have determined threshold situations on the basis of which transitional behavior (changes from subsistence to commercial farming and vice versa) could be predicted. Now, the above model-like concepts could be extended to include market uncertainty, for example, along the lines recently suggested by Day and Tinney and Hurter and Moses.[94]

Conclusion

In this chapter, four conceptual frameworks were designed to represent the development of location theory during the last ten to fifteen years, particularly the more recent thinking of geographers working in this field. Yet, due to various constraints, this presentation remains incomplete and biased. Among the more important aspects which had to

be omitted were "Central Place" and related pattern concepts as well as diffusion and pattern development concepts which, however, are covered by Chapters 4 and 2 respectively.

Biases encroached upon this presentation, for instance, in the form of an overemphasis on "internal" location factors and decision-making processes. It was felt, however, that the long domination of "transport costs" and other "external" location factors in the theoretical and descriptive geographic literature, as well as the most recent research trends in theoretical geography, justified this biased approach.

The four frameworks have been presented with little reference to graphs and diagrams, and without any reference to mathematical formulae. Whereas graphs presenting distance and other variables require lengthy explanations, are quite limited in their scope, and are extremely well covered by the standard literature in location theory, this is all quite different with mathematical formulations, which, no doubt, will increasingly be introduced into locational theorizing. On the other hand, this author firmly believes that the future of location theory does not solely belong to sophisticated mathematical decision models; at least equally it belongs to a body of "middle-range" concepts which will continue to grow for the multiple purpose of being the foundation for understanding and teaching models, of representing the transitional zone between empirical findings and their feedback into high-powered mathematical models, and of forming the breeding ground for intuitive ideas and speculative, deductive concepts which are so essential as intellectual inputs for mathematical model builders.

FOOTNOTES

[1] A broad institutional definition for Location Theory was introduced by the National Academy of Sciences Report which identified "Location Theory Studies" as a new subsystem within geography having emerged from the traditional subfields economic, urban, and transportation geography on a "higher level of generalization." National Academy of Sciences — National Research Council. *The Science of Geography*. Report of the Ad Hoc Committee on Geography. Washington, D.C.: The Academy, 1965. See pp. 44-53.

[2] Recent surveys of Location Theory include Thoman, Richard, Conkling, Edgar C., and Yeates, Maurice H. *The Geography of Economic Activity*. Second edition. New York: McGraw-Hill, 1968. pp. 147-215; Hamilton, F. E. Ian. "Models of Industrial Location." in *Models in Geography*. Chorley, R. S. and Haggett, P., editors. London: Methuen, 1967. pp. 361-424; Harvey, David W. "Theoretical Concepts and the Analysis of Agricultural Land Use Patterns in Geography." *Annals of the Association of American Geographers* 56: 361-374; No. 2, June, 1966; Hoover, Edgar M. "Spatial Economics." *International Encyclopedia of the Social Sciences*. New York: Macmillan and the Free Press,

1968; and King, Leslie J. "Approaches to Location Analysis: An Overview." *East Lakes Geographer.* 2:1-16, 1966. See also the well-selected readings in Smith, Robert H. T., Taaffe, Edward J., and King, Leslie J., editors. *Readings in Economic Geography: The Location of Economic Activity.* Chicago: Rand McNally, 1968; and Karaska, Gerald and Bramhall, David. editors. *Locational Analysis for Manufacturing.* Cambridge, Mass.: M.I.T. Press, 1969.

[3] Beckmann, Martin. *Location Theory.* New York: Random House, 1968. p. 3.

[4] Pred, Allan. *Behavior and Location.* Lund. Sweden: Gleerup, 1967.

[5] Simon. Herbert A. "Theories of Decision-Making in Economics and Behavioral Science." *American Economic Review* 49:253-283; No. 3, June, 1959; and Cyert, Richard M. and March, James G. *A Behavioral Theory of the Firm.* Englewood Cliffs, N.J.: Prentice-Hall, 1963.

[6] Hansen, Niles. *French Regional Planning.* Bloomington: Indiana University Press, 1968. pp. 103-104.

[7] Friedmann, John R. P. "Economy and Space." *Economic Development and Cultural Change* 6:249-255; No. 3, April. 1958. p. 253.

[8] Detailed historical accounts of this period can be found in Ponsard, Claude. *Histoire des Theories Economiques Spatiales.* Rennes: Colin, 1958 (translation forthcoming, Regional Science Research Institute, Philadelphia) and Isard, Walter. *Location and Space Economy.* Cambridge, Mass.: M.I.T. Press. 1956. Ch. 2.

[9] Isard, Walter. *Location and Space Economy.* p. 24.

[10] Isard, Walter and Reiner, Thomas A. "Regional Science: Retrospect and Prospect." *Papers and Proceedings of the Regional Science Association.* 16: 1-16; 1966.

[11] Isard, W. *Location and Space Economy;* Garrison, William L. and Marble, Duane F. "The Spatial Structure of Agricultural Activities." *Annals of the Association of American Geographers* 47: 137-144; No. 2, June, 1957; and Moses, Leon N. "Location and the Theory of Production." *Quarterly Journal of Economics* 72: 259-272; No. 2, May, 1958.

[12] Greenhut, Melvin L. *Plant Location in Theory and Practice: The Economics of Space.* Chapel Hill: The University of North Carolina Press, 1956; and Tiebout, Charles M. "Location Theory, Empirical Evidence, and Economic Evolution." *Papers and Proceedings of the Regional Science Association* 3:74-86; 1957.

[13] For a more comprehensive statement on the research frontier in this field during the late 1960's, see the report of the geography panelists to the Behavioral and Social Sciences Survey: Taaffe, Edward J. *Geography.* Englewood Cliffs, N.J.: Prentice-Hall, 1970. pp. 53-64. See also Bartels. Dietrich. "Theoretische Geographie." *Geographische Zeitschrift* 57: 132-144; No. 2, July, 1969 for a critical view across the continental fence.

[14] Teitz, Michael B. "Toward A Theory of Urban Public Facility Location." *Papers and Proceedings of the Regional Science Association.* 21:35-51; 1968. p. 35.

[15] See Pitts, Forrest R. "Scale and Purpose of Urban Simulation Models." *Research and Education for Regional and Area Development.* Ames, Iowa: Iowa State University Press, 1966. pp. 255-262 for a brief survey of simulation models.

[16] Isard, Walter and Reiner, Thomas A. "Regional Science: Retrospect and Prospect." p. 9.

[17] Hägerstrand, Torsten. "What About People in Regional Science?" (Presidential Address, Regional Science Association, Copenhagen, 1969), forthcoming in *Papers,* 1970.

[18] Hamilton, F. E. Ian. "Models of Industrial Location." in *Models in Geography.* p. 416.

[19] Townroe, P. M. "Locational Choice and the Individual Firm." *Regional Studies* 3:15-24; No. 1, 1969, p. 24.

[20] Interested readers may consult the following literature: General introduction: Isard, W. *Location and Space Economy;* Present state of the art: Alonso, William.

"A Reformulation of Classical Location Theory and its Relation to Rent Theory." *Papers and Proceedings of the Regional Science Association* 19:23-44; 1967; Agricultural Location Theory: Dunn, Edgar S., Jr. *The Location of Agricultural Production.* Gainesville: University of Florida Press, 1954; and Peucker, Thomas. "An Extension of the Thünen Model by Climatic Factors and Technical Progress" (unpublished dissertation, University of Heidelberg, 1966); Industrial: Moses, Leon N. "Location and the Theory of Production." *Quarterly Journal of Economics* 72:259-272; No. 2, May, 1958; and Churchill, Gilbert A. "Plant Location Analysis: A Theoretical Formulation." (unpublished D.B.A. dissertation. Indiana University, Bloomington, 1966); Urban-Residential: Alonso, William. *Location and Land Use.* Cambridge, Mass.: Harvard University Press, 1964; Recreational: Böventer, Edwin von. "Land Values and Spatial Structure: A Comparative Presentation of Agricultural, Urban, and Tourist Location Theories." *Papers and Proceedings of the Regional Science Association* 18:231-242; 1967.

21 Marshall, Alfred. *Principles of Economics.* Eighth edition. London: Macmillan, 1920. Book V, Chapter 3, ¶4.

22 Isard, Walter, *et al. General Theory: Social, Political, Economic, and Regional.* Cambridge, Mass.: M.I.T. Press, 1969. p. 106.

23 Isard. *Location and Space Economy.* p 79.

24 Weber, Alfred. *Theory of the Location of Industries.* Chicago: University of Chicago Press, 1929.

25 The Weber problem still incites discussion in the literature, since there has not been any analytical method found to solve the relevant equations simultaneously for the coordinates of the optimum location. See, for example: Kuhn, Harold W. and Kuenne, Robert E. "An Efficient Algorithm for the Numerical Solution of the Generalized Weber Problem in Spatial Economics." *Journal of Regional Science* 4: 21-33; No. 2, Winter, 1962; and Alonso. "A Reformulation of Classical Location Theory and Its Relation to Rent Theory." who proposed algorithms for iterative solutions. Seymour, David R. "The Polygon of Forces and the Weber Problem." *Journal of Regional Science* 8: 243-246; No. 2, Winter, 1968. p. 245 demonstrates that "the polygon of forces technique is not a solution in itself to the Weber problem, although it can be incorporated into algorithms for iterative methods." In addition to the use of the weight triangle (a method described by Pick in Weber. *Theory of the Location of Industries.* p. 229 ff. which applies, however, only to the triangular case), the Varignon Frame lends itself well to classroom demonstration. It is suggested that teachers might apply this principle (described by Peck in Weber, *Theory of the Location of Industries.* p. 229; Tiebout. "Location Theory. Empirical Evidence, and Economic Evolution." p. 76; and Alonso. "A Reformulation of Classical Location Theory and its Relation to Rent Theory." p. 24.) to a mounted wall map with meaningful reference locations (cities, raw material, sources, etc.) as corners of the polygon.

26 Isard. *Location and Space Economy.* pp. 99-100 has demonstrated that this method can also be applied to a four- (or more) sided locational polygon. Substitution between two transport inputs can then take place by moving along arcs which hold the combined transport costs to the two other points constant (this arc being part of an ellipse, if the two locational pulls have equal weight).

27 Moses. "Location and Theory of Production."

28 Beyers, William B. "Technological Change and the Recent Growth of the American Aluminum Reduction Industry" (unpublished Ph D. dissertation, University of Washington, Seattle, 1967) correctly points out that a non-competitive market structure for one or more of the inputs may also lead to a non-linear expansion path (i.e., to changes of the input coefficients with changing output levels).

29 Böventer. "Land Values and Spatial Structure: A Comparative Presentation of Agricultural, Urban, and Tourist Location Theories."

30 Alonso. *Location and Land Use.*

[31] Recently, a distinction has been made between congestion and pollution diseconomies. Congestion diseconomies are shared more or less equally by those who contribute to congestion (in subways, museums, public beaches, or highways), whereas in the case of pollution diseconomies (resulting from air-, water-, and view-pollution and noise) contributors and victims are usually different groups of people or activities: Rothenberg, Jerome. "The Economics of Congestion and Pollution: An Integrated View." *American Economic Review* 60:114-121; No. 2, May, 1970. A more general discussion of external effects (particularly localization and urbanization economies) can be found in Weber. *Theory of the Location of Industries*. Chapter 5; Hoover, Edgar M. *The Location of Economic Activity*. New York: McGraw-Hill, 1948. pp. 190-191; and Isard. *Location and Space Economy*. Chapter 8.

[32] Haig, Robert M. "Toward an Understanding of the Metropolis." *Quarterly Journal of Economics* 40:179-208 and 402-434; February, 1926.

[33] Examples may be the sharing of an apartment by bachelors (who are thus able to afford living in a higher-class neighborhood) or licensing, subcontracting, leasing or capacity-exchange agreements between firms.

[34] Krumme, Günter. "Notes on Locational Adjustment Patterns in Industrial Geography." *Geografiska Annaler* 51(B):15-19; No. 1; 1969. p. 16.

[35] See Krumme, Günter. "Toward a Geography of Enterprise." *Economic Geography* 45:30-40; No. 1, January, 1969 for a brief review of these interview and questionnaire surveys of newly located plants.

[36] Cameron, G. C. and Clark, B. D. *Industrial Movement and the Regional Problem*. Edinburgh: Oliver and Boyd, 1966. pp. 97-99.

[37] Churchman, C. West. *The Systems Approach*. New York: Delacorte Press, 1968, p. 206.

[38] Myrdal, Alva. *Nation and Family*. Cambridge, Mass.: M.I.T. Press, 1968. p. 52.

[39] Ullman, Edward L. "Amenities as a Factor in Regional Growth." *Geographical Review* 44:119-132; No. 1, January, 1954. pp. 126-127.

[40] Thomas, Morgan D. "The Export Base and Development Stages Theories of Regional Economic Growth: An Appraisal." *Land Economics* 40:421-432; No. 4, Nov., 1964, p. 431.

[41] Tiebout. "Location Theory, Empirical Evidence and Economic Evolution."

[42] Krumme. "Toward a Geography of Enterprise." p. 36.

[43] Stafford, Howard A. "An Industrial Location Decision Model." *Proceedings of the Association of American Geographers* 1:141-145; 1969.

[44] Steed, Guy P. F. "Corporate Enterprise and the Locational Decision Process." in *The Geographer and Society*. Sewell, W. R. D. and Foster, Harold D., editors. Victoria, B.C.: University of Victoria, 1970.

[45] Danielsson, Albert. "The Locational Decision from the Point of View of the Individual Company." *Swedish Journal of Economics* 56:47-87; No. 2, June 1964.

[46] Fleming, Douglas K. "Coastal Steelworks in the Common Market Countries." *Geographical Review* 57:48-72; No. 1, January, 1967. p. 51.

[47] It is recognized that probably no other locational decision-making factor than time differs more sharply between more traditional and industrial-capitalist societies. In no other culture but the so-called Western culture of Western Europe and North America is the concept of time so thoroughly dynamic. Consequently, concepts such as the "long-run" may differ considerably in their cross-cultural meaning. See Hall, Edward T. *The Silent Language*. New York: Doubleday, 1959. Chapter 1.

[48] Dziewonski, Kasimierz. "A New Approach to Theory and Empirical Analysis of Location." *Papers and Proceedings of the Regional Science Association* 16:17-25; 1966. p. 23.

[49] Hoover. *The Location of Economic Activity*. pp. 148-151.

[50] An excellent survey and analysis of residential location behavior (in the United States) as it relates to life-cycles can be found in Taeuber, K. *et al.* *Migration in the United States: An Analysis of Residence Histories.* Monograph No. 77. Washington, D.C.: United States Department of Health, Education, and Welfare, 1968. See also Simmons, James W. "Changing Residence in the City." *Geographical Review* 58:622-51; No. 4, October, 1968. pp. 629-631.

[51] Marble, Duane F. and Nystuen, John D. "An Approach to the Direct Measurement of Community Mean Information Fields." *Papers and Proceedings of the Regional Science Association* 11:99-109; 1963.

[52] Olsson, Gunnar. *Distance and Human Interaction.* Philadelphia: Regional Science Research Institute, 1965.

[53] See "Plant Sites 1969." *Chemical Week* 59-86; October 29, 1969.

[54] Cited by Klaassen, Leo H. *Methods of Selecting Industries for Depressed Areas.* Paris: OECD, 1967, p. 43.

[55] Webber, Melvin M. "Order in Diversity: Community Without Propinquity." in *Cities and Space.* Baltimore: Johns Hopkins Press, 1963. p. 43. Wingo, L., ed.

[56] Törnqvist, Gunnar. "Flows of Information and the Location of Economic Activity." *Geografiska Annaler* 50(B):99-107; No. 1, 1968. p. 101.

[57] Klaassen, p. 43.

[58] See Fig. 2, Hägerstrand.

[59] Webber, Melvin M. "Culture, Territoriality, and the Elastic Mile." *Papers and Proceedings of the Regional Science Association* 13:59-69; 1964.

[60] Webber. "Culture, Territoriality, and the Elastic Mile." p. 60.

[61] Isard. *Location and Space Economy.* pp. 84-85.

[62] Horton, Frank E. and Reynolds, David R. "An Investigation of Individual Action Spaces: A Progress Report." *Proceedings of the Association of American Geographers.* 1:70-75; 1969 p. 70.

[63] Hägerstrand. "What about People in Regional Science?"

[64] In a meticulously researched case study, Chapman, Murray. "Tribal Mobility as Circulation: A Case Study from the Solomon Islands" (Paper presented at the Annual Meeting, Population Association of America, Atlanta, Georgia, 1970) aptly describes the complex circulatory path within the overlapping, intertwined role-spaces of Marcus Pipisi, as he performs his roles of father, entrepreneur, district headman, and leader of both church and sub-clan on his journeys around Duidui on Guadalcanal in the Solomon Islands.

[65] Werner, Christian. "The Role of Topology and Geometry in Optimal Network Design." *Papers and Proceedings of the Regional Science Association* 21: 173-189; 1963. p. 173.

[66] Laulajainen, Risto. *The Base Location as a Factor of Efficiency for Mobile Activity.* Helsinki: Helsinki School of Economics, Geographical Studies No. 30, 1970.

[67] Wolpert, Julian. "Behavioral Aspects of the Decision to Migrate." *Papers and Proceedings of the Regional Science Association* 15:159-169; 1965. p. 164.

[68] Progress in making more explicit provisions for the role of government in location decisions has been slow, in spite of the fact that in large parts of the world practically all industrial location decisions are part of comprehensive planning schemes; even in Western countries location decisions are heavily and increasingly constrained and directed by multi-level governmental planning efforts, tax regulations, and other forms of interference. In addition, the locational problems in public sector investments is becoming increasingly significant, particularly in metropolitan areas. Here, modern and efficient, but at the same time accessible, locational systems have to be devised for post offices, hospitals, public schools, and libraries, fire and police stations, as well as administrative offices serving the dispersed urban population, in most cases under heavy budget constraints. (For further references, see Teitz, Michael B. "Locational Strategies for Com-

petitive Systems." *Journal of Regional Science* 8:135-148; No. 2, Winter, 1968.) It is felt that, in spite of recent progress in the development of central place theory, systems analysis, and the theory of multi-level governmental organization, further advances will largely depend on the state of our knowledge of governmental decision-making processes.

[69] Rushton, Gerard. "Temporal Changes in Space Preference Structure." *Proceedings of the Association of American Geographers.* 1:22?-232; 1969. pp. 129-130.

[70] See, e.g., Cameron and Clark, Chapter 6.

[71] Pred. p. 45.

[72] For example, see Beshers, James M. *Population Processes in Social Systems.* New York: The Free Press, 1967; and Florence, Sargent P. *Economics and Sociology of Industry.* London: C. A. Watts, 1964.

[73] Lee, Everett S. "A Theory of Migration." *Demography* 3:47-57; No. 1, 1966. p. 51.

[74] "There is no doubt that the new firms have a high but rapidly falling infant mortality . . . firms have no apparent rise in mortality due to high age. . . ." Wedervang, Fröystein. *Development of a Population of Industrial Firms.* Oslo: Universitetsforlaget, 1965. p. 175. See also Steed, Guy P. F. "Internal Organization, Firm Integration and Locational Change: The Northern Ireland Linen Complex 1954-64." *Economic Geography* 46; No. 3, July, 1970; and Creamer, Daniel. "Manufacturing Employment by Type of Location: An Examination of Recent Trends." *Studies in Business Economics.* No. 106, National Industrial Conference Board, 1969, Chapter 4.

[75] Steed. "Corporate Enterprise and the Locational Decision Process."

[76] Cyert and March. p. 123.

[77] Boulding, Kenneth E. *The Image: Knowledge in Life and Society.* Ann Arbor: University of Michigan Press, 1956. p. 27.

[78] Simon, Herbert A. *The Shape of Automation for Men and Management.* New York: Harper, 1965. p. 53.

[79] Kaufmann, Arnold. *The Science of Decision-Making.* New York: World University Library, 1968. p. 170.

[80] Alonso. *Location and Land Use.* p. 16.

[81] Given the assumptions "each seller will always bid on two randomly selected locations and gain no advantage . . . a bid on a single location is never worthwhile and . . . a bid on all three locations is advantageous only if the other seller bids on only one location (which he will never do)." Stevens, Benjamin H. "An Application of Game Theory to a Problem in Location Strategy." *Papers and Proceedings of the Regional Science Association* 7:143-57; 1961. p. 149.

[82] Stevens. pp. 144-145.

[83] Teitz, Michael B. "Locational Strategies for Competitive Systems."

[84] A less narrowly defined game would, of course, have to include the process by which the participants actually get together at the bargaining table (since joint action spaces may exist for any potential participant in more than one direction). Alfred Weber may have vaguely foreseen the analytical potential of game theory when he wrote: ". . . using terribly cumbersome abstract terminology (which unfortunately is nevertheless hardly adequate to express these matters), we might say: the isolated units of production will not agglomerate arbitrarily or indifferently with any of the others near them: but rather they will agglomerate with those smallest units which just suffice to make up a requisite unit of agglomeration, and which they can attract farthest to themselves, attracting first the smaller ones and then going upward in the scale to the larger ones." Weber. p. 140.

[85] Isard, *et al.* Chapter 9.

[86] Beshers. p. 135.

[87] Albach, Horst. "Simulation Models of Firm Growth." *German Economic Review* 5:1-26; No. 1; 1967. p. 1.

[88] Gould, Peter R. "Man Against His Environment: A Game Theoretic Framework." *Annals of the Association of American Geographers* 53:290-297; No. 3, September, 1963.

[89] Gould's model has been strongly criticized by Pred, p. 15, who argues that "in striving to rectify the usual geographic bypassing of behavioral considerations, Gould has resorted to the computational superman." He thus beats the same drum as Simon. "Theories of Decision-Making in Economics and Behavioral Science." p. 266, who maintained that game theory "requires even more fantastic reasoning powers than does classical economic theory." On the other hand, farmers and other mortals continuously play simple games not entirely different from the one presented in Gould's paper. It seems ambiguous to criticize a re- or pre-calculation of such games in a more precise manner and, at the same time, to disqualify more traditional, less sophisticated normative models because they ignore uncertainty as a decision-making variable. See Wolpert, Julian and Ginsberg, Ralph. "The Transition to Interdependence in Locational Decisions." *Behavioral Problems in Geography*. Evanston, Ill.: Northwestern University, Studies in Geography, No. 17, 1969 for a richly differentiated evaluation of gaming applications to man-man and man-nature encounters.

[90] Leven, Charles L. "The Economic Base and Regional Growth." *Research and Education for Regional and Area Development*. Ames, Iowa: Iowa State University Press, 1966. p. 86.

[91] Curry, Leslie. "Seasonal Programming and Bayesian Assessment of Atmospheric Resources." *Human Dimensions of Weather Modification*. Sewell, W. R. D., editor. University of Chicago, Geography Research Paper No. 105, 1966. p. 137.

[92] "A Strategy for Drought." in *Readings in Economic Geography*. Ward, Richard and Hoffman, Lawrence, editors. New York: Holt, Rinehart and Winston, 1960. p. 13.

[93] Hurter, Arthur P. and Moses, Michael A. "Price and Productive Uncertainties in Dynamic Planning." *Journal of Regional Science* 7:33-45; No. 1, 1967. p. 44.

[94] Day, Richard H. and Tinney, E. Herbert. "A Dynamic von Thünen Model." *Seminarberichte, Gesellschaft für Regionalforschung* 1:1-14; 1968. The probability transformation concept (which would make use of transition probability matrices and be interpreted as a "Markov Chain") presented in the latter part of this framework demonstrates a type of learning process. Due to space limitations, it has been left up to the intuitive abilities of the reader to apply the basic underlying ideas and processes to other situations. See, for example, Golledge, Reginald G. "The Geographical Relevance of Some Learning Theories." *Behavioral Problems in Geography*. Evanston, Ill.: Northwestern University, Studies in Geography, No. 17, 1969 and, for further references, Brown, Lawrence A. *Diffusion Processes and Location: A Conceptual Framework and Bibliography*. Philadelphia: Regional Science Research Institute, 1968. Kaufmann presents a readable introduction to "Sequential Processes of Decision" (Chapter 6) and "Learning by Experience and Simulation" (Chapter 7).

Chapter 2

Cultural Ecology

Marvin W. Mikesell

The problem of man's role in nature continues to be a critical issue for geographers and, indeed, for mankind. That our initial attempts to work out a philosophy of "environmental influences" were unsuccessful is well known. Yet, as Erhard Rostlund suggested a decade and a half ago, "environmentalism was not disproved, only disapproved." [1] Moreover, "possibilism," the generally accepted alternative to "determinism," offered no real challenge and, hence, produced no real response from subsequent generations of American geographers. Although motivated mainly by a residual fear of "environmentalism," this negative or neutral attitude has also been encouraged by the separation of physical and human geography. For example, the "inventory and prospect" published by the Association of American Geographers in 1954 contains chapters devoted to nature, and chapters devoted to culture, but none devoted to their relationship.[2] Similarly, most textbooks present physical and human geography as autonomous enterprises with only a tenuous or implicit connection.

This situation is bound to change, for it seems clear that "environmental quality" will be a much-debated issue in the coming decades. Indeed, "clean air and clean water" has become the rallying cry for a new wave of protest; and the fact that students are playing a prominent

role in this movement should be of more than passing interest to those who are responsible for American education. In addition, the extraordinary development of ecological reasoning in anthropology,[3] and the stress of environmental problems by the mass media,[4] pose challenges for all geographers.

The Meanings of "Culture" and "Ecology"

Evidence of implicit recognition of the concept of culture can be found in antiquity, but the modern meaning of the term, derived from the German *Kultur* and the Latin *cultura,* was established by Edward Tylor in 1871, who defined culture as ". . . that complex whole which includes knowledge, belief, art, law, morals, custom, and any other capabilities and habits acquired by man as a member of society."[5] Numerous other definitions have been proposed, but there seems to be general agreement that culture refers to the man-made part of environment and to patterns of learned behavior. In other words, culture does not refer to human reflexes or drives *per se,* but rather to elements of man's mature endowment that he has acquired from his fellow men by a learning or conditioning process. As a key concept in modern social science, culture is comparable to gravity in physics and evolution in biology. It is the highest level of integration in the study of mankind and, hence, subsumes such more specific concepts as "economy," "society," and "government."[6]

The concept of culture thus represents a way of thinking about the world, rather than a particular class of phenomena. The inevitable difficulties encountered in the use of the concept are derived from three seeming paradoxes. In the first place, although there are many universals of culture (language, religion, social organization, livelihood, entertainment, and so on), each local manifestation of these elements is unique. Secondly, culture is stable and yet dynamic. Examples of true stagnation are hard to find, and continuity is evident even in cases of rapid evolution. Finally, and most significantly, culture fills and largely determines the course of our lives and yet rarely enters into our thoughts.

Given these inherent complications it is not surprising that few attempts have been made to treat culture or cultures "holistically." Rather, students of culture have tended to focus upon certain universal elements of culture as a basis for comparison. For example, anthropologists have placed emphasis on kinship structure, and cultural geographers have given particular attention to livelihood. Most studies of culture proceed

inductively from the examination of specific cultural manifestations, i.e., culture traits. For example, studies of the distribution of culture traits may lead to the delimitation of culture areas, and studies of the changing composition of culture areas may lead to generalizations about cultural evolution. In both respects, emphasis is usually placed upon such cultural processes as invention, diffusion, adaptation, and accommodation.

Since the culture concept represents a way of thinking about the human world, rather than a class of phenomena, its use requires a discipline and a procedure for classification. The obvious value of the concept is that it exposes research problems that might otherwise remain unperceived, i.e., if human activities were studied only in reference to politics, economics, or social organization. The concept of culture also adds a sense of relativism and thus indicates limits to generalizations. However, as the highest level of integration in social science, it also entails some hazards. Studies of culture may be less specialized, less formal, and of less predictive value than those devoted exclusively to politics, economics, or individual behavior. Yet the generalizations achieved by students of culture demonstrate the advantages of a disciplined use of the concept.[7]

The concept of "ecology" was first proposed by the Swiss biologist Ernst Haeckel to refer to the correlation between organisms living together in a particular locality, and their adaptation to their surroundings.[8] Subsequent usage by biologists has retained the essential features of Haeckel's definition. For example, the *Penguin Dictionary of Biology* (Baltimore, 1951) describes "ecology" as the "study of the relations of animals and plants, particularly animal and plant communities, to their surroundings, animate and inanimate." This definition and, indeed, all biological definitions of the term refer to external or environmental factors in contrast to internal factors or mechanisms within organisms.

The transfer of the idea of ecology to human communities required an expansion of the original biological definition to include, not only the concept of culture, but also that of modified or artificial environments. During the 1920's numerous attempts were made by sociologists to apply ecological reasoning and biological analogy.[9] In subsequent decades, the concept of ecology has been applied also to political seicnce,[10] psychology,[11] anthropology,[12] archeology,[13] and, of course, geography.[14] Many of these applications depart significantly from the biological conception of ecology. However, in the case of the two disciplines of most direct concern in this essay, geography and anthropology, an attempt

has been made to retain a conservative definition of "environment" as a complex of natural phenomena.[15]

Cultural ecology differs from the earlier environmentalist tradition in geography in that nature and culture are seen not as opposing forces or separate entities, but rather as interlocking components of an "ecosystem," i.e., a set of "living organisms and nonliving substances interacting to produce an exchange of material between the living and nonliving parts." [16] Such systems, needless to say, may be very complex. Nor are the natural and cultural elements of ecosystems necessarily well defined, for man has had a profound effect upon nature. Moreover, the concept of a system embracing the totality of nature and culture is probably beyond the grasp of any one scholar or any one scholarly discipline. Consequently, the most common strategy in cultural ecology is to examine a particular link in a particular ecosystem, the connection, for example, between climate and agriculture. Establishment of the functional character of a link of this sort permits expansion into other components of a system, e.g., technology, social organization, landforms, and soils.

Much of what has just been said can be illustrated by a series of case studies. Indeed, case studies are the *sine qua non* of cultural ecology, for this concept, more than any other in modern geography, derives its meaning from the "real world." The brief accounts offered in the following paragraphs provide the basis for a summary consideration of the philosophy and methodology of cultural ecology, and also for a discussion of the use of the concept in geographic education.

Blood Feuds and Rye Bread

In most of the mountainous area of Northern Morocco wheat and barley are the staple foods. Yet one occasionally comes across loaves of rye bread. The people possessing such bread show considerable embarrassment when it is discovered; indeed, they may be overwhelmed with a sense of shame. Mostly the peoples of this area deny knowledge of rye bread and claim that any rye observed growing in their fields is used exclusively for thatch. Analysis of the distribution of rye reveals that it occurs sporadically as a weed in wheat and barley fields and occurs uniformly only on rough broken ground at the upper edges of areas of intensive cultivation.

Examination of the social and political organization of this area reveals that it has suffered historically from intense and prolonged blood feuds. In their efforts to preserve or restore order, Rifian tribal authorities

adopted various punishments for the instigators of feuds: fines, house burning, and, ultimately, banishment. Since most of the arable area of the Rif Mountains is fully utilized, exiled tribesmen had only two options open to them: to move far away to one of the Moroccan cities, or to occupy unclaimed or unutilized land located above the normal zone of cereal cultivation. Since the crop most suitable for such locations is rye, possession of rye carries the stigma of orphaned or exiled status. Hence the embarrassment, the denials, and the shame.

The moral of this story is that the attitude toward rye bread in the Rif Highlands can not be understood without consideration of the seemingly improbable connection between blood feuds and physical geography. The linkage in this case begins with the observed association of a particular crop and a particular environmental situation, and then extends into the configuration of Rifian culture.[17]

The Human Nature of *Maqui*

The comment made earlier about the adverse effect upon ecological reasoning of the separation of physical or natural science geography and human or social science geography is reinforced if we consider the character of vegetation in the Mediterranean region. It has long been customary in classroom presentations and textbooks to treat "natural vegetation" as an element of physical geography, and the treatment of this topic usually follows the consideration of climate. Areas of Mediterranean climate — mild rainy winters and warm dry summers — are clothed with the well-known Mediterranean type of vegetation, a combination of evergreen forest and scrub. More discriminating textbooks speak of forest, *maqui*, and *garrigue*, the latter being, respectively, relatively dense and relatively open formations of evergreen shrubs. In addition, the characteristic forest formation of the Mediterranean region is often held to be "scrub oak," i.e., widely spaced and relatively low formations of various species of oak.

Given this information, most students (and perhaps most teachers) jump to the conclusion that the relatively open, scrubby character of Mediterranean vegetation is a natural consequence of the Mediterranean climatic regime, i.e., summer drought. Actually, it is now well known that *garrigue* is a degraded form of *maqui*, and that *maqui* is a degraded form of forest. Moreover, if protected, most of the Mediterranean oaks become tall trees. Protected specimens of this sort appear frequently around cemeteries and other sacred sites in North Africa and South-

western Asia. Indeed, such sites may have forests that are so dense that insufficient insolation is received at ground level to sustain more than an herbaceous undergrowth.

In other words, the characteristic vegetation of the Mediterranean climatic region is produced and maintained by burning, cutting, browsing, and other destructive practices. If disturbed by any of these processes, most oaks sprout from their root systems or trunks and thus have a lateral rather than a vertical growth habit. If burned, cut, or browsed repeatedly, oak formations that originally were forests become indistinguishable physiognomically from formations of shrubs. The oaks may eventually be replaced by shrubs, especially thorny species that are relatively resistant to browsing, or species that produce abundant seeds that germinate quickly after fires. Vegetation of this sort is "wild" in the sense that its species are not cultivated, but it certainly cannot be described as "natural." In short, *maqui*, like the rye fields of the Rif, is understandable only if it is viewed as part of an ecosystem that includes human activities.[18]

Vegetables and Prawn Dust

The axiom that "no man is an island entire to himself" applies equally well to most human communities. Absolute self-sufficiency is rarely attained by any human group, and elaborate patterns of specialization and exchange are common even among peoples who may appear to be isolated and introspective. When two or more groups complement each other in a seemingly perfect way, cultural ecologists refer to the arrangement as "symbiosis."

An interesting example of symbiosis is given by James Clarkson in his study of a community of Chinese farmers in the Cameron Highlands of Malaysia.[19] Permanent settlement in this area began only in the 1930's, and the first Chinese in the highlands were mainly cooks and servants in European households. However, the Chinese soon began to grow cabbages and other vegetables for their own use as well as for their employers. In time vegetable farming became their predominant livelihood. But to produce vegetables commercially they needed the assistance of other peoples to carry the vegetables to urban markets and to supply necessary fertilizer in the form of soybean cake, dried fish, and, especially, the crushed shells of prawns. As a result of oral negotiations, an elaborate arrangement, largely restricted to Chinese, entails the cooperation of merchants who import the prawn dust from India, middlemen who

transport it to the highlands and also carry the vegetables to lowland markets, and gardeners who produce the vegetables in a "growth medium" formed by breaking soil into a fine tilth, working ash into it, and then fertilizing the plantings with a liquid produced by prolonged soaking of the prawn dust.

The fact that this symbiotic association is confined largely, if not exclusively, to Chinese demonstrates an inseparable connection between economic and social organization.[20] Since the vegetables are produced in an artificial medium, the livelihood of the Chinese of the Cameron Highlands also demonstrates that "environment" has a different and richer meaning in this context. Indeed, the traditional distinction between physical and cultural elements of geography is blurred almost beyond recognition.

The Decline of Pastoral Nomadism

The harmonious relationship just described has often also been held to pertain to the association of pastoralists and oasis dwellers. Yet something is obviously wrong with this relationship, because nomadism has long been declining as a mode of livelihood. Since the end of World War I pastoralists in steadily increasing numbers have yielded to pressure or temptation and have abandoned the nomadic way of life. The causes of this situation offer a number of lessons for cultural ecology.

In the first place, the social, political, and logistical constraints imposed by the necessity to move herds or flocks over long distances allow little latitude for experimentation.[21] Discipline, hardiness, and conservatism have always been essential features of the nomadic way of life. Moreover, few if any pastoral groups have been economically self-sufficient. Trading or raiding have been necessary to obtain an adequate diet and sustain material culture. Consequently, most culture historians suggest that pastoral nomadism began as an ecologically conditioned offshoot of cereal farming, a consequence of the expansion of cultivation into semiarid regions which permit extensive animal husbandry but discourage or prohibit agriculture without irrigation.[22] If this interpretation is correct, pastoral nomadism is one of the world's most highly specialized modes of livelihood, a specific, narrow adjustment to a marginal environment. Yet the fact that pastoral nomadism was not able to provide complete self-sufficiency meant that nomads were obliged to maintain contacts with agricultural communities. In return for cereals, vegetables, and implements of various sorts, they could offer only their animals or

the products of their animals. That this was not a balanced trading situation is evident in the fact that it was based upon coercion. The products of agricultural communities were obtained, not merely in return for animals and animal products, but also as tribute to overlords or as payment for protection. In addition, many nomadic groups derived additional income or sustenance from serving as guides or protectors of caravans.

The modern dilemma of pastoral peoples, and especially of desert nomads, thus derives from the fact that they are no longer able to serve as sovereigns of oases or guardians of trade routes. These responsibilities have been assumed by governments, and in many parts of the arid zone routes have shifted and transportation has been mechanized. Forced to rely exclusively upon the purely pastoral element in their livelihood, nomads have become impoverished, and with impoverishment has come a willingness to endure the toil and confinement of sedentary life.

Nor are desert nomads the only pastoralists to be forced to abandon their traditional livelihood. Mountain nomads have suffered similarly from the expansion of cultivation and settlement into their lowland or winter pastures. Thus deprived of half of their grazing resource, and unable to survive all year in their upland or summer pastures, mountain nomads have been forced to settle down or else have been reduced to a curtailed, gypsy-like pattern of movement in which pastoral livelihood is supplemented by wood cutting, road building, and other modes of employment. This situation is especially well documented in Southwestern Turkey, but it can also be observed in North Africa and other areas of Asia.[23]

Once prominent from Morocco to Mongolia, pastoral nomadism has become an anachronism, and, as such, is destined for extinction. Viewed from the standpoints of culture history and cultural ecology, it appears to be too narrowly adapted to a particular set of cultural and environmental conditions to be capable of alternative adaptation or evolution. In short, the modern decline of pastoral nomadism, like the early decline of livelihoods based upon hunting, seems to support the hypothesis of Elman R. Service that the more highly specialized and specifically adapted livelihood forms have severely limited potentiality for evolution.[24]

Pigs for the Ancestors

Domestic animals are usually raised for draft and transportation purposes, or for such products as meat, milk, and wool. But the motives

that have influenced breeding practices also reveal preoccupation with such non-utilitarian considerations as color of hides or hair and the shape of horns.[25] Man's most important source of protein may also be regarded as a pet, a standard of wealth, an object of sacrifice, or even as an ancestor or god. In other words, the seemingly ultra-utilitarian subject of animal husbandry can illuminate many aspects of culture.[26]

That a focus upon animal husbandry should produce such results was anticipated long ago by Eduard Hahn, whose pioneer work on domestic animals has often been regarded as the most significant single work in the history of cultural geography.[27] Similarly, the great French geographer, Albert Demangeon, used the association of lichens, reindeer, and Lapps as the basis for an ecological definition of human geography, and Julian Steward, an important pioneer in the development of American anthropology, made use of the association of vegetation, animal migrations, and hunting techniques in an essay devoted to the concept and method of cultural ecology.[28]

The interesting and complicated question of the role of domestic animals in cultural ecology is answered with admirable clarity in a study of the role of pigs in the culture of the Tsembaga of the New Guinea highlands.[29] The main thesis of this work is that ritual cycles involving the raising and sacrificing of pigs play an important role in regulating the relationship of the Tsembaga with other such groups and with their environment. The Tsembaga cultivate taro, yams, sweet potatoes, sugar cane, and tree crops, in addition to the raising of pigs. The size of the pig herd varies considerably, from about 250 to about 50 individuals. The reason for this fluctuation has to do mainly with "pig festivals," during which time adult animals are slaughtered, cooked, dedicated to ancestors, and the pork distributed by priority to warriors, allies, or the injured or ill. The principal function of the festivals is to regulate the size of the pig herd. If held within optimum limits, the herd plays a valuable role in keeping settled areas free of garbage and orchards free of undergrowth. Since pigs also play a useful role in softening and stirring soil, they can almost be regarded in this situation as cultivation machines.

Nonetheless, if the herd becomes too large the relationship of mutual benefit, or symbiosis, becomes one of parasitism or competition. Pigs then may damage crops, require more than an optimal share of the fruits of agricultural labor, and in general become a burden and nuisance for the Tsembaga. Hence the role of the pig festival, which not only pro-

vides a mechanism for the periodic reduction of herds to manageable and beneficial size and for the distribution of pork to allies, but also provides an occasion for courtship, political negotiation, trading (salt, axes, bird plumes, shell ornaments), and general entertainment. In short, pig keeping and pig festivals are key considerations in the cultural ecology of the Tsembaga and other groups of the New Guinea highlands.

Primitive Complexity

The ultimate test of any intellectual construct is its ability to help in the identification and solution of problems. We have spoken thus far of the value of cultural ecology as a means of clarifying complicated situations. It may also demonstrate that what was thought to be simple is in fact very complex.

A good illustration of the latter case is provided by cultural-ecological research on "shifting cultivation." This mode of livelihood, practiced widely in the tropical regions of both the Old and New World, was once thought to be a casual endeavor, the most primitive and uncomplicated of the world's ancient and surviving modes of agriculture. Shifting cultivation was also thought to be an extremely wasteful mode of livelihood — a menace to forest and soil.

The recent monograph of J. E. Spencer destroys many, if not most, of these stereotypes.[30] For example, it is clear that shifting cultivation is not a monolithic or inherently well-defined system. It varies along a gradient from hunters and gatherers, who practice some shifting cultivation, to essentially sedentary peoples, e.g., wet rice farmers, who also practice shifting cultivation as a complementary activity. Between these two extremes, Spencer discerns at least six transitional cases in which shifting cultivation is the predominant mode of livelihood. Moreover, in his attempt to identify shifting cultivators and delimit the area of their activity, Spencer was obliged to consider no less than nineteen "gross characteristics" and twenty-six "diagnostic criteria." The progression of his study entails consideration of crops, tools, methods, patterns of movement, and most features of the natural environment. Each of these considerations results in the construction of an elaborate matrix, and the study concludes with a suggested classification of "hierarchies of shifting cultivation" which includes three principal types and eighteen specific variations. Shifting cultivation is thus revealed, not as a particular mode of livelihood, but, rather, as a constellation of livelihoods. As for the presumed destructiveness of shifting cultivation, Spencer con-

cludes that it is not destructive of resources of value if the cultures concerned are relatively free of outside pressures. Indeed, shifting cultivators often utilize resources that more advanced agricultural peoples are unable to exploit efficiently.[31]

From "Closed" to "Open" System

If we return to the land of "blood feuds and rye bread" it is immediately evident that each of its mountain valleys has a well-defined pattern of land use. At the bottom of such valleys is a zone of irrigation, where water is diverted from perennial streams to irrigate summer crops of maize, beans, squashes, and other vegetables. Next comes a zone of dry farming devoted to cereals, vines, and fig trees. Above this zone is a less well-defined area of pastoral activity, wood cutting, and, as indicated earlier, occasional cultivation of rye. At still higher elevations, a few patches of the forest that once clothed the entire area may remain.

The economic system, of which this zonation is the essential feature, can be described as one of semi-specialization and exchange designed to promote community self-sufficiency. In other words, self-sufficiency at the scale of clan or tribe is achieved by the semi-specialized activity of individual families. Each clan grouping tries to be self-sufficient in cereals, but some land is always used to grow special crops for exchange. The surplus of foods thus produced is exchanged through the medium of weekly markets, which also facilitate the distribution of a few essential imports — sugar, salt, tea, and kerosene.

Viewed from the outside, the system seems to be "closed," a classic example of subsistence economy. Viewed from within, the system consists of an elaborate network of exchange patterns centered on weekly markets which enable most families to take advantage of local environmental conditions — shady or sunny slopes, higher or lower elevations, and so on. In addition to taking advantage of local variations of climate or soil in their choice of crops, they can make wooden implements, if they have access to a forest, or pottery, if they have access to clay.

Unfortunately, this intricate and seemingly sophisticated system has certain inherent disadvantages. In the first place, the valleys of Northern Morocco are "Malthusian traps," for their ridges usually coincide with tribal boundaries, and upslope migration may also be checked by adverse climatic conditions. The inevitable consequence of population increase is an intensification of cultivation in the zone of cereal farming and an extension of such cultivation into the zone of pastoral activity.

Since terracing is practiced only for irrigated crops, such intensification and expansion results in destructive erosion. Accordingly, people may be forced out of the system. Out-migration normally begins as a seasonal movement during the winter period of labor surplus and then becomes a general drift toward the Moroccan cities. If successful, emigration may provide a means for maintaining the valley ecosystem, but opportunities for external employment are severely limited in a pre-industrial economy.

Meanwhile, the introspective character of the tribal culture may be altered even more substantially by improvement of communication. The addition of a road to the system results in disruption of the traditional role of the weekly markets, for markets thus served tend to grow at the expense of others. Indeed, markets served by roads may become market towns, which means that the undifferentiated settlement pattern of the "closed system" begins to assume a hierarchical character. Merchants may elect to stay put instead of moving their goods from place to place, trading activity may be spread throughout the week, and entrepreneurs based in the new town may encourage cash cropping or the commercial exploitation of particular resources. In short, improvement of communication results in a centralization of trading facilities, and it may also result in a substantial expansion of the economic scale of the community. The closed system is thus opened to external forces that may radically alter its character.[32]

Pollution

In each of the previous examples, nature and culture were seen as interlocking components of a system. This perspective should also be helpful in approaching the awesome issues of environmental quality and pollution. To approach these issues ideologically would be to condemn our effort to mere advocacy. Presumably geographers ought to be able to speak as "expert witnesses" as well as "injured parties," but to do so requires that we focus on particular associations.

Having said this much, it is necessary to digress briefly in order to take account of some of the difficulties created by the eruption of "eco-activism." In the first place, much of what is being written and said is simplistic and even hysterical. "Crash programs," "teach-ins," "petitions," and "demonstrations" may well have some political or emotional value, but unless directed to a demonstrable causal relationship they tend to produce no more than an earnest, collective judgment that "something must be done."

An additional difficulty is created by the fact that the literature on pollution is of enormous quantity and extremely uneven quality. Perhaps the most reliable single source of information is the journal *Science*, which has carried articles on pollution and environmental quality frequently during the past few years, and has also made significant contributions in its editorial and correspondence sections. Two new international journals, *Biological Conservation* and *Atmospheric Environment*, also promise to be useful. The newsletter of the Conservation Foundation places particular stress on the legal and legislative aspects of the battle against pollution, as does the new journal *Environment*, which is published ten times a year by the Committee for Environmental Information in St. Louis. The series of pamphlets on "environmental health" issued by the United States Department of Health, Education, and Welfare is also helpful. Among popular magazines, as indicated previously, *Time* and *Newsweek* seem to be making the most persistent efforts to present reliable information on problems of environmental quality.

Substantial collective works have also appeared, including symposium volumes issued by the Conservation Foundation,[33] Resources for the Future,[34] and the American Association for the Advancement of Science,[35] a special issue of *Daedalus*,[36] the report of the Committee on Resources and Man of the National Academy of Sciences — National Research Council,[37] and several unbridled readings volumes.[38] It should also be mentioned that the Commission on College Geography of the Association of American Geographers has published a paper on "Air Pollution," and that the National Science Foundation has issued a collection of essays on "Human Dimensions of the Atmosphere." [39] Finally, one should not forget the symposium volume on "man's role in changing the face of the earth," [40] in which geographers made a major contribution, the pioneer work of Max Sorre,[41] and the studies of Anderson,[42] Bates,[43] Darling,[44] Leopold,[45] Sauer,[46] and other masters of ecological reasoning whose efforts to inform scholars, and even laymen, began long before ecology became an ideology.

We may now return to the question of how geographers might respond most effectively to the challenge of pollution and environmental quality. As already suggested, focus on a particular linkage seems necessary to avoid the frustration of impotent advocacy. The obvious choice, in our culture, is the link between automobiles and air pollution. This assertion is justified on two grounds: that the automobile is an extremely important

element of American culture, and that automobiles are one of the largest, if not the largest, contributors of air-borne contamination. Americans house, clean, and worry about the health of their eighty-seven million automobiles almost as if they were alive, and driving a typical vehicle in city traffic for an hour pours a pound or more of carbon monoxide into the air.

The prominence of the automobile in American culture is self-evident. Nevertheless, it is well to recall that by greatly increasing the scale of community life, it revolutionized American society and set in motion processes that have transformed the American landscape.[47] Urban sprawl is largely a manifestation of our motorized way of life, as are the characteristic American phenomena of ribbon business developments, vast parking lots, superhighways, and traffic jams. From adolescence to old age, most Americans (and now also most Europeans) drive automobiles. Add the concept of "planned obsolescence" and the overriding economic and technological importance of the automobile industry, and we have penetrated into the heart of American culture. America without its vast population of automobiles seems inconceivable; yet this population presents hazards that threaten the American environment.

The nature of the hazard is well known. Although few cities have installed monitoring devices to measure the accumulation of pollutants in the atmosphere, it is certain that automobiles expel substantial quantities of carbon monoxide and that ozone — the principal source of eye irritation in smog — is formed by the action of sunlight upon the effluent (nitrogen oxides and hydrocarbons) of automobile engines. Since the earth's atmosphere is a circulating system, and since only a small part of the planet is actually occupied by man, one might expect that such gases would be dissipated or else be so diffused as to be negligible, i.e., what Frank Graham refers to as "the illusion of dilution." Perhaps this was true at one time, but it is certainly not the case today.

Air pollution of the type just described is especially serious in areas that have abundant sunlight and regularly experience temperature inversions, whether by radiation or advection. Inversions of the former type are especially common in the Los Angeles region, which also happens to be flanked on three sides by mountains that restrict the horizontal flow of air. Temperature inversions, abundant sunlight, surrounding mountains, and a relatively shallow penetration of sea breezes together constitute an ideal laboratory for the development and perpetuation of smog.[48] In order to appreciate the seriousness of this prob-

lem in the Los Angeles area it is sufficient to add that this sprawling city has the world's largest concentration of automobiles.

But the photochemical smog born in the cultural and environmental setting of southern California is no longer unique to that region; nor is it the only serious case of automobile-induced pollution. Air is polluted wherever combustion occurs, and the internal combustion engine ranks first among all major sources of pollution in its emission of carbon monoxide, nitrogen oxides, and hydrocarbons.[49] Carbon monoxide presents a particularly serious threat to human health. Inhaling this gas has long been a popular method of suicide. It is now known that the gas becomes dangerous when it reaches a level of more than ten parts per million parts of air — a common occurrence in most American cities. Concentrations of this level can harm pregnant women and victims of bronchitis, emphysema, and heart disease. More than thirty parts per million of carbon monoxide cause many people to experience a loss of energy and decline in their physical reactions, probably because of a reduction in the amount of oxygen in their brains. Consequently, automobile pollution could be a cause of automobile accidents!

Recitations of this sort have appeared so frequently in recent months, in both popular and scientific journals, that the obnoxious and dangerous attributes of the automobile can probably be regarded as proved beyond reasonable doubt.[50] Is there an alternative? America without its automobiles seems inconceivable, for they are a vital element in the American way of life. Without automobiles, the American settlement pattern, the American economy, and an extraordinary range of American habits (from shopping to courtship) would be transformed. Yet one must also think of the American environment, and in this context the automobile seems to be playing a negative and even destructive role. If America without its automobiles is inconceivable, and continued or increased pollution from automobiles is also inconceivable, the American people would seem to be faced with a serious dilemma!

The solution to the dilemma seems obvious: a different kind of automobile.[51] Vehicles powered by steam or electricity would be the most practical alternatives. Indeed, it is difficult to mount an effective argument against steam-powered automobiles. They would produce substantially less hydrocarbons, nitrogen oxides, and carbon monoxide than current automobiles, and they could be just as large.[52] Electrically-powered automobiles would be silent and exhaust-free, i.e., they would produce *no* pollution. Another possibility would be to switch automobiles

to natural gas, in which case the internal combustion engine could be retained. Since natural gas burns cleanly, such vehicles would emit almost no hydrocarbons, and emissions of carbon monoxide and nitrogen oxides would also be substantially reduced.

Each of these alternatives has certain technical or economic disadvantages. The principal objection to steam-powered automobiles is economic — high development costs and the assumption that the necessary switch from high octane gasoline to kerosene would seriously disrupt the petroleum industry. Electrically-powered automobiles probably could not be larger than a Volkswagen, and they would have to be recharged after only about 70 to 80 miles of driving at moderate speeds. Moreover, each electrically-powered vehicle would have to transport a trunk-load of batteries. Similarly, the bulky gas-cylinders required for vehicles powered by natural gas would have to be refilled every 50 miles.

These major and minor impediments should not discourage development of an alternative to the internal-combustion engine, for the exhaust control devices made mandatory in California several years ago, and generally since 1968, merely reduce rather than prevent harmful emissions, and they work effectively only at speeds of more than about 50 miles per hour. By the end of the 1970's it is difficult to imagine that persistent movement at this speed will be possible in any American city. Moreover, the reduction in the emission of carbon monoxide planned for 1971 models will be achieved by increased engine heat, which in turn will increase emissions of nitrogen oxide.

It seems clear, given the great complexity of the automobile pollution problem, that electrical vehicles provide the only effective solution. If so, this assertion brings our discussion back to the context of academic geography, for the vehicle that is best for the American settlement system is not best for the American ecosystem and, conversely, the vehicle that would be best for our ecosystem would not function very effectively in our settlement system! Perhaps there is a purely economic solution to this problem a calculation of the relative costs of pollution damage versus pollution control.[63] If so, it has not yet been announced by economists. Nor is it likely to be, for pollution introduces issues that go beyond any system of purely logical inquiry. What is the value of one human life, one case of bronchitis, or one pair of irritated eyes? How much are Americans willing to "pay" for the privilege of driving when and where they please? Death, presumably, would be regarded as an intolerably high payment, but it would be difficult to estimate (or over-

estimate) public tolerance of noise, filth, and health hazards of unknown severity.

Summary of the Case Studies

These several brief accounts illustrate a number of principles. In the first place, each of the examples given demonstrates the basic idea of cultural ecology, which is that nature and culture should be viewed not as opposing forces or separate entities but rather as interlocking components of a system. In other words, the particular cases all suggest that man operates within nature rather than apart from nature or merely in response to the dictates of nature. The question so often posed by geographers in the past as to whether environment does or does not "determine" human activity has no real meaning in this context.

More specifically, the discussion of "blood feuds and rye bread" demonstrates a connection between environment and culture that could not be established by observation of nature or culture in isolation. The solution to this problem could be achieved only by a process of inductive reasoning that led eventually to the establishment of a link between environmental conditions (especially the vertical zonation of microclimates) and a social mechanism designed to prevent or resolve community conflicts.

The advantages of a combined cultural and environmental inquiry was also illustrated in the discussion of "the human nature of *maqui*." Specifically, this case demonstrated that the characteristic vegetation cover of the Mediterranean region cannot be understood without reference to burning, cutting, browsing, and other destructive practices. More generally, this discussion introduced the concept of "modified environments" and the distinction between "wild" and "natural" vegetation.

The brief account of the cooperation of merchants, middlemen, and vegetable gardeners in the Malaysian highlands suggested an association of mutual advantage and dependency (symbiosis) and an inseparable connection between economic and social organization.

The discussion of the decline of pastoral nomadism illustrated the vulnerability of overly-specialized livelihoods and the fragility of exchange mechanisms based upon privileged status or coercion.

The account of the role of pig festivals in the New Guinea highlands was designed to provide another illustration of the relationship of economic and social organization and also to demonstrate that the seem-

ingly utilitarian subject of animal husbandry can illuminate many features of culture.

The brief discussion of shifting cultivation was offered as a warning that cultural-ecological analysis can have the effect of an expansion rather than a deduction of scholarly inquiry — that its effect may be to pose questions as well as provide a basis for satisfactory answers. Anthropologists have long been aware that societies classed as "primitive" according to their technology may prove to be extremely complicated if examined from other perspectives.

The account of the development of a particular ecosystem in Morocco from a closed to an open condition illustrates the complicated pattern of specialization and exchange that can be established even in an isolated area of pre-monetary economy. This discussion also pointed to transportation improvement as a key factor in fostering cultural evolution.

Finally, although devoted to an ecosystem of maximum technical complexity, the discussion of the connection between automobiles and air pollution in the United States merely reiterated some of the ideas presented in the account of the connection between blood feuds and rye bread. Here again, the establishment of a particular link required extension of the inquiry into many features of environment and culture. At the risk of responding facetiously to a problem of terrifying implications, it might be suggested that modern Americans could profit from the example of the Tsembaga and devise a functional counterpart of their pig festivals for the elimination of surplus automobiles. In any case, the relationship between people and automobiles in the United States can hardly be described as "symbiosis!"

Cultural Ecology and Geographic Education

For many teachers in the social sciences and humanities, the issues raised in this essay might seem baffling and even threatening. Such should not be the case for teachers of geography, for the tradition of man-land studies is deeply rooted in the discipline of geography.[64] Indeed, as already suggested, this tradition was once dominant in American geography. It is true that anti-environmentalism and the separation of physical and human geography have resulted in a decline of ecological reasoning in recent decades, but as Rostlund suggested, the fact that we need a fresh start does not mean that we need to start all over again.[65] Geography has a vested interest in problems of man-land rela-

tions and environmental quality, for no other discipline has a richer heritage of trials and errors.

On the natural science side, geographers have the advantage of a perspective that encourages awareness of the relationship of climate, water, landforms, vegetation, and soils. Such cannot be claimed by many geologists, hydrologists, or meteorologists, and botanists and soil scientists may or may not be willing or able to look beyond their particular phenomena. In contrast, physical geography, if defined as "the study of the earth ecosystem in terms of its sub-systems and their spatial and temporal attributes," has an implicit if not explicit ecological rationale.[56]

The pedagogic problems created by the separation of physical and human geography obviously demand some mutual effort at reconciliation. This reconciliation might best be accomplished, perhaps, by a joint effort to understand the character of "modified environments." Here again, fortunately, considerable experience and momentum is already evident in American geography. Although accomplished primarily by cultural geographers, our large literature on deforestation, erosion, and reclamation provides an impressive foundation for more extensive studies in cultural ecology.

Moreover, although the technical literature of botany and zoology cannot be absorbed readily into geographic pedagogy, most of the basic concepts of ecology are intelligible to geographers. For example, Dansereau's summary of "ecological laws" contains no ideas and few words that exceed the comprehension of geographers.[57] Such concepts as "community," "habitat," "niche," "zonation," "succession," "energy flows," "biotype," "biomass," and "symbiosis" are well within the reach of the "average man" of geographic education. And in this respect, geographers have an enormous comparative advantage over other social scientists. For example, it is difficult to imagine any geographer displaying the climatological naïveté that appears in Duncan's account of the Los Angeles smog problem.[58] Finally, it should go without saying that "systems analysis," sampling theory, and most of the other components of a scientific study of ecosystems are already well established in geography.[59]

Given the prior commitment of geographers to deal with the man-land theme, and the presence within our ranks of experts on most aspects of nature and culture, it seems reasonable to expect that academic geography can provide leadership in the quest for environmental wisdom. In

any case, the essential challenge of cultural ecology is not fundamentally different from that of geography as a whole — to understand the variable character of the relatively small planet that is likely to be our only home. The search for such understanding promises to be intellectually rewarding. It could also be a requirement for our survival.

FOOTNOTES

[1] Rostlund, Erhard. "Twentieth-Century Magic." *Landscape* 5:23-26; No. 3, Spring, 1956, as reprinted in Wagner, Philip L. and Mikesell, Marvin W., editors. *Readings in Cultural Geography.* Chicago: University of Chicago Press, 1962. pp. 48-53. See also Lewthwaite, Gordon R. "Environmentalism and Determinism: A Search for Clarification." *Annals of the Association of American Geographers* 56:1-23; No. 1, March, 1966.

[2] James, Preston E. and Jones, Clarence F., editors. *American Geography: Inventory and Prospect.* Syracuse: Syracuse University Press, 1954.

[3] For indication of the scope of ecological reasoning in anthropology, see Vayda, Andrew P., editor. *Environment and Cultural Behavior: Ecological Studies in Cultural Anthropology.* Garden City, N.Y.: Natural History Press, 1969; Cohen, Yehudi A., editor. *Man in Adaptation.* 2 volumes. Chicago: Aldine, 1968; and Watson, Richard A. and Patty Jo. *Man and Nature: An Anthropological Essay in Human Ecology.* New York: Harcourt, Brace and World, 1969.

[4] See, for example, the series of reports on environmental quality in *Time* and *Newsweek* magazines. Many other magazines are carrying reports on pollution and other problems of environmental quality. The topic also has been presented frequently on television.

[5] Tylor, Edward B. *Primitive Culture.* 2 volumes. London: Murray, 1871. Vol. 1, p. 1.

[6] For a carefully documented study of the etymology of "culture" and its application as a scientific concept, see Kroeber, A. L. and Kluckholm, Clyde. *Culture: A Critical Review of Concepts and Definitions.* New York: Vintage Books, 1963.

[7] For further discussion, see the several articles on "culture" in the *International Encyclopedia of the Social Sciences.* New York: Macmillan and Free Press, 1968. Vol. 3, pp. 527-568.

[8] See, especially, his *The History of Creation.* Translated by Lankester, E. R. 2 volumes. New York: Appleton, 1876. Vol. 2, p. 354.

[9] See, for example, the collection of the papers of Park, Robert Ezra, in *Human Communities: The City and Human Ecology.* New York: Free Press, 1952.

[10] See, especially, Sprout, Harold and Margaret. *The Ecological Perspective on Human Affairs, With Special Reference to International Politics.* Princeton: Princeton University Press, 1965.

[11] See, for example, Barker, Roger G. *Ecological Psychology: Concepts and Methods for Studying the Environment of Human Behavior.* Stanford: Stanford University Press, 1968.

[12] Compare Mikesell, Marvin W. "Geographic Perspectives in Anthropology." *Annals of the Association of American Geographers,* 57:617-634; No. 3, September, 1967 and Vayda, Andrew P. and Rappaport, Roy A. "Ecology: Cultural and Non-Cultural." in Clifton, James A., editor. *Introduction to Cultural Anthropology.* Boston: Houghton Mifflin, 1968, pp. 477-497.

[13] See, especially, Butzer, Karl W. *Environment and Archeology.* Chicago: Aldine, 1964; revised edition, 1971.

[14] For discussion of the rationale of this tradition, see Wagner, Philip L. *The Human Use of the Earth.* Glencoe, Ill.: Free Press, 1960; and Eyre, S. R. and

Jones, G. R. J., editors. *Geography as Human Ecology: Methodology by Example.* London: Arnold. 1966.

15 For clarification of the distinction between the "human ecology" of sociologists and the "cultural ecology" of anthropologists and cultural geographers, compare Hawley, Amos H. "Human Ecology" and Steward, Julian H. "Cultural Ecology." *International Encyclopedia of the Social Sciences.* New York: Macmillan and Free Press, 1968. Vol. 4, pp. 328-344. See also Mikesell, Marvin W. "The Borderlands of Geography as a Social Science." in Sherif, Muzafer and Carolyn, editors. *Interdisciplinary Relationships in the Social Sciences.* Chicago: Aldine, 1969. pp. 227-248.

16 Odum, Eugene P. *Fundamentals of Ecology.* Second edition. Philadelphia: Saunders, 1959. p. 10.

17 For an extended discussion of the role of prejudice in regard to foods, see Simoons, Frederick J. *Eat Not This Flesh: Food Avoidances in the Old World.* Madison: University of Wisconsin Press, 1961.

18 The writer has dealt with this theme previously in "Deforestation in Northern Morocco." *Science* 132:441-448; No. 3425, August 19, 1960 and "The Deforestation of Mount Lebanon." *Geographical Review* 59:1-28; No. 1, January, 1969. A more comprehensive statement on the successional relationship of forest, *maqui,* and *garrigue* appears in Zohary, Michael. *Plant Life of Palestine.* New York: Ronald, 1962.

19 Clarkson, James D. *The Cultural Ecology of a Chinese Village: Cameron Highlands, Malaysia.* Chicago: University of Chicago Department of Geography Research Paper No. 114, 1968.

20 For further discussion of the applications of the concept of symbiosis, see Wagner's *The Human Use of the Earth.* pp. 71-74.

21 Johnson, Douglas L. *The Nature of Nomadism: A Comparative Study of Pastoral Migrations in Southwestern Asia and Northern Africa.* Chicago: University of Chicago Department of Geography Research Paper No. 118, 1969.

22 Compare Sauer, Carl O. *Agricultural Origins and Dispersals.* New York: American Geographical Society, 1952 and Cambridge, Mass.: M.I.T. Press, 1969 and Bobek, Hans. "The Main Stages in Socio-Economic Evolution from a Geographical Point of View." *Readings in Cultural Geography.* pp. 218-247.

23 For case studies, see "Nomads and Nomadism in the Arid Zone." *International Social Science Journal* 11:481-585; No. 4, 1959; "Nomades et nomadisme au Sahara." *Arid Zone Research.* Paris: UNESCO, 1963. Vol. 19; and "The Problems of the Arid Zone." *Arid Zone Research.* Paris: UNESCO, 1962. Vol. 18.

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25 Epstein, H. "Domestication Features in Animals as Functions of Human Society." *Readings in Cultural Geography.* pp. 290-301.

26 Compare Lewinsohn, Richard. *Animals, Men and Myths.* New York: Harper, 1954 and Leeds, Anthony and Vayda, Andrew P., editors. *Man, Culture, and Animals: The Role of Animals in Human Ecological Adjustments.* Washington, D.C.: American Association for the Advancement of Science, 1965.

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[28] Compare Demangeon, Albert. *Problèmes de géographie humaine.* Third edition. Paris: Colin, 1947. p. 27 and Steward, Julian H. *Theory of Culture Change.* Urbana: University of Illinois Press. 1955. pp. 30-42.

[29] Rappaport, Roy A. *Pigs for the Ancestors: Ritual in the Ecology of a New Guinea People.* New Haven: Yale University Press, 1967.

[30] Spencer, J. E. *Shifting Cultivation in Southeastern Asia.* Berkeley: University of California Publications in Geography, 1966. Vol. 19.

[31] For discussion of the character of shifting cultivation and wet-rice cultivation as distinctive but complementary systems, see Geertz, Clifford. *Agricultural Involution: The Process of Ecological Change in Indonesia.* Berkeley: University of California Press, 1963. See also the discussion of the historical role of seed and vegetatively reproduced crop plants in Harris, David R. "Agricultural Systems, Ecosystems, and the Origins of Agriculture." in Ucko, Peter J. and Dimbleby, G. W., editors. *The Domestication and Exploitation of Plants and Animals.* London: Duckworth, 1969. pp. 3-15.

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[50] Compare Lessing, Lawrence. "The Revolt Against the Internal-Combustion Engine." *Fortune* 76:78-83 and 180-184; No. 1, July, 1967 and Larsen, Ralph I. "Air Pollution from Motor Vehicles." *Annals of the New York Academy of Sciences*. 136:275-301; 1966.
[51] See, for example, *The Search for a Low-Emission Vehicle*, a staff report prepared for the Committee on Commerce, U.S. Senate. Washington, D.C.: Government Printing Office, 1969.
[52] Aaronson, Terri. "Tempest Over a Teapot." *Environment* 11:23-27; No. 8, October, 1969.
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[54] Pattison, William D. "The Four Traditions of Geography." *Journal of Geography* 63:211-216; No. 5. May, 196[illegible]
[55] "Twentieth-Century Magic." p. 53.
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Chapter 3

Environmental Perception

Thomas F. Saarinen

Social studies teachers have long been familiar with the effects of varying perceptions of environment on world history. One dramatic example which immediately comes to mind is the discovery of America by Columbus. Early in their school career children are generally taught that Columbus, in opposition to the common perception of his time, thought that the world was round. Acting on this idea he sailed west to try to reach the East Indies. Columbus was convinced that he had landed in the East Indies when, in fact, he had reached the shores of what to Europeans was a "New World." His inaccurate perception has ever since been memorialized in the place name, the West Indies, and in the term, Indian, which he mistakenly used to refer to the people he found living there. According to Wright,[1] Columbus was constantly seeing things that to him betokened the nearness of Marco Polo's Cathay and the Grand Khan's realms. Wright suggests that not only the routes of explorers but the character of their observations should be studied in light of their preconceived ideas, both true and false. Such studies might highlight the serendipitous nature of many geographic discoveries.

Given the perspective of several centuries and a single dramatic event it is easy for us to understand the role of perception in the case

of Columbus. We may also find it easy to understand the role of Columbus and other explorers in gradually broadening the geographic horizons of Europeans in the centuries following their Age of Discovery.[2] Such a topic was speculated on by Whittlesey in a stimulating essay which explored the way in which mankind's geographic horizons have expanded over time. He contrasted the primal, the regional, and the world sense of space.

The outlook of primitive people, and in the earliest period of human history, was almost literally confined to the physical horizon. The major landscape features might be known by their generic names as "the mountain," "the river," or "the village," and the geographic horizon was generally the physical horizon of man's experience. No doubt such narrowly restricted views of the world still survive, and even within modern cities there may be people whose minds only rarely touch on events beyond their block or neighborhood. According to Whittlesey, a broader regional sense of space appeared some 1800 to 2000 years ago as two areas of subcontinental size separately achieved political unity. The Romans and the Chinese, in producing a political unity based on effective internal communication, also provided some of their people with an awareness of a broader geographic horizon. Other regions appeared and former political regions contracted. But it was not until after the 15th century that a new wider geographic horizon began to appear. Following the European Age of Discovery, some of the areas beyond the oceans and the Sahara became known to Eurasian people.[4] A worldwide horizon appeared for the first time at the most advanced frontiers of thought. Whittlesey felt it was reasonable to assume that eventually all of mankind would advance to such a position, but his following remarks clearly indicate that he was sure this had not yet taken place at the time he wrote:

> Even in the lands where geography is part of a compulsory school curriculum, and among people who possess considerable information about the earth, the world horizon is accepted in theory and rejected in practice. A parochial outlook injects itself into every consideration of a political system more inclusive than the one in vogue, it appears in snap judgements on "foreigners," and it dims the view of existing interdependence in the economic order. The myopia is understandable. The weight of tradition is heavy. Until five centuries ago a primal or regional sense of space dominated human settlements everywhere. In the United States, where society is mobile, it is easy to forget that even now few members of the human species move beyond their native region, and that hardly anybody has fruitful contact with folk who think in patterns different from his own.[5]

The rapid acceleration in the technology of transportation and in the communications media since the appearance of Whittlesey's article twenty-five years ago may have had the effect of extending the numbers of people with the worldwide horizon. But we really do not know for the question has not been researched in spite of its potential importance. For social studies teachers it would seem to be a significant question. What kinds of geographic horizons are present in the minds of their students, and how might these be extended? At what ages and stages are children ready to grasp a broader concept of space?

Today most school children probably think beyond the earth to space, but we do not really know to what degree they are aware of their own neighborhood, of a regional sense of space, or the world as a whole. We know next to nothing about how people perceive or react to the weather and climate in their area, or what they notice and respond to as they walk in the woods or along city streets. What is it that makes certain cities or portions of cities pleasant, and what sorts of satisfactions are sought in the wilderness?

Aim and Organization of Chapter

Much of the current research on perception of environment is designed to try to find answers to such questions as those above. Clearly such answers are essential to any program to enhance the quality of our environment. If creation of a high quality environment becomes a major national priority rather than remaining merely a focus for much high-sounding rhetoric, there will be a great need to more fully understand many aspects of the man-environment relationship.

In this chapter the aim will be to review a number of the directions such research has taken among geographers and wherever possible to select studies which have some relevance to the task of teaching. Hopefully some such material will be incorporated in various ways in social studies courses and help provide students with a greater awareness of certain aspects of the man-environment interaction.

The discussion will be organized according to scale starting with the broadest level, that of the world as whole or major regional segments of it. At this level the concern is clearly with attitudes, mental images, or organized conceptions. In a certain sense this is a good way to begin because it emphasizes what is characteristic of all such work in geogra- [illegible] namely, concern with social perception.[6] The focus is not on the [illegible]us present and the capabilities of the sense organs. Rather it is [illegible]e feelings, attitudes, ideas, or images which result from man's

cognitive structuring of his physical and social environment. These depend on a variety of social and cultural factors and vary with the individual's past history and present "set" or attitude acting through values, needs, memories, moods, social circumstances, and expectations.

The national level is the next to be considered, followed by the level at which appears the greatest preponderance of geographic studies — that of large conceptual regions. The ability of geographers to select significant broad regions for study will perhaps provide their greatest potential for original contributions to work on perception of environment. Such selection of significant regions should not be limited to broad areas, but in practice this has been the case to date. As a result, geographers have so far been less active in perception studies at the metropolitan and neighborhood level which are the smallest scales considered here.

Limitations of the Chapter or How to Go Further in Pursuing the Topic

By confining the discussion to recent work within geography, the impression may be gained by the reader that research interest in perception of environment is limited to geographers. This is not the case. The research interest is characterized by its interdisciplinary nature. This is clearly evident in reviews of the field [7] by geographers, as well as in collections of papers which have been published.[8] An indication of the range of fields involved is provided by a recent directory of researchers in behavior and environmental design.[9] Over thirty separate fields are listed including such diverse disciplines as anthropology, architecture, ecology, economics, education, psychology, sociology, zoology, history, museology, hospital administration, planning, and transportation. A common factor is the concern with current environmental problems and the prominence of planning considerations. For geography the result has been a strong infusion of behavioral science techniques and theories, as will be evident in some of the studies discussed below.

Nor are the scales considered the only ones on which research has been focused. A recent review by the author [10] considered the range of studies on perception of environment in terms of scale from personal space, room geography, larger architectural space, roads and pathways, neighborhoods or districts, the city, larger conceptual regions, countries, to the world. This chapter, focusing on the work of geographers, will not consider the smaller area studies for these to date have been the

realm of other disciplines. Nor will it consider the work of other disciplines at broader levels. The result is that many important studies and areas of interest are ignored, such as the work of personal space by the anthropologist Hall [11] and the psychologist Sommer,[12] the sociological studies of neighborhoods in England by Lee[13] and in France by Bardet,[14] the work by psychologists, architects, and others on the perception of architectural space; [15] the ideas of Barker [16] and his colleagues on ecological psychology, Craik [17] on environmental psychology, the pioneer perception study of city planner Kevin Lynch.[18]

Theory and methodology will be mentioned only incidentally here. Research on perception of environment is so recent that no real body of theory has developed. In geography the first empirical work of this type is less than ten years old. For the same reason no well-developed methodology is available. In fact, a dominant concern of much of this research is the search for effective methods of measuring perception of environment. The major problem in studying people's perception is that of measurement, since people often have difficulty articulating the conscious or unconscious feelings, attitudes, or ideas associated with perception. In many cases, perception must be inferred from behavior or sought in indirect ways as will be noted in several instances below.

The preceding paragraph may provide the impression that the ideas involving perception of environment have only recently appeared in geography. This is not so. Perception of environment is part of the larger system of man and environment which has always been a major concern of geography. Cultural geographers have long used the term *cultural appraisal* to refer to the differing perceptions of various culture groups. They have often documented, for example, that succeeding culture groups in the same area may appraise the environmental resources differently and hence exploit it for different purposes.[19] The term *regional consciousness* used by regional geographers expresses an aspect of environmental perception which appears at all levels from a small locality, to a neighborhood, a nation, or an even broader grouping. Regional consciousness means the awareness of togetherness of people in an area.[20] This sense of shared existence may derive from attitudes, origins, associations, or organizations. It is often revealed by names given to areas on local maps or through popular usage.

Regional consciousness can also have a hierarchical aspect. An individual could be conscious of loyalties, or a sense of shared existence, with other people of the same street, neighborhood, state, or nation. For

example, he might think of himself as an East Calgarian, a Calgarian, a Western Canadian, and a Canadian, each illustrating a different level of regional consciousness. The problem of regional description [21] is also one of perception since it depends on the individual selection of what is included or emphasized as in the case of Columbus above. Some of the more successful examples of regional description have appeared in regional novels, where a particularly perceptive person, describing an area with which he is familiar, is somehow able to conjure up images and associations that clearly evoke the distinctive quality of a place. Good regional novels can therefore be useful in the classroom situation, precisely because of this advantage which overcomes the sterility of highly generalized discussion of broad regions which is almost inevitable in geography textbooks.[22]

The above examples indicate some of the long term interests of geographers in perception of environment. Recently, however, there has been a change in emphasis. Instead of an interesting incidental aspect of a broader study, people's perceptions have become the key concept in the inquiry. Instead of depending on the subjective view of the author, data are collected directly from the people involved by such means as interviews and questionnaires. Instead of looking at cultures far away in distance or time, geographers are looking at their own culture to determine how perception affects the way we use our environment. The main emphasis in the sections which follow is on their more recent studies of environmental perception, though the first section will start with a much older example.

The World

The discussion of perception of environment at the world level which follows consists of two main sections. The first deals with some examples of broad scholarly studies which are concerned with the history of attitudes toward nature. They illustrate the persistence of certain ideas, which today as through the centuries may serve to explain some of man's actions with respect to the environment. The second section is concerned with current conceptions of world areas and peoples, or mental maps, and how they are formed.

Over one hundred years ago Alexander Von Humboldt asserted:

> . . . in order to comprehend nature in all its vast sublimity, it would be necessary to present it under a twofold aspect, first objectively, as an actual phenomenon, and next subjectively, as it is reflected in the feelings of mankind.[23]

To accomplish the latter he traced variations in expressed attitudes and feelings toward the nature of peoples of Indo-European speech, ranging from Northern Europe to Indian tropical regions. Early impressions which Humboldt felt could exercise powerful and lasting effects on the youthful mind are derived from such sources as literary descriptions of nature, the art of landscape painting, and the direct contact with natural forms as in botanical gardens with exotic plant species. Each of these is discussed at length in the second volume of his *Cosmos*. Groups in different areas had their own characteristic expressions of love of nature. Over time in any one area the writings often changed dramatically as nature descriptions, and their effect on emotions, became the major objective rather than an incidental part of the background. Humboldt advocated, as an educational device, the opening in large cities of a number of panoramic buildings, containing pictures of landscapes of different geographical latitudes and from different zones of elevation. He felt that the study of nature was markedly influenced by the feelings of mankind as aroused by literary description, landscape painting, and contemplation of exotic plants.

Sweeping in its scope is Glacken's *Traces on the Rhodian Shore*.[24] Three main themes are traced from classical times to the end of the 18th century: the idea of an earth created by design, the influence of environment on man, and the influence of man on his environment. The attitudes implied in these ideas did not, of course, stop at the 18th century, but continued to the present. An understanding of the origins and early history of these ideas should make more meaningful modern attitudes toward the earth. For example, the present interest in ecology has deep roots which can be traced in the designed earth idea which tried to see earthly environments as wholes, as manifestations of order. The idea of the influence of man on his environment is more important today than ever before, as the inadvertent side effects of man's actions create problems of crisis proportions in our cities, in our air, and in our water. The idea of environmental influence has been most important in discussions of national character. Glacken, writing about the conspicuous interest in national character in 17th Century England, outlined for our times as well the pros and cons of such studies:

> These writings on national character had their attractive and their seamy sides. They provided an outlet for curious, active, and open-minded intelligence; sharp observation often resulted in valuable descriptions of the workday world, diet, and regional differences. Their great weakness was their proneness to bias, to insufferable smugness, often to bigotry. Their crudity lay

in the assumption that it was possible to label nations or peoples quickly and firmly; peoples had to submit bravely to a single label which summed them up. Earlier writings on national character had similar shortcomings, and our own age with its two world wars and many small ones has seen a proliferation of them.[25]

Despite their drawbacks, studies of national character are fascinating. They continue to attract researchers, such as the most recent example from geography, Campbell's call for the consideration of personality as an element of regional geography.[26]

Attitudes toward nature varied greatly in different areas and ages. Tuan has demonstrated that the publicized environmental ethos of a culture seldom covers more than a fraction of the total range of environmental behavior.[27] He compared the Chinese and European attitudes toward environment and noted the discrepancy between these attitudes and behavior. Western humanists commonly point out the virtues of the Oriental's adaptive approach toward nature in contrast to the aggressive masculinity of Western man. Certainly the adaptive attitude toward nature does have ancient roots in China. Yet, in spite of this, deforestation occurred there as a result of certain practices such as the burning of trees to deprive dangerous animals of their hiding places, burning trees to make charcoal for industrial use, and the construction of the old Chinese cities in which timber was the basic structural material. Such practices also had support in ancient ideas. The point to be made here is not that environmental attitudes are not important, but that they are complex, often contradictory, and interact in unpredictable ways.

The persistence of old ideas, even in the face of scientific evidence to the contrary, is well documented in another study of Tuan's, *The Hydrologic Cycle and the Wisdom of God*.[28] In it he points out the remarkably late acceptance of the extent of dry climates in the world. At least one of the factors explaining this was the acceptance as an article of faith of the idea of "the well-watered earth." To acknowledge the extent of deserts would necessitate abandonment of long-held beliefs. This persistence of old ideas is a factor which must be reckoned with on many levels of environmental perception.

Perception of environment, at the broadest level, involves such things as national stereotypes, ethnocentrism, xenophobia, national attitudes, and national character. Teachers wishing to verify the existence of national stereotypes, or ethnocentric views of the world, can do so with a few simple exercises. Haddon, for example, asked students to write down in short phrases or single words, the thoughts and images that

were conjured up by the name of a particular country.[29] The results may prove disturbing to those averse to distortions, but they may also provide a starting point for an areal unit. Another simple device is to distribute a blank sheet of paper and have students draw from memory a map of the world, or issue them an outline map of the world and ask them to fill in the names of the political units present. Even a quick inspection of such data reveals that there are vast areas of ignorance and distortion as one moves away from the home area. An example of ethnocentric thinking commonly spread in our schools is to be seen in the names applied to world areas. For example, Near East, Middle East, and Far East which express the degree to which each of the areas is removed from the assumed center of civilization, Europe. Even such seemingly neutral terms as latitude and longitude reflect the parochial view of an earlier period. They originated in the Mediterranean area where the dimension measured by longitude was indeed longer than that measured by latitude.[30]

Bunge's polemical article, "Racism in Geography," notes many obvious and subtle examples of ethnocentrism in widely accepted geographical concepts.[31] There is no reason to suppose that decision-makers on the international level are entirely free of stereotypic thinking about other nations. For this reason, such perceptions are likely to affect international relations. The importance of such mental images is recognized in the preamble to the constitution of UNESCO, "Since wars begin in the minds of men, it is in the minds of men that the defenses of peace must be constructed."

Some recent studies by geographers have sought clues as to the origin of mental maps. The same sort of parochial outlook noted by Whittlesey above apparently remains, in spite of the possibilities for instantaneous communication from all parts of the world. In fact, the media appear to provide a new source of distortion. For example. Cole and Whysall have demonstrated that the available information sources they investigated tend to amplify the importance of the local area and reduce the importance of other regions.[32] Their world maps, with areas drawn proportional to the number of mentions on the B.B.C. and *Pravda*, show great distortions (Figure 1). Britain is indeed great in the B.B.C. mention map, in fact, larger than any continent. In the *Pravda* version, the U.S.S.R. is large enough to absorb the remainder of the world. Before Americans laugh, they might look at a similar map constructed by Goodey from places named in one issue of *Time* magazine.[33] In this

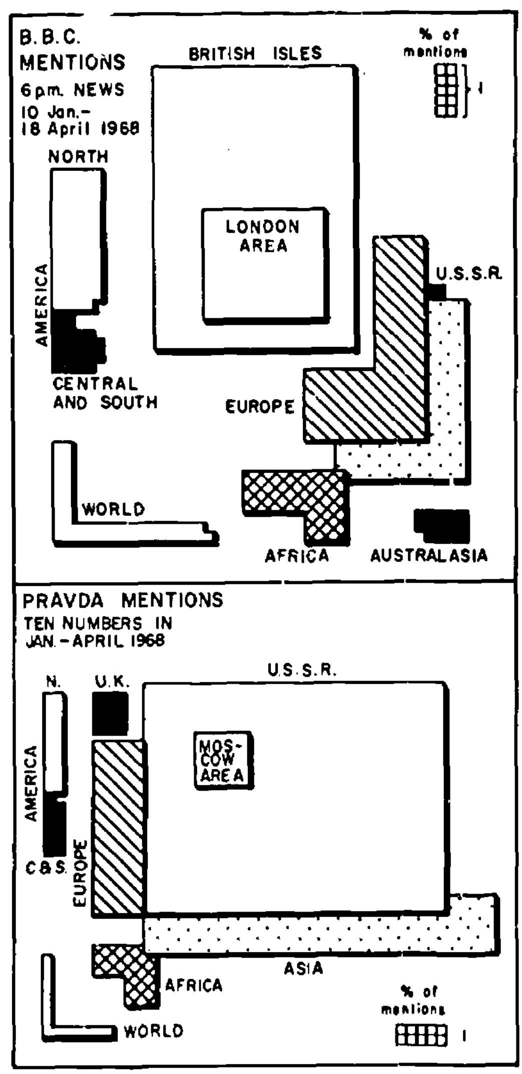
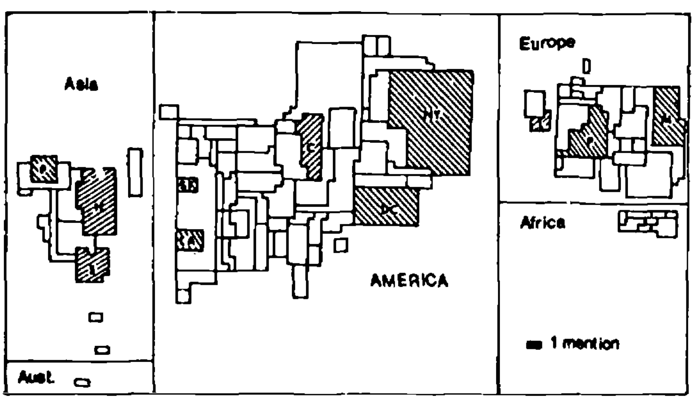

B.B.C. MENTIONS
6 pm. NEWS
10 Jan.– 18 April 1968
BRITISH ISLES
% of mentions
1
NORTH
AMERICA
LONDON AREA
U.S.S.R.
CENTRAL AND SOUTH
EUROPE
WORLD
AFRICA
AUSTRALASIA
PRAVDA MENTIONS
TEN NUMBERS IN JAN.–APRIL 1968
U.S.S.R.
N.
U.K.
MOS-COW AREA
AMERICA
C & S.
EUROPE
ASIA
AFRICA
% of mentions
1
WORLD

FIGURE 1

FIGURE 2

The Geography of an Issue of Time after Goodey

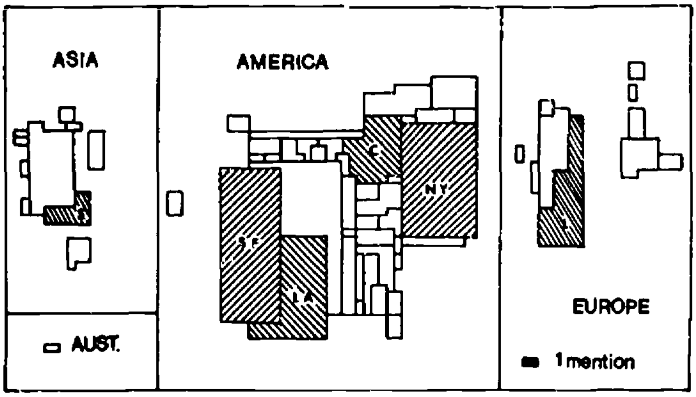


version, Asia seems to consist of Hanoi, Saigon, Peking, North and South Vietnam, and a few minor surrounding places (Figure 2). Europe has more divisions, but is clearly dominated by London, Paris, and Moscow. The United States, of course, is much larger than all the other areas put together, but as in the other maps of this type cities stand out. This urban dominance is even more pronounced in another world map version, again by Goodey, based on four issues of the *Rolling Stones*, a popular music magazine (Figure 3). Here America largely consists of San Francisco and Los Angeles attached to California, and the Northeast largely made up of Chicago and New York. It does not seem likely that the communications media will soon switch to a less biased coverage of the world. Therefore, it is essential that teachers are aware of the existence of the bias so that they can take pains to compensate for it. They might also try to provide their pupils with an empathetic appreciation of the world as seen from various national perspectives.[24]

A paper by Ginsburg examines the Chinese perception of a world order.[25] The traditional view was of a Sinocentric world order. This is in keeping with the examples above in which the world always seems to center on the nation being studied. One difference in the case of China is the length of time that this perception has persisted. For centuries upon centuries, the Chinese remained unchallenged as the central

FIGURE 3

The Geography of Four Issues of Rolling Stones

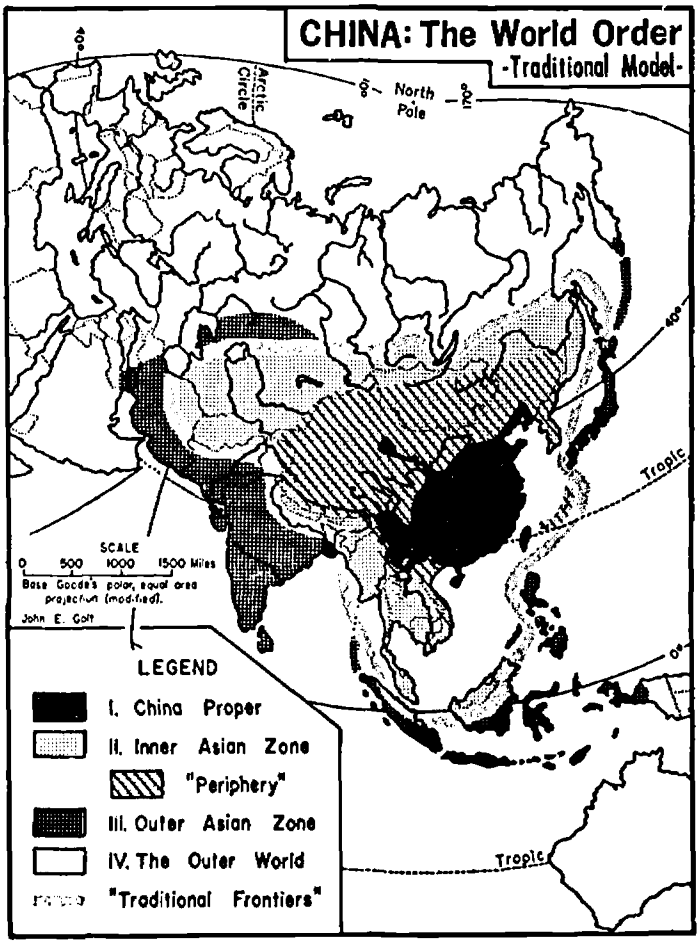


power in a vast Asian orbit. Surrounding the core area of continuous Chinese control, from ancient times, was a series of roughly concentric zones in which their power and authority diminished gradually in all directions. Ginsburg distinguishes four zones as seen in Figure 4. The Inner Asian Zone includes those areas not in the core area (Zone 1), but over which China has exerted various degrees of control and with which she always had intimate relations. The Outer Asia Zone includes areas somewhat farther removed which were relatively well known to the Chinese though, with some exceptions, they were never in true tributary or client relationships with China. The Outer World (Zone 4) contained all the rest, areas of which the Chinese were ignorant of or indifferent toward. It seems likely that the traditional view of the world persists today, with perhaps minor modifications here and there. Without knowledge of such a world view it may be difficult to comprehend the major decisions in Chinese foreign policy. But if the world view is known, the foreign policy is much easier to understand; i.e., Taiwan is regarded as a part of the core area, and certain Soviet provinces were traditionally a part of Zone 2.

The Country

Several different approaches are evident in perception studies at the national level. Among those noted here are studies of national landscapes and landscape preferences as seen in the work of Lowenthal[16]

FIGURE 4

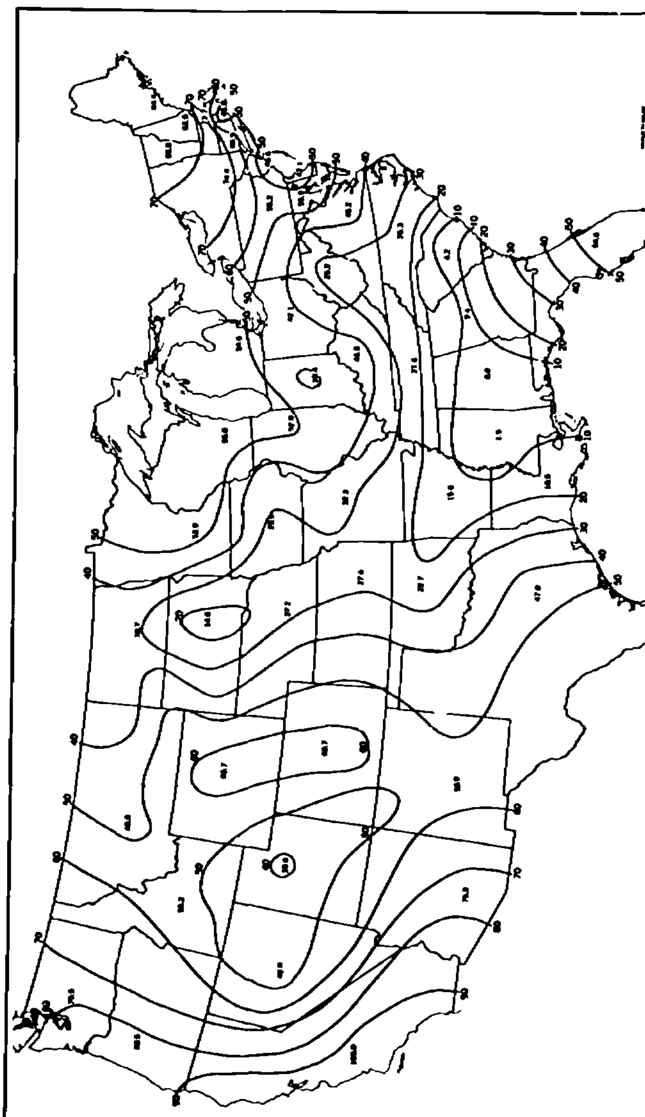


and Lowenthal and Prince,[37] the preference maps of Gould [38] and Gould and White; [39] and an interesting practical application of regional consciousness by Palomaki [40] in Finland.

Lowenthal and Prince collaborated for two studies on "The English Landscape" and "English Landscape Tastes." The emphasis in the

articles is on the thesis that landscapes are formed by landscape tastes. What people perceive as the ideal is what they aim at as they transform the landscape. The idealized images of the past and present are sought by examining travellers' accounts, landscape paintings, literature, and attitudes expressed in speeches, public hearings, newspaper articles, and letters. It is assumed that the articulate minority responsible for such source materials are the people most influential in creating landscape tastes and hence in molding the landscape. The authors suggest that the key to summarizing the relationships between the English people and their landscape is the world "amenity." This term is attached to whatever seems to need protection. Thus amenities may at various times be historic buildings and the flavor of the past, open spaces, views and vistas, facilities for recreation, or access to points of scenic interest. Government departments and private interests exhibit the English talent for compromise, and the result is a settled and comfortable land. Lowenthal later studied the American Scene, which is generally seen by visitors as vast, wild, empty, formless, and unfinished, and subject to violent extremes. But most Americans probably see it in other ways. Lowenthal states that our whole way of life determines our view of nature. Therefore, planning and design should be grounded on an intimate knowledge of the ways people think and feel about environment. But much of this remains unknown. We do not know what, if anything, people really attend to in their surroundings, or what is noticed at home, on vacation, at work, or in the classroom.

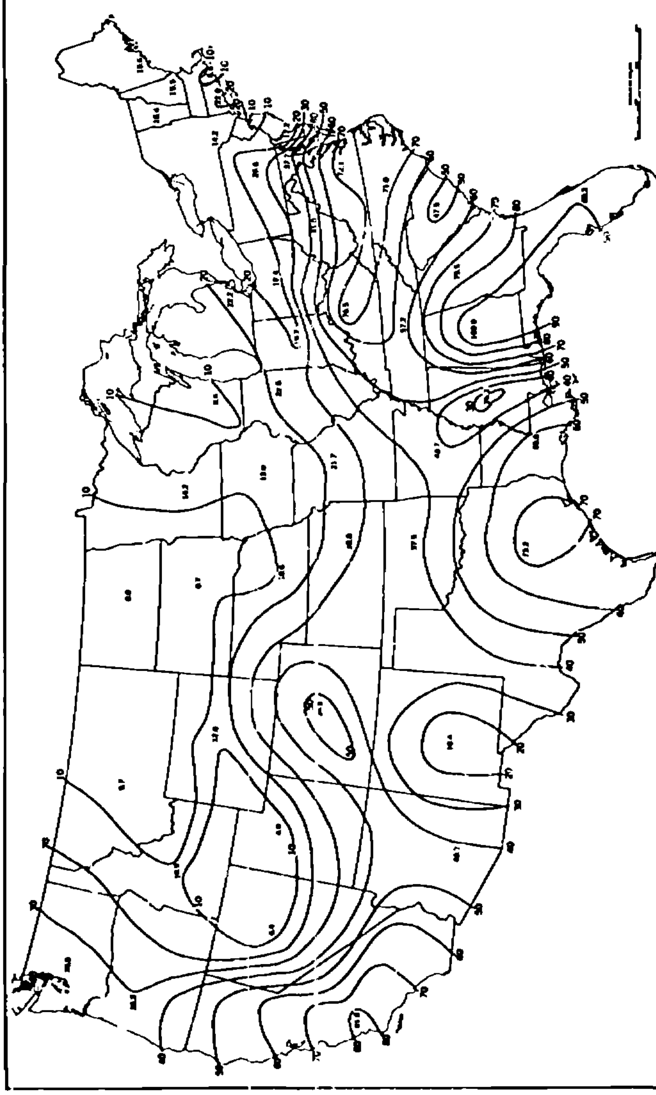
Also at the national level are the studies of Gould on place preferences. Samples of students from different universities were asked to provide rank order listings of their preferences for states in the United States. The scores derived from a principal components analysis of these data were used to construct isoline maps which reflect the relative desirability of various areas to the students. A remarkably similar map of the United States emerged for most groups of American students. The West Coast is seen as the most desirable area. From a high here the surface slopes downward to the Utah perceptual basin, rising once more to the Colorado high. Over the Great Plains there is a general decline eastward with a low point in the Dakotas. Near the 100th meridian, a change takes place with a rise toward the northeast, and a drop in desirability toward the South, the lowest perceptual trough of the entire surface. The map of the California students corresponds rather well to common elements (Figure 5) found on the preference maps from



The View From California: The First Dimension

FIGURE 5

FIGURE 6



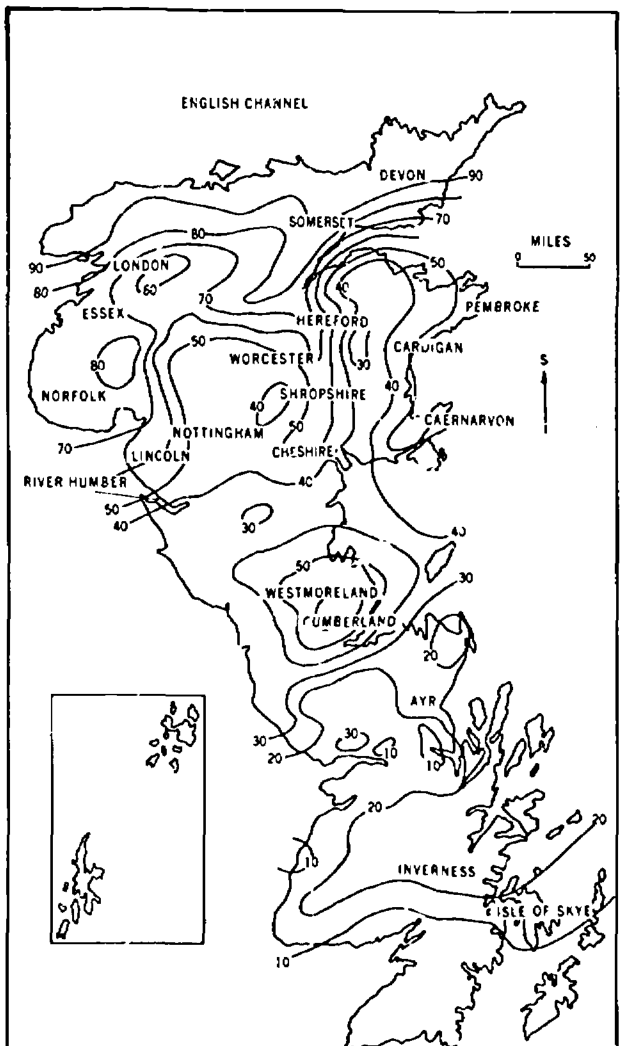
The View From Alabama: The First Dimension

Minnesota and Pennsylvania. The only major exceptions are higher ratings for home areas. However, the maps of Alabama students show a different set of preferences (Figure 6). From their perspective the North is seen as undesirable, the South is more highly differentiated with Alabama the most desirable, and a new low appears over New Mexico. Clearly the home area ranks high in such preference maps. But Goodey's similar study in North Dakota [41] indicates that here at least the home state is not seen as most desirable. However, he found that the most familiar states, that is, the ones most often visited, showed up as most desirable, and these were also the ones to which North Dakotans most generally migrated. Gould and White applied the same sort of procedure to determine British school-leaver's residential preferences. Field work was carried out in 23 locations in the British Isles, and in each case the home area was rated as desirable, even in some cases where the general perception surface for all the groups classifies it as undesirable. Figure 7 shows the general or national perception surface and illustrates another lively aspect of the study of Gould and White, that is, a break from the usual tradition of placing north at the top of the map.

In Finland the province as a regional concept is well-developed, and people have a strong sense of belonging to particular provinces. Palomaki utilized this sense of regional consciousness to delimit the present-day provinces of Finland. A sample of over 5,000 primary school teachers was asked, "To what province do you consider your school district belongs?" The results of the survey were compared with previously defined functional provinces based on central place theory. Although there was in general a good agreement, certain differences appeared. Most outstanding are the presence in people's minds of several provinces in the north which have not as yet developed effective central places. The province of Oulu, for example, splits into three parts while that of Rovaniemi divides in two. In other instances, the historical provinces of Savo and Häme remain conceptual entities though each is made up of more than one functional province. Palomaki's approach could easily be applied in other countries and areas within countries. It would also be interesting to try it in cities to see what kind of neighborhood identification people have. This is clearly related to some of the studies to be discussed below at the urban scale.

FIGURE 7

The general or national perception surface.



Larger Conceptual Regions

Judging by the number of studies, the scale most congenial to geographers is that of an area not so large and complex as a country yet much broader than a city. Perception studies at this scale have been numerous and varied in type. Some center on the concerns of cultural geography and, more recently, on historical geographic themes. Others are concerned with developing models which incorporate behavioral variables. But by far the most numerous and well-established are the set of studies derived from the interest of geographers at the University of Chicago in perception of natural hazards. It is this research tradition which will be the major focus of attention in the following section.

An early example in cultural geography is Fonaroff's study of the Navajo tribal range.[42] He showed how a federal program of stock reduction for this over-grazed range failed because the officials did not take into consideration the Navajo society's perception of the situation. The same sort of failure may attend many, if not most, well-meaning but ill-informed attempts to improve techniques of people in the non-Western world. In such situations it is essential to start where the people are, by investigating their perception of the situation. This is well-illustrated by the study of Blaut and others in the severely eroded Blue Mountains of Jamaica.[43] Here he found that one of the reasons conservation methods were not being accepted by farmers was that they failed entirely to perceive, or perceived imperfectly, the process of soil erosion in cause and effect terms. In order to introduce the desirable conservation methods in such a situation it would be essential to start any educational program at the level of local beliefs. A positive example is provided by Boxer's analysis of the urbanization process in a development area of Hong Kong's New Territories.[44] Here a smooth transition to a modern urban-industrial society has been facilitated because the planners and administrators have been sensitive to the *feng-shui* beliefs of the agricultural villagers. These traditional beliefs provided definite ideas as to the manner in which urban space should be allocated. The officials involved showed an understanding of the importance of the people's ideas by taking great pain to arrive at a consensus. In addition to financial compensation, building rights, and provision of new temples and shrines, the Government also paid for the employment of geomancers to supervise site construction and village removals and to ameliorate the damaging effect on *feng-shui* resulting from topographic alterations. Though

Boxer's study is of an urban area, it is noted here because of its similarity to the studies just considered.

Somewhat different in orientation are historical studies which use past perceptions of environment as a device to explain development or use of an area. Two recent examples of this type are those of Bowden [45] and Newcomb.[46] Bowden examined the idea of the Great American Desert which has been commonly stated as existing in the public mind during the first half of the nineteenth century. If such an image existed, it might be expected to have slowed or halted migration to the perceived desert interior of the continent. Bowden analyzed newspapers, atlases, gazetteers, geographies, and school books of the period from 1800 to 1860. He found that the desert image was confined mainly to the educated elite of New England and the North East, and doubted that the image was even shared by the elite of the South, the Interior, or by the less well-educated folk who were the potential settlers. Newcomb studied a small area in Northern Jutland, Denmark, from the Stone Age to the advent of the Industrial Revolution. He speculated on the ways in which people apparently perceived the Vester Han Herred district, and how aspects of these perceptions were fulfilled in terms of natural resource exploitation. Five phases are described: the Stone Age mining of flint; the selection by Vikings of building sites for both ritual and settlement purposes; the medieval construction of parish churches out of glacial debris; the replanning of the rural landscape by means of enclosure; and the more recent impact of reclamation projects. Each of these phases involved a precise perception of particular resources, and each has left clearly demonstrable effects on the present-day land surface.

A burgeoning research theme in geography, which involves a consideration of perception, is that of spatial diffusion.[47] Studies of this type have had a strong emphasis on model building. They attempt to systematically work out the spatial dimensions of the communication process which is basic to an understanding of the diffusion of innovations in a community or region. Most of these are derived from the work of Hägerstrand in Sweden. Wolpert,[48] for example, demonstrated that a sample of population of farmers in Sweden did not optimize their resource productivity. In part this was because they did not have perfect information due to the unpredictable change and lag in the communication and perception of information. Later studies have attempted to develop models to help explain the communication process.[49]

The geographic work on perception of natural hazards has been ably summarized by the principal researchers Burton, Kates, and White.[50] They describe the paradox presented by growing damages due to natural hazards, even as man becomes more able to manipulate or control certain aspects of nature. Geographers have long been curious about the behavior of people who persistently return to resettle areas after devastation by floods, volcanoes, earthquakes, drought, or other natural disasters. Although it seems likely that modern man is more aware of the risks of repeated disasters, the reinvasion of hazard zones probably continues as in the past. In fact, even more pressure is probably placed on these areas as population numbers grow and man and his works continue to spread over the earth. And, with increasing pressure on resources, a more delicate adjustment to nature becomes necessary.

To understand the long-term human adjustment to hazard, the inhabitants' view of the hazard is sought. This provides the possibility of assessing man's ability to perceive and understand the world around him and to choose appropriate courses of action. Improved public policies may be achieved by educating and informing in areas where knowledge is deficient. In many cases this could mean providing the people involved with a broader view of the complete range of theoretically possible adjustments. As can be seen in Table 1, there are many more possibilities than the prevailing public approach of offering immediate relief followed by a technological solution as when dams follow floods and irrigation projects follow droughts. Clearly there are many alternatives. The problem of flood damage, for example, might be more wisely handled by preventing dense development on flood plains rather than relying on the commonly perceived solutions of bigger dams and levees. With a more rational adjustment, much loss of life and other damages could be avoided both on a national and a global level. Russell [51] suggests that the chances for such a societal adjustment would be much improved if our ideal of mastery over nature were modified to admit the inevitable occurrence of some losses. Discussions could then take place to carefully assess the most desirable balance between the level of expected losses and the costs of further adjustments to avoid them.

The perception of hazard,[52] whether due to flood,[53] drought,[54] snow,[55] landslides,[56] tidal waves,[57] or coastal storms,[58] involves a high degree of abstraction and generalization of a complex reality. Although experts are able to work out with some precision the chances of recurrence of various hazards, they can not, of course, predict exactly when they will

TABLE 1

THEORETICAL RANGE OF ADJUSTMENTS TO GEOPHYSICAL EVENTS

Class of Adjustment	EVENT		
	Earthquakes	*Floods*	*Snow*
Affect the cause	No known way of altering the earthquake mechanism	Reduce flood flows by: land-use treatment; cloud seeding	Change geographical distribution by cloud seeding
Modify the hazard	Stable site selection: soil and slope stabilization; sea wave barriers; fire protection	Control flood flows by: reservoir storage; levees; channel improvement; flood fighting	Reduce impact by snow fences; snow removal; salting and sanding of highways
Modify loss potential	Warning systems; emergency evacuation and preparation; building design; land-use change; permanent evacuation	Warning systems; emergency evacuation and preparation; building design; land-use change; permanent evacuation	Forecasting; rescheduling; inventory control; building design; seasonal adjustments (snow tires, chains); seasonal migration; designation of snow emergency routes
Adjust to losses:			
Spread the losses	Public relief; subsidized insurance	Public relief; subsidized insurance	Public relief; subsidized insurance
Plan for losses	Insurance and reserve funds	Insurance and reserve funds	Insurance and reserve funds
Bear the losses	Individual loss bearing	Individual loss bearing	Individual loss bearing

occur in any one area. Non-professionals are even less at home with the probabilities of risk and the uncertainty. Some of the common responses to the uncertainty of natural hazards are indicated in Table 2. Society's handling of extreme natural events might be considerably improved if the average man could be educated to think rationally about random events. When rare random events are considered from a global perspective, they no longer appear infrequent or unusual. Hewitt notes that the "once-in-two-thousand year" event for a 10,000 square mile area in North America may turn out to have an average global recurrence of

TABLE 2

COMMON RESPONSES TO THE UNCERTAINTY OF NATURAL HAZARDS

Eliminate the Hazard		*Eliminate the Uncertainty*	
DENY OR DENIGRATE ITS EXISTENCE	DENY OR DENIGRATE ITS RECURRENCE	MAKING IT DETERMINATE AND KNOWABLE	TRANSFER UNCERTAINTY TO A HIGHER POWER
"We have no floods here, only high water."	"Lightning never strikes twice in the same place."	"Seven years of great plenty . . . . After them seven years of famine."	"It's in the hands of God."
"It can't happen here."	"It's a freak of nature."	"Floods come every five years."	"The government is taking care of it."

several times per year.[59] Table 3 shows the relative importance of various types of natural hazards in the world as gauged by the loss of life attributed to each during the period 1947-67.

From a consideration of hazard perception, the work of geographers has developed in a number of directions. There has been a broadening and deepening of hazard research, utilizing a broader range of methods.[60]

TABLE 3

PERCENTAGE OF TOTAL LOSS OF LIFE FOR EACH DISASTER TYPE

Disaster Types	*Number of Lives Lost*	*% of Total Loss of Life*
Floods	173,170	39.2
Rain	1,100	0.2
Gale and Thunderstorms	20,940	4.7
Blizzards and Snowstorms	3,520	0.8
Sand, Dust Storms	10	—
Cyclone and Tidal Waves	89,440	20.2
Tidal Waves	3,180	0.7
Hurricanes	13,225	3.0
Tornado Groups	3,395	0.8
Typhoons	52,400	11.9
Hailstorms	—	—
Heatwaves	4,675	1.1
Cold Waves	3,370	0.8
Fog	3,550	0.8
Earthquakes	56,100	12.7
Volcanoes	7,220	0.6
Avalanches	3,680	0.8
Landslides	2,880	0.7
Total	441,855	100.0

There has been an attempt to move towards a more general understanding of the role of attitudes in resource management. This development has included studies of attitudes toward water, in general, plus specific studies of water use for industry, domestic supplies, and recreation. In addition, there has been increasing interest in public attitudes toward air and water pollution. In all cases attention has been focused on the key decision-makers, as will be noted below.

What is currently known about public attitudes toward environment, some of the pitfalls involved in attitudinal studies, and how attitudes relate to actions are discussed in a pair of papers by White and Lowenthal.[61] White opens with the statement that:

> At the heart of managing a natural resource is the manager's perception of the resource and of the choices open to him in dealing with it. At the heart of decisions on environmental quality are a manager's views of what he and others value in the environment and can preserve or cultivate. This is not a conclusion. It is a definition: natural resources are taken to be culturally defined, decisions are regarded as choices among perceived alternatives for bringing about change, and any choice presumes a view of the resource together with preferences in outcome and methods.[62]

Perception of the resource, and the range of choice, has been discussed briefly above in connection with natural hazards. The role of attitudes is still far from clear, but they appear to enter into decisions in three ways: first, through the personal attitudes of those making the decisions; second, through their opinions as to what others prefer; and third, through their opinions as to what others should prefer. One problem is that too many decisions are made on the basis of someone's opinions of other peoples' attitudes without any real knowledge as to what these attitudes are. For example, officials in New York rejected many technically feasible, and economically attractive, sources of water supply because they felt that the people of New York preferred pure upland supplies, and would be unwilling to drink water from closer polluted sources, such as the Hudson River. The important point is not whether this was true or not, but that the officials made the decision on the basis of an untested assumption as to the people's preferences or, perhaps, what the officials thought they should prefer. Since this basis for decisions is not uncommon it becomes important to probe the attitudes of the decision-makers. One significant finding is that decision-makers often feel a strong professional identification which tends to shape their perception of the environment. Thus conservationists, economists, foresters, and engineers

would see environmental problems and solutions in terms of their professional role which might be further removed by the principal concern of the agency which employs them Engineers, for example, see themselves as technical advisors, not professionally competent to trace all the social impacts of particular decisions, yet they are heavily relied upon for their advice on a broad range of water problems with broad social, political, and economic implications.[63]

The water system feels the hand of men more than any other aspect of the natural environment. Therefore, it is not surprising that much research has been directed towards an understanding of the attitudes toward water and decision-making in resource management. Particular aspects of water management have been examined in detail. Some examples are the work of Wong on industrial water,[64] the study on the domestic water supply by MacIver,[65] Baumann's research on the use of water reservoirs for recreation,[66] and Barker's on perception of water pollution as a factor affecting recreational use.[67]

An expanding area of perception research in resource management is that concerned with recreation. This might be expected to continue to grow as increasing affluence, greater leisure time, greater mobility, and a growing population produce further pressure on outdoor recreation areas. As congestion in national parks and forests increases, isolated areas become rarer and concern for wilderness preservation grows. However, this concern may not be shared by all. Some people seek some sort of communion with nature and the privacy of the wilds, but many others prefer maximum social contacts and the conveniences of home when they go camping.[68] To provide for all, more information on attitudes toward nature and wilderness are needed. Lucas found that in the Boundary Waters Canoe Area of northeastern Minnesota there were two main types of visitors.[69] Each had different areal perceptions of wilderness, and these differed in turn from the officially designated wilderness of the resource managers. Motorboatists were less bothered by other people, by roads, or by logging than canoeists. The delimited wilderness of canoeists, as outlined on maps, was much smaller in area than that of the motorboatists. Zoning within the wilderness area would make it possible to provide for the perceived wilderness of each. The same zoning approach could be used in other types of wilderness, or recreation areas, to provide for the different needs of the backpacker and the tote-goat folk.

The City and Smaller Areas

In moving from a consideration of broad conceptual regions to the scale of the city, or smaller areas, the number of geographic studies of perception drops rapidly. Two recent reviews of aspects of the literature on perception as related to urban areas by geographers at the University of Toronto illustrate the paucity of empirical work by geographers. The reviews of both Bunting and Punter [70] consist essentially of studies by people in other disciplines. Goodey's [71] review for urban and regional studies relies more on the work of geographers, but his intention is different. His study pulls together research at many different scales to illustrate how they could be used in urban and regional research. This is a useful approach since the techniques developed in studies of a particular scale can probably be fruitfully applied at other smaller or larger scales. So far geographers have produced only a few scattered perception studies at the city scale or smaller sizes. These represent the diffusion into geography of concepts, or approaches from other social sciences. For the purposes of this chapter a few representative studies will be selected, more to illustrate the diversity of approaches than to generalize about current research results. The discussion starts at the broadest level and proceeds toward smaller portions of the urban environment.

At the broadest level would appear any studies concerned with the entire urban area. Examples could include Rooney's study on the urban snow hazard in the United States.[72] This is an application of hazard research and really fits on a broader scale. Many cities are compared in terms of the degree of disruption due to snow. Another example is the article of Lycan and Sewell on perception of air and water pollution in the urban environment of Victoria, British Columbia.[73] This study could also be considered an extension of the research on natural hazards with the more recent move toward questions of how people perceive the man-created hazards of air and water pollution. In Victoria the pollution problem is small compared to many cities. Still a pollution problem was perceived, and people in different areas of the city viewed the problem differently. However, the spatial variation appeared to depend more on the general attitudes and attributes of individuals than proximity to the sources of the problem. Perception of pollution seemed to be correlated with such attitudes as a concern for pleasant climate and natural beauty and a dislike of high rise apartments and urban sprawl. In addition, sophistication gained through travel or residence in other areas tended to relate to recognition of a local pollution problem.

A technique which provides input for comprehensive design of cities is that advanced by Kevin Lynch and since applied by people in many different fields at various scales.[74] Some studies by the author illustrate its application in geographic research.[75] The main aim is to provide information as to how people use the city and find their way around in it. By having a person sketch a map, and describe the parts felt to be most distinctive, an individual image of the city is obtained. This can be described in terms of the main elements, paths, edges, districts, nodes, and landmarks.

Studies in Tucson and Chicago indicate that, in spite of individual and group variations, there is a high degree of conformity and consistency in the major elements so that one can speak of the public image. This was the case in a study of the University of Arizona Campus and in another of the Chicago Loop (Figures 8, 9, and 10). In the latter case, three groups were tested. Each drew maps and listed the most distinctive areas in the Loop. Certain areas and elements were included or omitted from the composite maps of all three groups. The grid pattern was noted. The distinctiveness of the image diminished westward and north-south streets were dominant. Major elements which appeared to some degree in all maps were State Street with its department stores, the contrast between the open space of Grant Park and the massive wall of Michigan Avenue, the canyon-like LaSalle Street dominated by the Board of Trade Building, and the vista of major landmarks lining the north branch of the Chicago River. However, the workers within the Loop tended to have a more tightly defined area, with more internal detail, while groups from the outside included a broader area, with much more emphasis on external landmarks.

The technique is simple and easy to apply and analyze. Teachers could readily gain an impression of the city's image by having their students sketch a map of it. It would be interesting to find out what elements are added or omitted at various age levels. The same exercise could be tried at the neighborhood level to be considered below.

Studies such as the one just discussed are concerned with what is included in the image of the city, rather than why certain elements are included. To fully answer why would require an understanding of the role of sentiment and symbolism. A recent master's thesis by Bunting discusses the Toronto City *Hall* as an urban symbol.[76] Since its unveiling as the winning design in an international contest, the city hall has been the center of controversy. It has a striking design, with two curv-

FIGURE 8

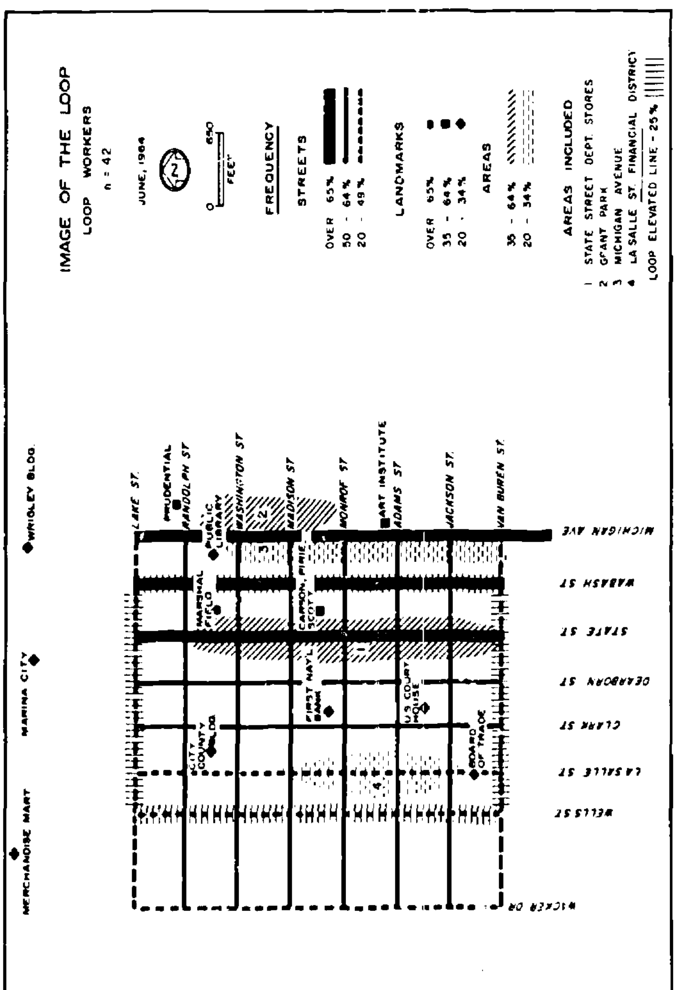


IMAGE OF THE LOOP
LOOP WORKERS
n = 42
JUNE, 1964
0 650
FEET
FREQUENCY
STREETS
OVER 65%
50 - 64%
20 - 49%
LANDMARKS
OVER 65%
35 - 64%
20 - 34%
AREAS
35 - 64%
20 - 34%
AREAS INCLUDED
1 STATE STREET DEPT. STORES
2 GRANT PARK
3 MICHIGAN AVENUE
4 LA SALLE ST. FINANCIAL DISTRICT
LOOP ELEVATED LINE - 25%
MERCHANDISE MART
MARINA CITY
WRIGLEY BLDG.
LAKE ST.
PRUDENTIAL
RANDOLPH ST
PUBLIC LIBRARY
WASHINGTON ST
MADISON ST
MONROE ST
ART INSTITUTE
ADAMS ST
JACKSON ST.
VAN BUREN ST.
MARSHALL FIELD
CARSON, PIRIE, SCOTT
FIRST NAT'L BANK
CITY COUNTY BLDG.
U.S. COURT HOUSE
BOARD OF TRADE
MICHIGAN AVE
WABASH ST
STATE ST
DEARBORN ST
CLARK ST
LA SALLE ST
WELLS ST
WACKER DR

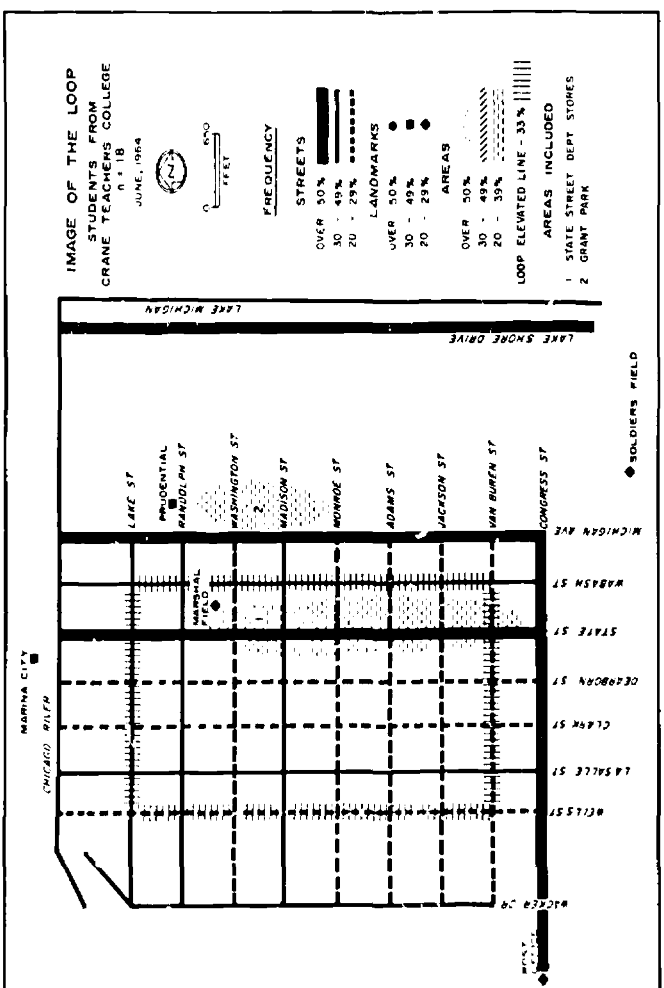


IMAGE OF THE LOOP
STUDENTS FROM
CRANE TEACHERS COLLEGE
n = 18
JUNE, 1964
0 FEET 650
FREQUENCY
STREETS
OVER 50%
30 - 49%
20 - 29%
LANDMARKS
OVER 50%
30 - 49%
20 - 29%
AREAS
OVER 50%
30 - 49%
20 - 39%
LOOP ELEVATED LINE - 33%
AREAS INCLUDED
1 STATE STREET DEPT STORES
2 GRANT PARK
LAKE MICHIGAN
LAKE SHORE DRIVE
SOLDIERS FIELD
LAKE ST
PRUDENTIAL
RANDOLPH ST
WASHINGTON ST
MADISON ST
MONROE ST
ADAMS ST
JACKSON ST
VAN BUREN ST
CONGRESS ST
MICHIGAN AVE
WABASH ST
STATE ST
DEARBORN ST
CLARK ST
LA SALLE ST
WELLS ST
WACKER DR
MARSHAL FIELD
MARINA CITY
CHICAGO RIVER

FIGURE 9

FIGURE 10

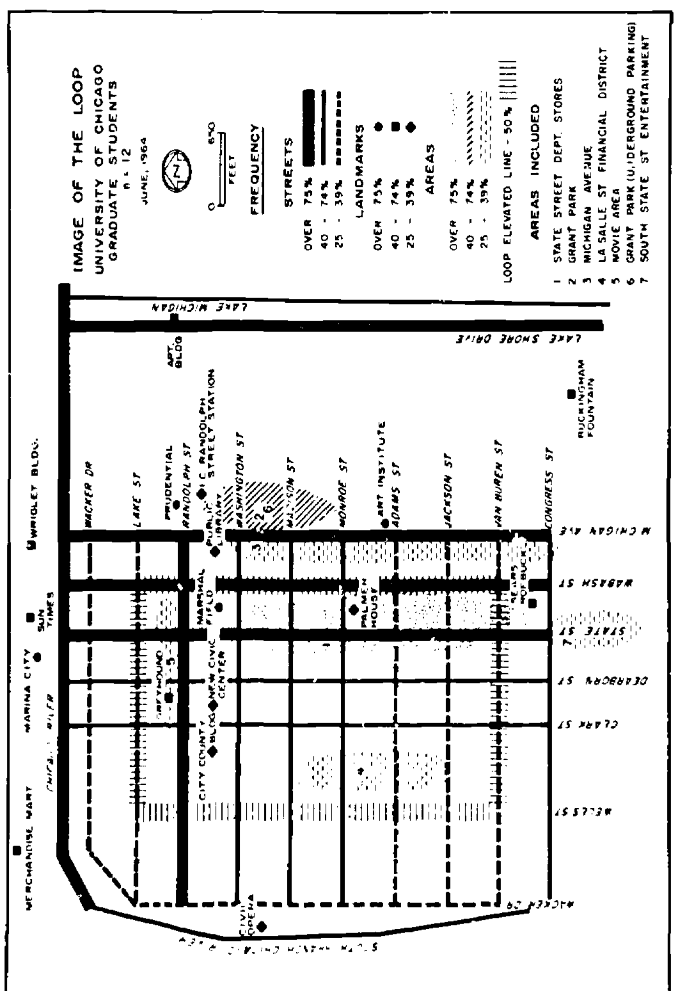


IMAGE OF THE LOOP
UNIVERSITY OF CHICAGO
GRADUATE STUDENTS
JUNE, 1964
FEET
FREQUENCY
STREETS
OVER 75%
40 - 74%
25 - 39%
LANDMARKS
OVER 75%
40 - 74%
25 - 39%
AREAS
OVER 75%
40 - 74%
25 - 39%
LOOP ELEVATED LINE - 50%
AREAS INCLUDED
1 STATE STREET DEPT. STORES
2 GRANT PARK
3 MICHIGAN AVENUE
4 LA SALLE ST FINANCIAL DISTRICT
5 MOVIE AREA
6 GRANT PARK (UNDERGROUND PARKING)
7 SOUTH STATE ST ENTERTAINMENT
LAKE MICHIGAN
LAKE SHORE DRIVE
APT. BLDG
BUCKINGHAM FOUNTAIN
WRIGLEY BLDG.
SUN TIMES
MARINA CITY
MERCHANDISE MART
WACKER DR
LAKE ST
PRUDENTIAL
RANDOLPH ST
I.C. RANDOLPH STREET STATION
PUBLIC LIBRARY
WASHINGTON ST
MONROE ST
ART INSTITUTE
ADAMS ST
JACKSON ST
VAN BUREN ST
CONGRESS ST
MICHIGAN AVE
WABASH ST
STATE ST
DEARBORN ST
CLARK ST
WELLS ST
MARSHALL FIELD
PALMER HOUSE
GREYHOUND
NEW CIVIC CENTER
CITY COUNTY BLDG
CIVIC OPERA
WACKER DR

ing walls, 27 and 20 stories tall, shielding the centrally placed dome of the Council Chambers. Whether this progressive symbol was reacted to positively or negatively was strongly influenced by the individual value systems. Conservative people tended to react negatively to it and to the kind of city it symbolizes.

Another type of sentiment, or symbolism, is associated with perception of neighborhoods. This is a type of study more thoroughly investigated in recent years by sociologists.[77] Only a few samples of this type have been completed by geographers interested in this form of regional consciousness or territoriality. Zannaras[78] and Metton[79] both defined neighborhoods by using individual delimitations of the area on maps provided. The summation of individual action spaces produced a common spatial area which could be designated as the neighborhood for the majority of the respondents. Metton, whose data was derived from a densely built-up area of Paris, found that the form and size of the neighborhood depended on the relative locations of the home, the market, and local commercial establishments. In his area, the size was on a pedestrian scale, that is, limited to a distance that people would find convenient to cover on foot. Similar studies would be useful in less densely built-up areas where the automobile is dominant. One good reason for making studies of neighborhoods might be to avoid the kind of situation described by Doeppers which occurred in the Globeville neighborhood in Denver.[80] Here a freeway was constructed which cut through the social fabric of an old ethnic neighborhood and contributed to its decline.

Some recent geographic studies, somewhat similar to these on neighborhoods, indicate an increasing interest in the use of perception in urban areas. Horton and Reynolds propose to examine the formation of action space in the city.[81] The action space of an individual is defined as the area within which he has contact, and within which his activities take place. Another study has investigated the perceived distance between selected points within the city of Columbus, Ohio.[82] One interesting finding was that there was an underestimation of distance in areas away from the Central Business District (CBD) and an overestimation of distance in the area toward the CBD. Reasons suggested to account for this were that increasing congestion and travel time tend to increase the perceived distances between places, and that a denser packing of land uses toward the CBD makes distances appear longer.

The smaller American city has been the subject of some excellent articles by an empathetic participant observer, J. B. Jackson, in *Landscape*. "Other-Directed Houses" [83] and "The Stranger's Path" [84] provide perceptive analyses of certain selected but ubiquitous features of the American scene. The first is concerned with the way the public perceives and uses the highway strips leading out of our towns. The second discusses the probable sequence of scenes and business encountered by the stranger as he enters any small American city. The Path is primarily a district for unattached men from out of town replete with bars, beer parlors, lunch counters, pawnshops, hotels, missions, and entertainment establishments which line the way from the railroad or bus depot to Main Street. It is generally "loud, tawdry, down-at-the-heel, full of dives and small catch-penny business," and as such, subject to no small amount of disapproval by some respectable elements of the community who often do not recognize the purposes it serves. For, in spite of its evident lack of respectability, the Path provides an entry point to the city where all sorts of marginal businesses can get started, survive, and thrive. It serves as a lively place of general exchange, which is one of the chief purposes of the city. When urban renewal indiscriminately bulldozes such areas, it is not just eliminating a dirty and decaying portion of the city but an important portion of the pedestrian stream without which the most expensive or impressive civic center remains lifeless and uninviting. Planners should remember that planning must provide a place for all people and activities if the city is to remain a vital central place.

Other studies of the impressions of people moving along paths provide, perhaps, the smallest scale of research on perception which geographers have considered to date. An ambitious study by Lowenthal [85] has involved testing a large number of subjects as they move along a series of paths. By noting all their impressions along varied paths an effort is being made to develop a standard set of environmental dimensions. Clayton [86] carried out a similar study in which he tried to determine the rural-urban breakpoint along a set drive, ranging from an urban to a rural environment. His findings suggest that there is a strong subjective element in the interpretation of the terms rural and urban.

Conclusions

This brief overview of the work of geographers on perception of environment is not evenly balanced according to different scales. Much

more has been done at the broad regional level than at other scales. Thus, the discussion of perception of natural hazards involved a higher degree of generalization than that of the world, country, city, or smaller areas where less work has been done. It seems likely that this state of affairs is not permanent. There is evidence of a growing interest among geographers in how people perceive all aspects of their environment. Ten years hence a very different impression would be likely, with a more even balance, and a greater degree of generalization at all levels. But in the future, as today, one should realize that the work of geographers is only one segment of the broader interest among social scientists, designers, planners, and others, in perception of environment. For the teacher, these are clear implications of how such research should be used. If citizens are to make wise decisions with respect to the environment, it is essential that they be provided with an accurate assessment of the man-environment relationship. This applies at all levels, from the local area to the world. Any efforts that teachers make to expand or explore the mental horizons of their students by means of environmental perception studies should be useful. It not only will provide the teacher with a better idea of the gaps in knowledge, but it should stimulate the students to examine their environment with a greater degree of curiosity.

FOOTNOTES

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[5] Whittlesey. p. 14.

[6] For a thorough discussion see: Tajfel, Henri. "Social Perception." *International Encyclopedia of the Social Sciences*. pp. 567-575.

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Chapter 4

Changing Urban Spatial Patterns

Arthur Getis

The writer's freshmen students, whose homes are in all sections of New Jersey, are unfamiliar with Philadelphia and New York. In fact, most have little idea of what Newark, New Jersey's largest city, is like. These young people, mostly from middle class communities, are typical of most suburbanites today. That is, they find little need to leave the suburban environment for their day-to-day needs, and they have no real desire to be city dwellers. When they marry they look for apartments far from the city center, a course of action that was virtually impossible a decade or so ago, when there were few apartments in the suburbs.

The urban areas of present-day United States can quite easily be divided into two parts, the central cities and the suburbs. Each part is quite completely self-contained in terms of the services offered its residential population, and each part is becoming more and more a workplace for those who live there. This latter fact is modified by the increasing role of the central business district in supplying business services to both central city and suburb.

What the 1960's showed us is that with large scale agriculture and the use of labor-saving machines, the national settlement pattern can very well be one of urbanization. The 1960's with their turmoil and

urban unrest were the precursors of the 1970's — what might be called the beginning of the urban age. But what a portentous beginning. No longer are we to think in urban-rural terms. It is much more realistic to be conscious of central city–suburban differences.

The mass movement to central cities in the last seventy-odd years was modified in the 1940's by an equally important movement toward the suburbs. People who had come from rural areas to the cities found it was possible for them and their children to live outstide the central city and commute to work. In the 1960's the movement was not only a continuation of this outward thrust, but significantly most new suburban residents came from smaller cities or from suburbs of other cities. The result has been the development of a new dichotomy in our society. There is now a central city life-style and a suburban life-style. Each group has little understanding of the other. On the surface the suburbanite sees little need for the central city. The central city slum dweller has but a minimal knowledge of the way of life of the suburban resident. On a personal level, then, the two parts are quite disparate, but in a functional, cold, commercial environment we can see their interdependence. Above and below the ground, myriads of wires and pipes, and highways and railways tie the urban areas together. If we in the 1970's are to be in a position to cope with the urban age, we must realize the interdependence of the system called "the city" which includes both slum and subdivision.

In this chapter we briefly explore the modern city through approaches taken by geographers. The concepts and techniques geographers use to analyze urbanization are outlined, with significant terms and expressions italicized. It is hoped that the usefulness of this approach will be self-evident, and that the annotated bibliography at the end will act as a guide for classroom exploration of the problems that urbanization has brought.

How Urban Areas Have Grown

To say that cities have grown is an understatement. The metropolitan population of Cleveland is today two million, when a generation ago it was one million. Further, Cleveland has not been thought of as a glamour city — one which is attractive to retirees or to those searching for a comfortable life. Such cities as Miami and Tucson have grown beyond imagination, from outposts of civilization just 30 or 40 years ago, into bustling metropolitan areas.

Urban areas are burgeoning because people have found that it is economically efficient to live in them. Jobs are available. Those who create jobs find that they can achieve *economies of agglomeration* there. That is, benefits resulting from urban conveniences accrue to the firm which locates in an urban environment. This is true whether the firm is a research organization, a metal-stamping plant, or a bank. The freeways and railways of the city, and the relatively short distances between the suppliers, the workers, and the customers, bring savings in time and cost. This potential accessibility is attractive. Economy in production is a result. This means that industries of all kinds group in and around metropolitan areas. It is this agglomeration that has spurred the large scale growth of most cities.

In our urban age, the *primary stage* activities, such as mining and lumbering, and the *secondary stage* activities, such as manufacturing and processing, do not stimulate growth as much as do the *tertiary* and *quaternary stage* activities. In a complex, technologically motivated society it is the service industries which expand at the most rapid rate. The tertiary stage industries, such as goods and service retailers and wholesalers, are found in larger numbers than ever before. Those supplying business and professional services to industry form a new large mass of quaternary activities. Firms such as IBM, Control Data, and Xerox are growing rapidly and have offices in most metropolitan areas.

From the turn of the century on, the increase in technology and the development of job opportunities in urban areas made cities attractive to those employed in agriculture. The need for agricultural laborers was reduced, and the cities filled with these people searching for a better life. By the 1960's, however, the great movement from farm to city was for all practical purposes a thing of the past — with one notable exception. Today it is the rural black people of the South who are on the move, seeking employment and opportunity in the metropolitan areas of the country.

Great urban motorways make it relatively easy to move goods and people around metropolitan areas. As a result, population densities have declined somewhat as people trade accessibility for living space. With comfortable automobiles as opposed to crowded buses the extra commuting time seems no great sacrifice. Only in the central business district of the largest cities is there still a desire to crowd. Huge office buildings are transforming the centers of most cities into business heartlands, but retailing is not keeping pace as the storeowners follow their

customers to giant shopping centers in the suburbs. Retailing in most city centers is designed to serve more and more the vast numbers of office workers and less and less the casual woman shopper.

What Went Before Influences Us Now

No matter what progress in transportation technology takes place, the city is still tied to its past. The activities of people in the city today have grown out of what has preceded them. Ports have been modernized, railyard operations owe much to computer efficiency, steelmaking seems almost like a dehumanized process, but our cities grew up around these originally human intensive activities. The commerce due to heavy industry, and not heavy industry itself, has now altered our urban areas. These early economic stimulants are with us today in a new form, but they are not missing from the landscape at all.

The patterns of land use developed in earlier generations continue to affect us. Street systems are a case in point. There have been attempts to superimpose a system of urban freeways on the narrow streets of a pre-automobile society. While this is possible, it is difficult to alter the old street patterns. As the automobile era continues to gain momentum, the narrow colonial streets of Philadelphia and Boston, little more than alleyways by today's standards, are increasingly difficult to cope with. Only far-sighted administrators and planners seem to be able to extricate cities from their potential demise. Cities, with their legacy of past patterns, are unable to move vibrantly into the future without intelligent decisions by people who understand their past and have the necessary knowledge to attempt to predict their future.

The early American city was essentially simple in pattern. Workplaces were within walking distance of the home or, at a later stage, a trolley ride away. Shops were found at the corners of blocks and sometimes in between. Things had become more complex by the time that Burgess wrote in the 1920's, but still he was able to depict the city in a fairly straightforward way by constructing a series of concentric rings about the central business district (Figures 1A and 1B).* Although he was most influenced by the pattern in Chicago at that time, the *concentric zone arrangement* of land uses was generally accepted as a reasonable approximation of American cities. Hoyt's view that transport arteries distort the concentric zones into *sectors* has been interpreted as a refinement of the Burgess scheme (Figure 2). The signifi-

* For the purpose of facilitating analysis, Figures 1A, 1B, 2, and 3 appear on consecutive pages 106-109 and are uninterrupted by textual material.

cance of these spatial views of more than a generation ago is the implication that there is order to city land-use systems and that there are predictable zonations. Cities differ not so much in how they look or how they function, but in their special economic base: agriculture, mining, shipping, or whatever it may be.

Different Kinds of Cities

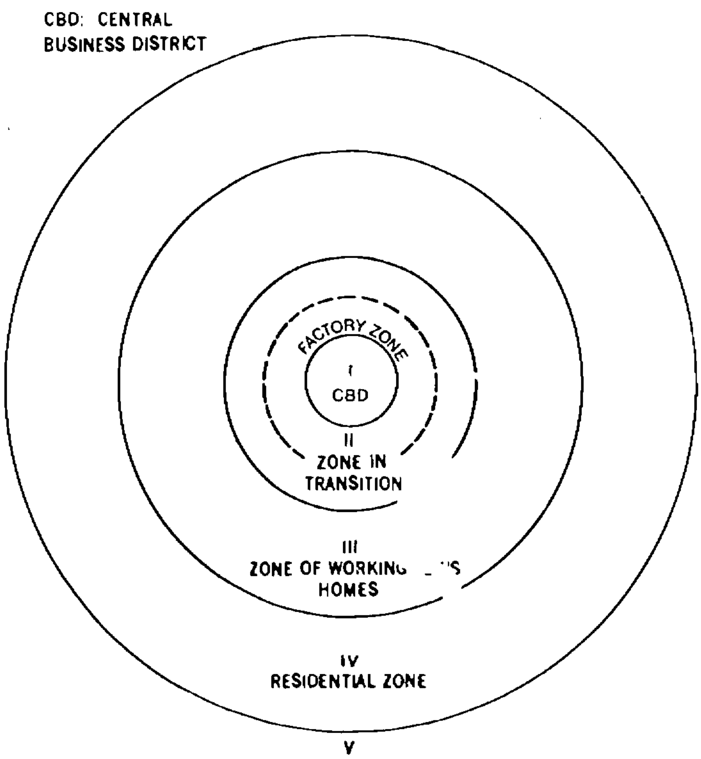
The most numerous kinds of cities are the *central places*, that is, the towns, no matter how small, whose main function is to supply goods and services to a surrounding population. In the South Germany of the 1930's, as portrayed by Christaller, these were chiefly market centers for a dispersed farm economy. Christaller's central place theory accounts for the very regular pattern of towns one finds in large farming regions. Depending on the size of the market, towns will supply more or fewer goods in greater or lesser amounts. As a result, a *nested hierarchy* of towns of different sizes emerges within the farming region (Figure 3). Each large town, and there are few of these, serves vast areas with a large array of goods and services. There are many small towns (villages and hamlets), each with a small market area and offering a modest array of goods and services. These small towns are within the market areas of the larger towns and cities. When the farm area is similar in its crops and economy, towns of roughly the same size are rather evenly distributed as Christaller predicted (Figure 4).

All urban areas provide goods and services to a surrounding population and thereby are to some extent central places. However, towns engaged primarily in industrial and commercial activities of a noncentral place character are not found equidistant from one another. Such cities are often found at highly accessible locations — witness St. Louis near the junction of two great rivers. Nevertheless, these least cost sites which attract industry and commerce are not always guidelines to understanding city location and size. One might imagine settlements of the smallest order being found at almost every conceivable site at one time, but some are still hamlets today, or even ghost towns, while others have mushroomed into huge metropolitan centers.

The size of a city depends on its *economic base*. The ability of key industries, those responsible for the production or the distribution of goods and services, to grow and prosper influences indirectly the number of people attracted to the city. The influence is indirect because it is the availability of income which in turn is used to hire people that plays the important role. The economic base consists of more than

FIGURE 1A

CONCENTRIC THEORY OF URBAN STRUCTURE



The Burgess model: the theory suggests that a city expands radially from its center so as to form a series of concentric zones. (Source: Park, Burgess, and McKenzie, editors. *The City* [1925], pp. 51-53, as adapted by Johnson, *Urban Geography* [1967], p. 164.)

FIGURE 1B

THE MODEL APPLIED TO CHICAGO

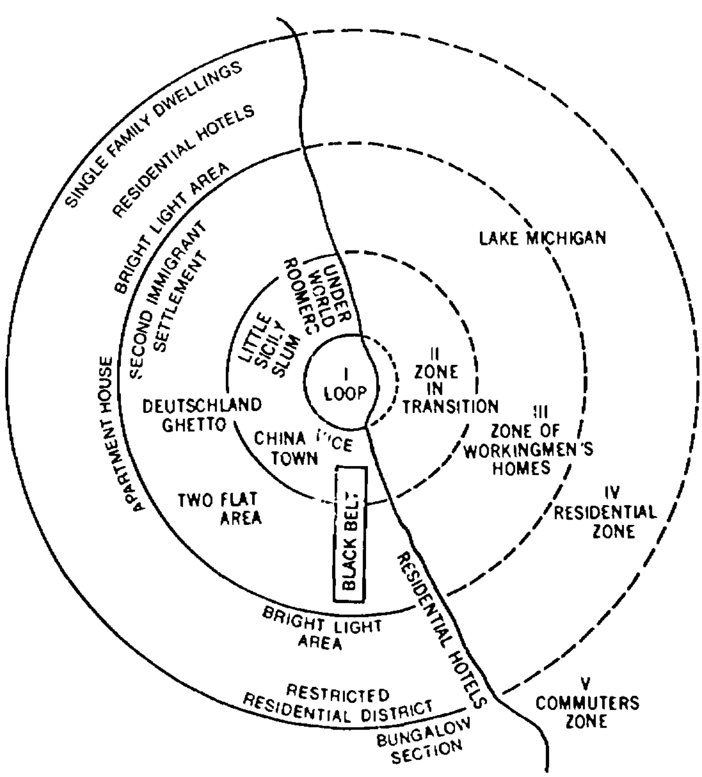
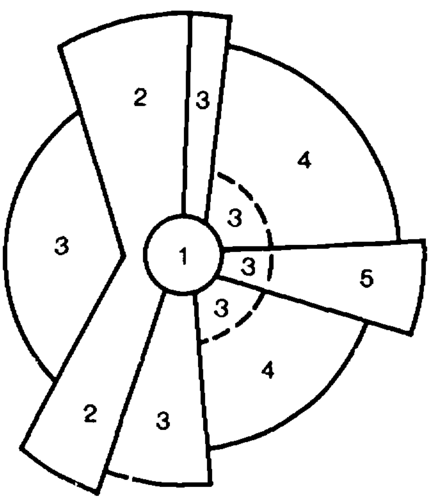


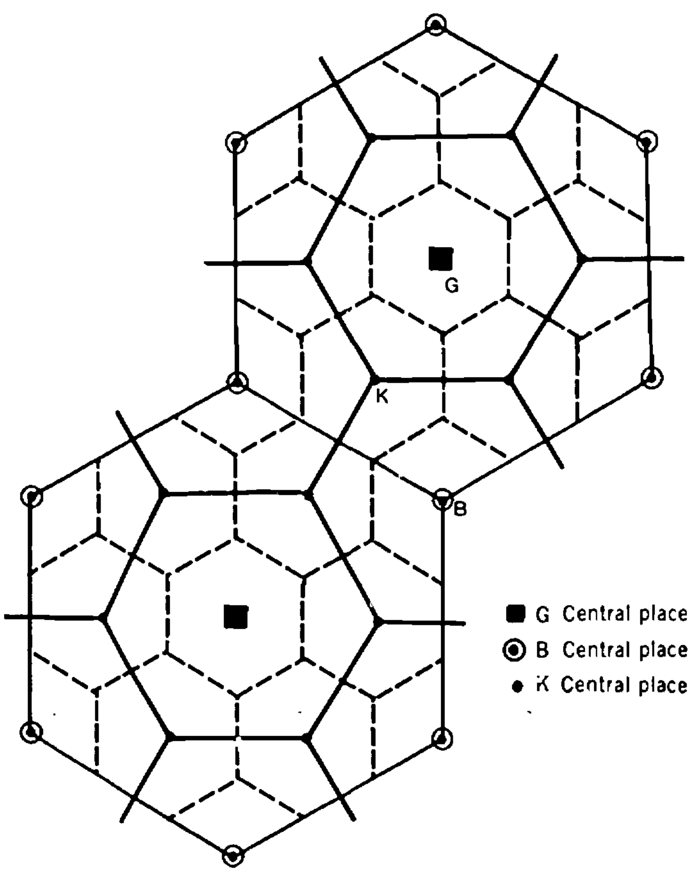
FIGURE 2



1. Central Business District
2. Wholesale Light Manufacturing
3. Low-class Residential
4. Medium-class Residential
5. High-class Residential

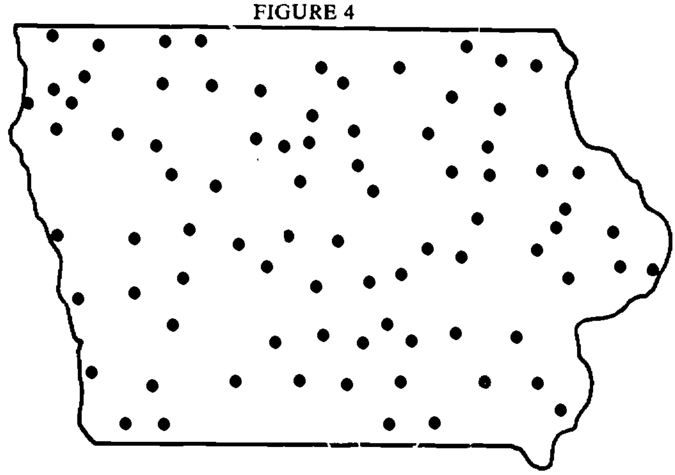
The Hoyt model: the different types of residential areas tend to grow outward along distinct radii (important transport routes). (Source: Harris and Ullman. "The Nature of Cities." *Annals of the American Academy of Political and Social Science*, 242·11; November, 1945.)

FIGURE 3



The Christaller model: the outermost lines separate the markets of the largest towns (G central places). The inner solid lines, also in hexagonal form, separate the medium size town's markets (B centers). The dashed lines do the same for the small K central places. (Source: Getis and Getis. "Christaller's Central Place Theory." *Journal of Geography*, 65:225; No. 5, May, 1966.)

FIGURE 4



The location of towns of 2,500 to 15,000 population in Iowa. Notice the regularity in the distributional pattern.

just key industries. It is also the reservoir of community and business services, such as power and water supply, highways and rail lines, and police and fire protection. Employees of the community and business services, such as accountants and bankers, computer operators and advertisers, all help bring money into the city.

Communities with a well-developed economic base are those destined for continued growth. Thus cities that are already large have an enormous advantage for the future. We see them spilling over their political boundaries at a rapid rate. They no longer follow the Burgess model, in fact we now call them metropolitan areas and some have even used the term *Megalopolis* to describe the mammoth multi-centered urban conglomerate.

The economic base of a city includes its relations with other areas; no one city exists without others. People and goods are constantly crossing the city's border. As is true with the Christaller model so it is true for all cities that they are part of a system of cities. In the words of Brian Berry, eminent urban geographer, "the most immediate part of the environment of any city is other cities."

The Modern City

Industrial Expansion

Large cities and manufacturing go hand in hand. New York, Tokyo, London, and Moscow, to name the world's largest cities, are also the most important locations for manufacturing in their respective countries. The growth of manufacturing helped to make them the *primate* cities that they are. In the modern metropolis, however, industry is by no means confined to downtown, waterfront, or railroad locations. This is not to say that such sites are no longer important, but today the locational weight placed on such factors has shifted.

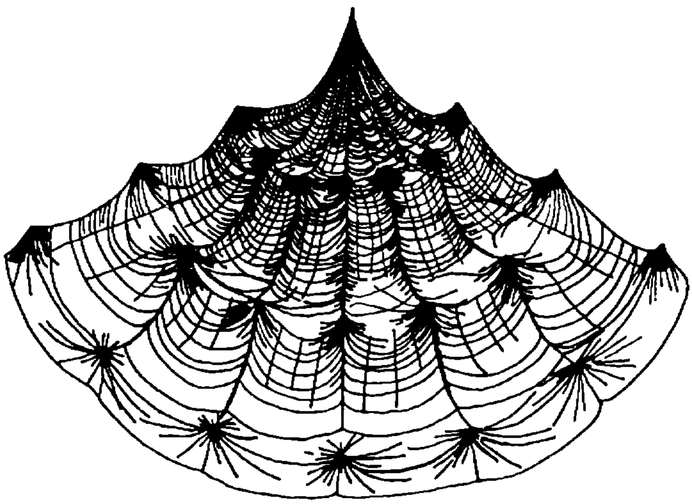
Modern industry is large, efficiently organized, and convenient to both workers and suppliers. Sites near freeway intersections in the suburbs provide the needed space for efficient single-story construction and large parking areas. Workers, living near connecting highways, can make the daily trip with relatively little effort. The huge market of the metropolitan area is nearby. This *market orientation* of firms is becoming more and more evident as *raw material orientation* seems now to be relegated to those few industries having to process bulky and relatively inexpensive products such as copper ore and lumber.

As always, transportation costs tend to be the key factor in determining the location of industries. Actually a good term to use is *accessibility*. It is true that the tax structure, utility costs, and quality of the labor market are important locational factors, but they can be considered as refinements of the need for industry to be accessible to materials, markets, and men. (It is interesting to note that some industries are now locating to take advantage of women workers. Insurance company offices, for example, are being moved to the suburbs to be near to otherwise unemployed wives.) So it is the freeway which is replacing the railroad as the most access-giving type of transport link. Although railroads have responded with some success by developing a piggy-back truck-trailer carrying service, the ease in using highways has drastically altered patterns of industrial location.

Residential Location

With the new importance of suburban areas, land values in the suburbs have risen. At one time it was common to consider the *value of land* an explanation for high *residential densities* in the city and low densities in the suburbs (Figure 5). Now, with the already useful land of the central city combined with the potentially useful land of the

FIGURE 5



Generalized land value surface within a city (suburban land is not included). It is expected that since high land values encourage businessmen to use their land intensively, and if costly land is used for residential purposes, then population densities will be high. (Source: Berry, Tennant, Garner, and Simmons. "Commercial Structure and Commercial Blight." University of Chicago, Department of Geography, Research Paper, No. 85, p. 14.)

suburbs, the residential population has evened out. The *density decline function* so popular in the 1960's as a way of explaining many kinds of urban land-use patterns may have to be renamed without the word "decline" in the future (Figure 6). Only at the fringes of suburbs are residential densities low, and even those areas are subject to rapid growth as the inner suburbs fill. None of this would be possible without relatively inexpensive, flexible, and convenient transportation. In other words, the accessibility which comes from the development of freeways is in large part responsible for the form that the massive metropolis takes.

Economic Opportunity, the Affluent, and the Deprived

Most of the world has experienced an economic boom since the late 1940's. In many countries individual incomes and standards of living

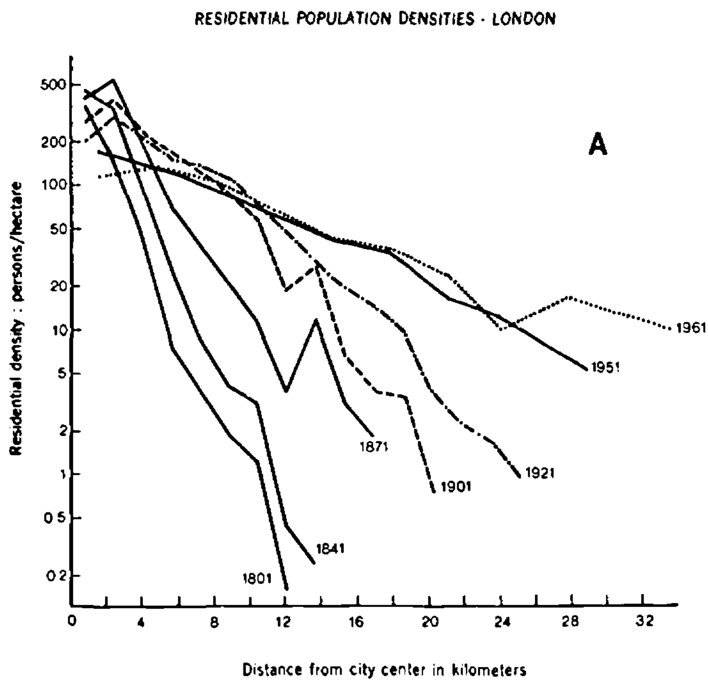
have increased immeasurably. Although there is economic growth in Asia, Africa, and South America, per capita income increases are less noticeable, mainly because of continued and rapid population growth. Except for a few years, however, the people of Western Europe and North America have been finding it increasingly possible to own more goods. Greater skills are needed to run a technologically advanced economy. The rewards for skilled workers are large. It is pathetically true, of course, that not all people are sharing equally in this economic boom. There are many poor people in the economically advanced nations, especially in the United States. What effect does this affluence and poverty have on our cities? What spatial patterns result?

First, let us consider the city from the viewpoint of the economically well-to-do. The affluent are highly mobile, i.e., they have the means to move around a good deal and they take advantage of that opportunity. They have one or more automobiles, live in well-appointed apartments, or, more likely, own houses on at least modest-sized lots. The cost of driving their automobiles is not a major outlay, or if it is, it is thought to be a necessary cost. Although they would like to live close to their workplace, they still may travel up to an hour to get to work. In fact, there is no real concern with distance unless the work trip reaches about thirty minutes commuting time one way. This *critical isochrone* is great enough so that the workplaces available to the affluent are numerous and highly scattered. In addition, economically advantaged individuals have relatively little difficulty in changing their home place. In recent years this change of residence has accompanied a change in position and, not infrequently, a change in social status as well. In the United States each family moves, on the average, once in five years.

The mobility of the affluent extends beyond considerations of workplace and residential locations. With transportation costs a relatively unimportant factor, more use is made of transportation. One is not relegated to shopping at the corner grocery. Places far afield are hosts to consumers. There is an upper limit as to how far people will travel to shops, but on highspeed urban freeways, shopping centers ten miles from the home can be reached easily. In response to this mobility, entrepreneurs have built modern shopping areas at widely spaced intervals, where people can buy many different kinds of goods, as had previously been the case only in the central business district. There is also less need for the corner grocery store. One can fill a car with goods,

FIGURE 6 A

Density-distance relationship for London, 1801-1961

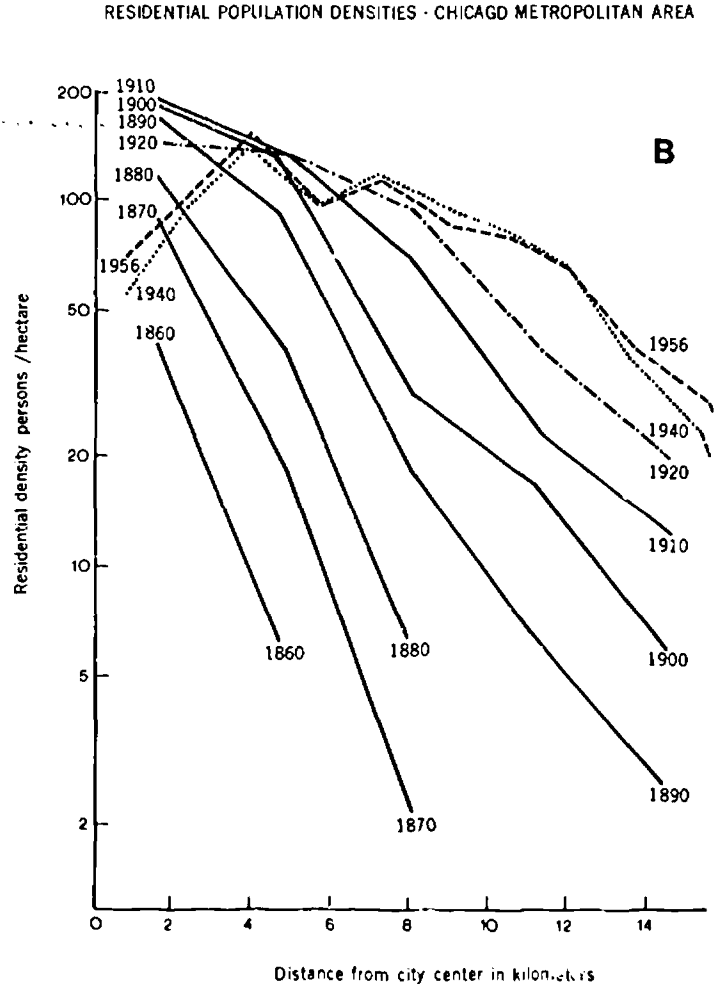


store many of them in a refrigerator upon arrival at home, and then use the time thus saved for further shopping, work, or leisure activities. Presently located along urban and suburban arterials are many services and recreation sites which offer the affluent alternate ways to use their extra time.

The spatial form of the suburbs, the chief home location of the affluent, has been fashioned by their willingness to spend money for items which make life easier or, some would claim, more pleasurable. These consumer tastes, together with the desire for privacy and the availability and use of the automobile, are the major forces responsible for the freeways and shopping centers, the arterials lined with hamburger stands and discount houses, and the modern houses with large lawns free of crab grass.

FIGURE 6 B

Density-distance relationships for Chicago, 1860-1956. (Source: Clark, *Population Growth and Land Use*. pp. 343, 344.)



Life in the inner city is considerably different. The *invasion-succession* process of blacks replacing whites is still in effect. Large areas of the central city are almost completely inhabited by blacks, most of whom have arrived in the last ten to twenty years. The tremendous migration of rural Southerners to chiefly northern and western industrial cities has not abated in recent years. The economic and social deprivation in the rural South and the attractiveness of potential economic opportunities in America's cities are the main causes of this migration.

Within the inner city the black ghetto has been expanding under the pressure of the continually arriving immigrants. However, the spread has not keep pace with the pressure. Real estate and banking practices, responding to certain social pressures, have controlled the spread of the ghetto, limiting expansion to the old neighborhoods of the inner city and virtually excluding blacks from the suburbs. This pattern of racial segregation is of profound importance in understanding the structure of contemporary American cities.

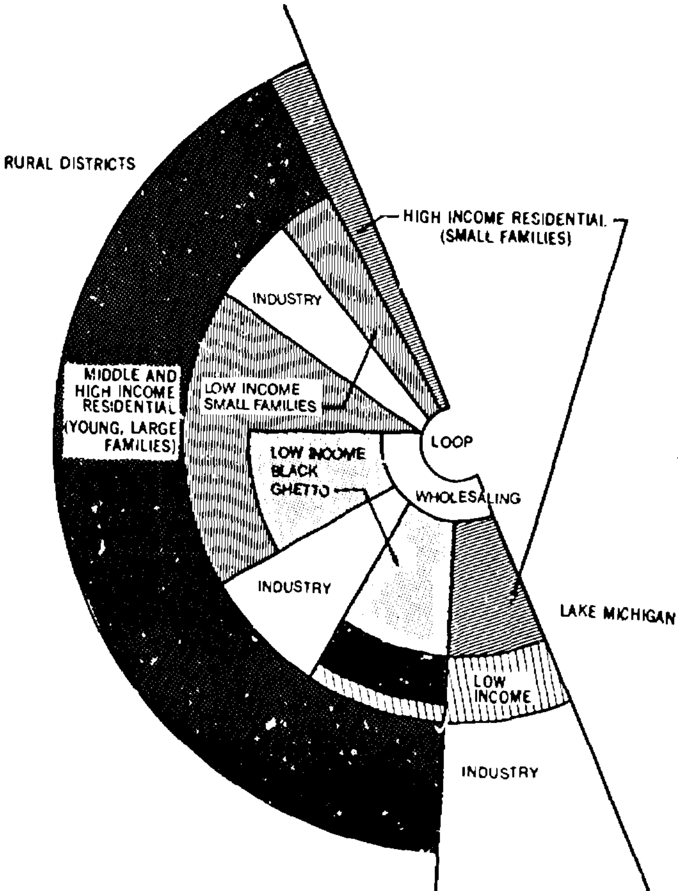
The Burgess and Hoyt models, discussed earlier, must be modified to show one or more contiguous zones having black residents at all levels of the social hierarchy. In other words, the spatial manifestation of race has to be superimposed on the categories of land uses traditionally used to describe urban patterns (Figure 7).

The mass exodus of whites from the enlarging ghettos puts middle class people farther from the city center than the upper income groups, a reversal of the earlier pattern. More and more black neighborhoods in the city are expanding to the edge of the upper income neighborhoods and coming to a halt there.

Patterns of industry and commerce are also affected by the divergence between the afflu nt and the deprived. It was said before that many modern industries, in search of space, accessibility, and nearness to a preferred labor force, are being established or being moved into the suburbs, far from the relatively immobile black population. As a result, in many cities the unemployment rate is high in the inner city and almost nonexistent in the suburbs. The urban transportation systems have not been geared to connect ghetto with suburb.

We referred earlier to an apparent dichotomy between urban and suburban regions, though in actuality they form a highly integrated system. That system is mainly one of commerce and industry, however, and not one based on social interaction. Each shop or plant, each bus, train, or truck, each wire or sewer pipe, is but one outlet or vehicle

FIGURE 7



Generalized social and land use areas of Chicago. (Source: adapted from Phillip Rees, "The Factorial Ecology of Metropolitan Chicago, 1960," M.A. Thesis, Department of Geography, Uni·ersity of Chicago, August 1968.)

for the flow of people, goods, messages, and refuse from city to city, city to suburb, and suburb to suburb. As a case in point, the inter-industry linkages which promote industrial concentrations and flows between plants are not self-contained. Supplies from other urban areas or from the inner city are necessary for the survival of any firm. It is these inter-industry connections which bear heavily on the location of firms and help to produce the general patterns of location and spatial behavior characteristic of a system of cities.

Problems of the Modern City

The problems of the modern city, of which much has been written recently, can be listed in a number of overlapping categories. Each of these problems must be resolved if a smoothly functioning urban system is to prevail.

1. Segregation — How can racially segregated populations, at odds with one another, work together toward a progressive, socially wholesome society?
2. Schools — How can schools develop quality education in the face of enormous pressures resulting from social upheaval?
3. Crime — How can urbanites live closely together in harmony and good will when divisive forces at work within the society give rise to extraordinarily high crime rates?
4. Traffic congestion — How can metropolitan areas continue to offer economics of urbanization when they are being strangled by the very vehicles responsible for their prosperity?
5. The physical environment — How long can a society continue to exist if the fundamental elements for life — air and water — are polluted?
6. The human environment — Can mental health prevail in places where noise levels and invasions of privacy go beyond acceptable standards?

These and other problems face the students of today for they are the decision-makers of tomorrow. The 1970's must be faced by sober and responsible men and women knowledgeable in the ways of urban life. In order to make sound decisions, they will have to be aware of the problems resulting from growth, change, and closeness. The goal, of course, is to spare the next generation the urban discomfiture suffered by many members of this generation.

The problems of urban areas are well-known, but solutions are difficult. There is at least the hope that by studying the kinds of problems mentioned above we may yet arrive at solutions. There is no doubt that a greater understanding of the concepts of the social sciences is necessary. The hypotheses geographers particularly explore are spatial in nature, and, as we have seen, many urban problems arise from spatial phenomena. Thus it seems fitting for young people to consider seriously the contribution to understanding one can get from a spatial view of urbanism. The annotated bibliography which follows lists key reference works in this field. The list has been purposely kept short. None of the references is beyond the understanding of the alert high school student.

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Geography of Cities; Unit I, Teacher's Guide and Student Resources in an Urban Age. High School Geography Project. New York: Macmillan, 1969.

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Johnson, James H. *Urban Geography: An Introductory Analysis.* New York: Pergamon Press, 1967.

A well-written survey, in textbook form, of the literature and main ideas of urban geography. It is also a useful reference book. Available in paperback as well as hardcover.

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Contains a series of articles clearly outlining current trends in urban geography. Also, included is an article on Christaller's central place theory. This issue has been reprinted as "Urban Geography." *Topics in Geography,* No. 1, National Council for Geographic Education.

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On the Economic Base

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This is a useful summary and critique of the methods of determining the economic base.

On Current Urban Problems

Scientific American. 213:41-214; No. 3, September, 1965. Also published in book form as *Cities; A Scientific American Book.* New York: Alfred Knopf, 1966.

This issue contains twelve well-illustrated and stimulating articles covering urban problems chiefly from a physical planner's point of view. Renewal, transportation, and air pollution are a few of the problems discussed.

On Social Aspects of Urban Life

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A perceptive treatment of ghetto formation and urban residential segregation.

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A comprehensive survey of recent literature from a number of fields.

Chapter 5

Regional Development

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Economic change does not occur evenly over space. Today areas such as Southern California or Florida display startling rates of growth while other areas, such as the Upper Midwest, are growing very slowly. Some regions are even in a state of decline. As a nation we have been traditionally concerned with national development rather than development at the regional scale; nevertheless, from time to time there is an upsurge of interest in regional development. During the 1930's, for example, considerable attention was directed to the economic plight of the South, particularly the Tennessee Valley area, while in the early 1960's the severe poverty of the Appalachian Region came to be regarded as a black spot in a relatively affluent society. Currently, concern over the quality of the environment, and the seemingly intractable problems of the larger metropolitan areas, have indirectly raised the issue of regional development in terms of how society ought to organize the distribution of economic activity throughout the country.

The purposes of this chapter are threefold: first, to examine some of the determinants of regional growth; second, to discuss the geographic structure of economic activity within the individual region; and finally to scrutinize certain aspects of regional development in a na-

tional setting. The term *region* will be used to connote some subnational area. It will not generally refer to a large urbanized area such as Greater Boston, but to a more extensive area (covering several states or parts of states), possibly containing one or more of these metropolitan centers. In the case of predominantly rural sections, the region could refer to a multi-county area. There is, of course, no single, ideal set of regions since their delimitation could be made according to a variety of criteria, including homogeneity of particular economic and social characteristics or domination by a center of trade and transportation.[1]

Forces Behind Regional Development

In the literature of economic development, the term *development* is usually defined as an increase in real per capita income which occurs over some specified period of time. In the case of regional development, however, we are frequently inclined to regard development in terms of increases in aggregate income or increases in levels of population and employment. This is a perfectly acceptable view of development, particularly since changes in overall levels of economic activity within a region are frequently the focus of interest. Nevertheless it is important that this distinction be recognized. In this paper "development" will be used in this aggregate sense, unless otherwise stated.

The Export Base Theory

Perhaps the most common approach to the explanation of regional development is the *export base theory*.[2] This theory is based on the presumption that the economic activity of a region can be divided into two broad categories or sectors: the export and the local sectors. In the broadest sense the *export sector* can be defined as that part of the regional economy which brings income into the region. For example, industries serving markets located outside the region, whether national or international, would be classified as part of the export sector. The *local sector*, on the other hand, exists to serve demands which originate within the region itself. These will include consumer demands such as those involving personal services, but will also include the demands exerted by local industry. The two sectors can thus be distinguished on the basis of their dependency. The magnitude of the export sector is influenced by forces external to the region, whereas the extent of the local sector is determined by forces which originate within the regional economy itself.

The export base theory holds that the key determinant of regional growth is the ability of a region to expand its export base, i.e., the export of goods and services. According to the theory, it could be argued that the growth of the Pacific Northwest Region of the United States during the late nineteenth and early twentieth centuries was largely the result of the growth of the lumber industry. Similarly, the post-Civil War growth of the Western Pennsylvania Region, centering on Pittsburgh, was due primarily to the growth of the coal and steel industries. More recently, the expansion of the aerospace industry in Southern California could be regarded as one of the major causes of that region's growth.

However, the growth of a region over a given period of time is not limited to the growth of the export sector: the local sector will also grow. This is because the increased flow of income into the region increases the demand for goods and services produced within the region. For example, increased payrolls within a region resulting from an increase in export demand would stimulate the growth of such regional activities as retailing, wholesaling, and personal services. This secondary growth is sometimes referred to as the *regional multiplier effect*. The essence of the export base theory is that although regional growth is possible through the growth of the local sector, the impetus for expansion comes with the growth of the export sector. All other things being equal, growth of the local sector is conditional upon growth of the export sector.

The local sector not only consists of consumer-oriented activity, but also involves goods and services which are provided to regional industries. For example, within a particular region many of the financial, business, and legal services which are required by an export industry are usually provided within the region itself. It would be wrong, however, to conceive of the local sector as involving solely service activities. Manufacturing activity can certainly comprise part of the local sector. For example, bread does not generally enter into interregional trade so that its production can be regarded as part of the activity of the local sector. Such activities as ice-making, soft-drink bottling, and certain types of printing activities also fall into this category. Furthermore, some regional manufacturing activity may be involved in the supply of components to other regional industries, and this would be classified as belonging to the local sector, although there is some debate on this point.

With the establishment of an export industry (or industries) within a region, there arise possibilities for the development of *linked industries.* Two principal forms of linkage are possible: backward and forward linkage. The process of *backward linkage* involves the emergence of an industry within the region in order to supply inputs to an established industry. For example, a food processing and canning industry, if successfully developed, may attract a branch of the metal container industry to that region. Furthermore, although such an industry may arise initially to serve the requirements of the canning industry, its successful establishment may make it possible for the industry to export part of its output to other regions. This would represent an expansion of the export base and would be accompanied by a concomitant expansion of the local sector.

A *forward linkage industry,* on the other hand, would be one that develops in order to utilize as an input the output of an industry which was formerly export-oriented. For example, the location within a region of a chemical industry which initially exports its entire output may encourage the development of a paint industry designed to serve the regional market and using locally-produced chemicals as raw materials. Part of the original export industry thus becomes locally-oriented rather than wholly export-oriented as was formerly the case. As with backward linkage industries, a forward linkage industry may commence operation in order to serve exclusively regional demands, but the passage of time may enable this industry to serve export markets also.

The growth of linkages around the original firm in the export sector may sufficiently improve the locational milieu of the region and so encourage additional firms, thus permitting a further expansion of the region. The emergence of linkages (particularly backward linkages) around an export industry has frequently enabled a region to consolidate and improve its competitive position *vis à vis* other regions, and in this way to develop an identifiable regional specialization.

THE ROLE OF IMPORT SUBSTITUTION

Beyond a certain point the export base theory becomes a less useful conceptual model and needs to be supplemented with a theory which considers growth influences originating within the region itself.[3] As a region's economy expands, a point is reached at which the region is able to supply a good or service on its own behalf whereas formerly the

good had to be imported; hence the term *import substitution*. To consider a simple case, a relatively small region, with a population of 250,000, may not be able to support a bottling plant. After a period of growth, due to an expansion in the export sector and secondary expansion of the local sector, its population may have increased to 400,000. By that time a bottling plant has been profitably located in that region. Thus, a population of 400,000 is more than satisfying the threshold requirement for the profitable operation of such a plant. The threshold population will be dependent on the minimum efficient plant size, which will, of course, vary from industry to industry. Strictly speaking, thresholds should be measured in terms of demand or purchasing power rather than in terms of population.

This process of increased regional self-sufficiency can make a significant contribution to regional growth. As a region crosses successive demand thresholds it is able to engage increasingly in such a process. What happens, in effect, is that beyond certain critical levels it is more profitable for a given good to be supplied from within the region rather than from the outside. This is one explanation for the tendency toward market orientation that can be observed in some of the more advanced economics. The post-war decentralization of the American automobile assembly industry to centers such as Los Angeles, Minneapolis, and Kansas City is one of the more spectacular examples of regional import substitution. In certain cases the process of import substitution is able to relieve an expanding export sector of the task of supporting immigrants to a region who have come there in response to its reputation for growth and in the hope of securing employment when they arrive. Certainly the post-war migration to California has not been accommodated *solely* by an expanding export sector.

The process of import substitution ought not be thought of as applying only to consumer goods. The post-war oil refineries that have developed in the Eastern Seaboard and Pacific Northwest Regions are not only concerned with the production of automobile gasoline: they produce, in addition, a variety of fuels and industrial products for intermediate demand, i.e., requirements for industries, within the region. Similarly, the expansion of steel production on the Eastern Seaboard over the last thirty years, notably at Baltimore and near Philadelphia, has been oriented primarily to regional markets rather than to national ones. Instead of importing steel and oil from other regions, as was formerly the case, these products are today produced within the Eastern Sea-

board Region. However, this change in industrial location patterns was only possible once the demand within the region reached a sufficiently high level.

So far import substitution has been viewed largely in terms of regional demand reaching certain critical threshold levels. Import substitution can also occur as a result of a reduction in the critical threshold level. This could be brought about by technical change. Innovations may, for example, reduce the minimum efficient plant size and hasten the process of import substitution. A very rapid increase in interregional transport costs might also have the same effect, since regional production would then be more profitable than centralized national production with its increased distribution costs. By contrast, increases in the minimum efficient plant size, or significant reductions in transport costs, tend to raise the critical demand thresholds and, thus, reduce the possibility of further import substitution, or at least retard the process.

In some cases, the occurrence of import substitution involves the development of linkages to the export sector, as discussed above. For example, a regional export industry may initially import a particular input or raw material from outside the region. If the export industry expands a point may be reached where a supplying industry may find it profitable to locate in that same region to supply the export industry, thus forming a backward linkage. The example of the container industry, mentioned earlier in connection with food processing, is an illustration of this.

Forward linkages from a regional export industry, involving import substitution, are also possible, and they can develop in the following manner: a regional industry may initially export its entire output to be transformed elsewhere into some final product, and this product may then be imported into the region in order to fulfill local demand. If demand for this product within the region becomes sufficiently high, firms producing the finished product may wish to move closer to their suppliers (and their final markets) by locating branch plants in that region. Alternately, firms within the region may develop spontaneously or may diversify their activities to meet this regional demand. The case of the paint industry, cited above, corresponds to this type of import substitution.

Lest a false notion be conveyed, it must be stated that import substitution can be wholly independent of the export sector. Furthermore, it is possible for the process of import substitution itself to induce

industrial linkages. For example, a region may attract an automobile assembly plant which locates there in order to supply a growing regional market. The initial operation of the plant, however, may well be dependent on the supply of components from outside the region. If the industry is successfully established, and particularly if it expands, the automobile industry's input requirements in that region could reach a sufficiently high level that the production of components within the region by supplying industries would then become profitable. In such a case the original process of import substitution will have stimulated backward linkages. This kind of development might be conveniently termed *secondary import substitution.*

Forward linkages resulting from import substitution are also possible. Regional demand for steel, for example, may expand to such a level as to warrant the establishment of a steel plant in the region. However, the very existence of such a plant will improve the locational environment of the region with respect to other industries not already located, or at least poorly represented, within that region. Under these new conditions steel-using industries, such as engineering or consumer goods industries, might then find the region a profitable location for supplying a local market which was formerly supplied from other regions. This type of forward linkage can also be considered a secondary import substitution, and results from the original process of import substitution. Needless to say, the mere process of import substitution does not guarantee development of linkages involving secondary import substitution, but the extent to which they occur is an additional source of regional growth.

It is not difficult to see that processes of export growth and import-substitution, and the establishment of linkages which develop in relation to each, are closely interwoven and that the process of regional growth takes place in a highly complex manner. The presence of a new export industry or, for that matter, a new regionally-oriented industry, has the effect of modifying the industrial structure and, thus, the locational environment of the region. Such modifications may facilitate expansion of the export base, or provide possibilities for further import substitution. Consequently, after a period of initial regional growth, the expansion of the export base and the growth of import substitution tend to be mutually-interacting processes and any approach to regional growth which places excessive emphasis on one or the other would seem

to be unrealistic, particularly in the case of large and structurally complex regions.

THE STAGES THEORY OF REGIONAL GROWTH

In addition to the export base and import substitution approaches to regional growth, a further approach, known as the *stages theory*, has been suggested.[4] In essence this theory holds that over a long-range period, regional growth will typically be associated with a sequential pattern of dominant specializations, i.e., export bases. The following five stages have been suggested: first, the stage of the self-sufficient subsistence economy with no interregional trade; second, the growth of transport links with other regions, leading to the development of interregional trade and the emergence of regional specializations in primary activities such as agriculture, fishing, and resource exploitation; third, the development of secondary (manufacturing) production specializations, mostly in the processing and refining ends of manufacturing; fourth, a growth in emphasis on fabricative manufacturing specializations (sectors which use manufactured rather than raw material inputs) and the development of interindustry linkages; fifth, the final advanced stage, with specialization in tertiary activities, involving the export to other regions of capital, technical expertise, and commercial services.[5]

Such an approach thus offers a description through time of the development process at the regional level. Yet it is really something more than a description: there are important theoretical underpinnings to the theory. The effect of diminishing returns in agriculture, for example, partially explains the gradual shift of resources into resource-related manufacturing and, eventually, to specialization in that sector. The influence of low income-elasticity of demand (the tendency for the growth of demand for goods to be slower than the growth of income) for the region's exports is a further influence in the relative shift away from agriculture. This factor may also subsequently cause a shift from resource-related manufacturing to fabricative manufacturing.

One explanation for the eventual evolution into the service specialization stage can be sought in terms of interregional advantage. A single region, existing within a system of regions, may at a given point in time be interregionally competitive in the production of manufactured goods. Through time, however, similar industrial development in other regions, even if only of the import substitution type, will tend to reduce this competitiveness because distribution costs then assume a critical importance. Such developments elsewhere make regional exports of

manufactured goods less competitive and force the region into another sphere of specialization (according to the theory, the supply of services) where a degree of interregional competitiveness may be realized due to the relatively small significance of transport costs. Furthermore, with industrialization proceeding in other regions, the demands for tertiary activities (technical services, business services, finance, etc.) will be increased and thus offer to the original region the opportunity for a new sphere of specialization.

This approach to regional development ought not to be thought of as an alternative to the export base theory. Rather it might be seen as a long-term view of the export base theory, explicitly highlighting temporal changes in the composition of the export base. Moreover, the stages theory is not in conflict with the notion of import substitution, especially since the process of import substitution in a particular sector of a regional economy may be conveniently regarded as a precursor to the next stage of specialization for the region.

The stages theory is not without its critics. It has been argued that while this theory may possibly possess some validity in a European setting, it is not valid in the "New Lands" such as North America. There, it is claimed, the subsistence stage did not exist or was extremely short-lived. Settlement and development proceeded according to a region's capacity to establish a successful, competitive export base. Although this criticism may be accepted, it is nevertheless possible to discern stages of specialization in many regional economies in North America. In the case of the New England region, definite stages of development can be observed, the first being a primary specialization with the export of raw materials, such as lumber, to the British market. This was followed by a period when manufacturing was the dominant specialization with the primary orientation to domestic markets. Through this period manufacturing was transformed from the processing type, such as leather working and woodprocessing, to the fabricative type, such as the production of machinery in which industrial linkages become very important. Today it is possible to identify elements of the final advanced stage with the tertiary specialization consisting of export services such as insurance, finance, education, publishing, and research and development activity. Needless to say, few regions in North America have reached or even begun to approach this final stage.

A second criticism of the stages theory concerns the normative connotation implicit in the theory, namely, that a region must inevitably

industrialize in order to achieve growth. To be sure, an agricultural region may achieve growth by such avenues as shifting to more profitable specialty crops or developing an export base in service activities. However, in the case of the agricultural region which is suffering from diminishing returns in agriculture, is constrained physically from shifting agricultural resources into crops for which the income-elasticity of demand is higher, has exhausted all possibilities for resource-based industrialization such as food processing, and does not possess an eminently suitable locational environment so as to be attractive for export-oriented service activities, few alternatives for continued growth exist other than those which involve industrialization.

It would certainly be a mistake to regard the stages theory as a rigid schedule for development: a system of probabilities would appear to be a more appropriate characterization. If it is conceded that the sequence may become distorted by technical change or government intervention in time of war, for example, and that development beyond a particular intermediate stage may be impossible by dint of a region's unfavorable resource and locational endowment, the stages theory does not seem an unreasonable explanatory statement of long-run regional development.

THE SUPPLY SIDE OF REGIONAL GROWTH

The discussion of regional growth in this section has been primarily concerned with the demand side of growth. In the case of the export base theory, for example, it was argued that a region's growth depended on its ability to develop its export base. However, there was no explanation of why some regions are able to accomplish this with great success while other regions exhibit a disappointing performance. Similarly, the import substitution approach to regional growth stressed the fact that growth was dependent on the attainment of a critical level of regional demand. Other than considerations of minimum efficient plant size and technical change, there was little emphasis on the factors which determined the level of this critical threshold within a particular region. Moreover, the stages theory of regional growth was concerned with the pattern of regional exports through time, but did not examine the ease with which the transition from one stage to another occurred. No matter how valid these various approaches to regional growth may be, they are incomplete without reference to the supply factors which influence growth.

Supply factors are well known in the analysis of industrial location and include such aspects of the regional economy as natural resource endowment and the availability of raw materials, manufactured inputs, capital, power supplies, labor, and entrepreneurial talent.[6] An equally important supply factor is the general location of the region, particularly as it relates to the assembly of materials for production and access to external markets.[7] One example of how supply factors are able to exert an influence on regional growth is the ability of the Southeastern States to acquire as an export base an increasing share of the nation's textile industry, primarily as a result of the availability of low cost labor within the region. By contrast, the willingness of Detroit bankers to back the fledgling automobile industry financially has been suggested as one of the several factors which led to the establishment of the industry in that area. Supply factors may also influence regional growth based on import substitution. The development of steel production on the Eastern Seaboard was facilitated not only by the relative proximity of coal supplies but also by the accessibility of the area to imported high-grade iron ore from Venezuela and Canada.

Naturally, at any given point in time, the nature and quality of supply factors are likely to reflect the legacy of previous periods of regional economic development. Thus, the development in one period is able, through the workings of supply factors, to influence development in a subsequent period. Several examples are cited to illustrate this point. The development of the coal mining area of Northeastern Pennsylvania occurred in such a way as to result in a very unbalanced industrial structure. This had the effect of producing a pool of potentially low cost female labor, the existence of which later encouraged into the region certain branches of the apparel industry that were anxious to avoid the high operating costs of New York City. In the case of Detroit, the fact that the area did possess engineering and vehicle components industries during the late nineteenth century was an important factor in the establishment of the automobile industry there. Finally, the development of the aircraft industry in the Midcontinental Region of Texas, Oklahoma, and Kansas has been partially attributed to the willingness of the oil entrepreneurs and financiers of the region to reinvest their profits in local enterprises after the early twentieth-century boom in oil exploitation had passed.

One supply factor which is becoming increasingly significant is the existence of amenities within a region.[8] The existence of a favorable

climate is today recognized as an important factor in the regional growth process. For industries such as the manufacture of certain scientific instruments, movie-making, and aircraft production, climatic conditions are an important locational requirement, or at least a locational advantage, and this partially accounts for the growth of these industries in the Western and Southwestern regions of the country in such states as California, Arizona, and Texas. In the case of the aircraft industry, mild winter climates permit considerable savings in the heating of large plants. Climate also exerts an influence in terms of the number of cloud-free days per year in cases where test flying is an important consideration.

The existence of a favorable climate has also been important in relation to *footloose industries.* These are industries which have no particular orientation such as proximity to markets or to raw materials. For such industries there is a good deal of freedom in location decisions and a region with a favorable climate and pleasant surroundings may well be chosen in the hope of attracting and retaining a labor force which might also have a high productivity level due to reduced health-related absenteeism. Furthermore, the role of climate has an obvious importance in attracting tourists and retired people to a region. In both cases this could represent an expansion of the region's export base.

The consideration of amenities should not be confined to natural amenities such as favorable climates and pleasant natural surroundings: man-made amenities are also assuming a growing importance in regional growth. The availability within the urban centers of a region of high quality school systems, parks, municipal services, and cultural facilities, as well as access to entertainment and outdoor recreation, are becoming increasingly important in the locational decisions of firms. The expansion in research and development activity in the Boston area, and in such West Coast centers as Santa Monica and Palo Alto, tends to reflect this trend This amenity factor is becoming particularly important in the location of branch plants for the retention of executives and highly trained manpower. Some measure of the influence exerted by amenities in locational decisions can be derived by observing the stress laid on this factor in promotional literature published by chambers of commerce and official groups interested in stimulating development in their regions.

Broadly speaking, it is possible to view supply factors as the ones which determine the nature and structure of a region's export base by

granting to a region the possibility of fulfilling potential demands which exist in external markets. Supply factors thus govern the competitiveness of a region's economy within a multi-region economic system. In addition, supply factors are able to influence the direction and extent of regional import substitution. Moreover, they may partially explain the rate of transition through the various stages of export specialization and may draw attention to the difficulties involved in such a transition. It is thus possible to regard the process of regional development as the resultant of forces of demand and supply which both act on the regional economy over a given period of time.

The Structure of Regional Development

Up to this point the principal forces behind regional growth have been discussed without any reference to the geographic distribution of economic activity within the region. From what has been said so far, it might be inferred that economic development is spread evenly throughout the region or that it is all concentrated at a single location. Actual conditions do not, of course, correspond to either situation, and there is variation in geographic structure from region to region. In the Middle Atlantic Region, for example, the overwhelming majority of economic activity is currently concentrated in relatively few metropolitan complexes which include New York City, Philadelphia, Baltimore, Pittsburgh, and Buffalo. However, in the Southwestern Region, in addition to the metropolitan centers of Dallas, Houston, San Antonio, and Oklahoma City, centers of intermediate size such as El Paso, Tulsa, and Amarillo also possess a significant share of the region's economic activity. By contrast, the Pacific Northwest Region (Washington, Oregon, and Idaho) has better than 50 per cent of its economically active population located outside the principal centers of Seattle, Portland, Tacoma, and Spokane; mostly in centers with populations under 100,000. Notwithstanding the considerable diversity in regional structure, it is possible to generalize about the major forces which determine the geographic distribution of economic activity within a region.

The Influence of Large Scale Production

Perhaps the most fundamental force behind the structure of regional development is the scale at which production occurs among the industries of the region. In certain industries, particularly those which employ techniques of mass production, there are considerable economies

of scale, i.e., the unit cost of production is low as a direct result of production taking place on a large scale. In these industries the minimum efficient plant size tends to be large so that relatively few plants are required to produce the total output of the industry nationally. Examples of these industries include automobile assembly, aircraft production, and the manufacture of basic steel. For other industries, such as textiles, the minimum efficient plant size is not as large, and in the case of the jewelry and precision instruments industries, very few economics of large scale production are possible. Naturally, the extent to which a region's industries are characterized by large scale production will influence the relative concentration of economic activity within the region. Large scale production in a particular regional industry not only involves concentration in its own right, but also encourages further concentration. This occurs because the location of the industry itself will determine the location of certain service activities which supply the workers of the industry, and the location of other industries which may be technically linked to the industry in question.

Agglomeration Economies

The influence of large scale economies alone is not sufficient to explain the structure of regional development. After all, the fact that regional industrial production may take place in large scale units does not require the concentration of the various units themselves at relatively few locations within the region. Nevertheless, within the regional systems of highly developed nations, such forms of concentration are frequently encountered. In the parlance of economic geography, this kind of concentration is referred to as *agglomeration*, and since this concentration is, on balance, favorable to the production units involved, we speak of advantages of agglomeration or *agglomeration economies*. Unlike large scale economies, agglomeration economies are not dependent on the investment decisions of a single firm, which reflect technological conditions within the industry concerned, but arise from the collective decisions of numerous independent firms. Some writers regard advantages of large scale production as agglomeration economies because they have the same effect, namely, concentration;[9] however, in this discussion they have been treated separately.

There are several identifiable types of agglomeration economies, although the distinction is sometimes blurred. Perhaps the most pervasive type are the economies of urbanization. These reflect the fact that an

urban location, with its availability of municipal and general commercial services, established transport connections, and suitable industrial land, represents a more advantageous location than a non-urban location. The individual firm, if it chose such a non-urban location, would have to provide all these services on its own behalf and, except in the most unusual circumstances, this would prove more expensive than in an urban location. The successful growth of industrial parks during the post-war era near the outskirts of metropolitan centers is an indicator of the importance of urbanization economies. The principal advantages of these parks appear to involve such considerations as land availability with possibilities for future expansion, the adequate provision of public utilities, facilities for waste disposal, the availability of service roads and parking space for employees, as well as accessibility to major highway systems. In general, the scope of urbanization advantages tends to increase with city size although the size at which they cease to increase has been the subject of considerable debate However, the continued attraction of economic growth to the large metropolitan areas suggests that this critical size may not yet have been attained. This is not meant to imply that continued metropolitan expansion may not involve serious problems of a social nature.

In this brief discussion of economics of urbanization, account also needs to be taken of services which are required for the commencement, maintenance, and expansion of production. The advantages accruing from these services may be called *urban complex economies.* They refer to access to such specialized services as management consulting, advertising, public relations, research and development, legal services, repair services, and the expertise of designers, architects, accountants, etc. These kinds of services tend to reach their highest level of refinement in the large metropolitan center, although they are generally available in some form in smaller urban centers. Frequently, all but the largest of firms are unable to supply these necessary services for themselves, and thus there is an advantage to them in locating in the larger metropolitan centers. There is also the simultaneous tendency for this range of service activities to gravitate toward these metropolitan nodes since a location outside them would generally not be viable.

A further factor which is able to influence the agglomeration of economic activity is the advantage of localization. This is the tendency for firms or plants in the *same* industry to locate within close range

of one another in order to derive benefits which develop as a result of such a common location and which in all likelihood would not develop if the productive units were dispersed throughout a region. This phenomenon of localization within a region can only occur if there is a relatively large number of firms (plants) within the industry, indicating that the influence of economies of scale within the individual plants is only moderately pronounced. Economies of localization typically include such advantages as the existence of a developed pool of skilled labor from which a firm can draw. This advantage may be strengthened by the development of technical education facilities in that particular industry. (This is sometimes undertaken with the cooperation of local schools and colleges.) Other important localization economics stem from the advantage of specialized ancillary services, the advantage of bulk buying and selling, and the possibility of favorable freight rates on raw materials and on finished products, reflecting the magnitude and/or regularity of the total level of shipments.

One final tendency toward agglomeration, and a further force making for concentration, involves the joint location of plants which do not belong to the same industry but which, nevertheless, are interrelated in terms of their supplies and sales. This is one possible manifestation of the development of linkages which was discussed earlier in connection with regional growth. Although spatial proximity is by no means a necessary characteristic of industrial linkage within a region, there is, nevertheless, a strong tendency in this direction among certain groups of industries, e.g., the industrial complexes associated with shipbuilding, automobile production, and the manufacture of chemicals and allied products. For want of a better term, the advantages derived from this form of spatial juxtaposition may be referred to as "industrial complex economics." Industrial complex economics can be viewed as a parallel to urban complex economies, the principal distinction being that industrial complex economies involve the convenient exchange of commodities and services rather than solely the exchange of services.

The principal element in industrial complex economics consists of the reduction of flows of goods between plants and, consequently, a reduction of transportation costs on inputs and outputs among the constituent units of the complex. However, this geographic proximity also reflects advantages which may be derived as a direct result of close contact. For example, one sector of the complex becomes intimately aware of the particular technical requirements that exist in other sectors, with the consequent possibilities of rapidly implemented innova-

tions and improved quality control throughout the whole complex. In the case of complexes such as those associated with petrochemical production, the savings involved may be considerable. A further advantage of this type of agglomeration consists of the utilization of waste products which would otherwise have no economic use, such as the use of byproduct gas (produced at steelworks-oriented coke ovens), as a fuel in the production of steel. Furthermore, heated water and "waste heat" created by thermal power stations may be utilized to reduce the expenditures on power and heating in constituent plants of the complex. A particular form of industrial complex economy occurs when the various components of the complex are physically linked to one another by such channels as pipelines, conveyor belts, etc. The principal advantage is that the end product of one sector of the complex does not have to be physically or organically modified for onward shipment to the next phase of production, as would be the case if the next production phase took place at some distant plant outside the complex.

It would be misleading to regard agglomeration advantages as being of equal importance for all industries and thus exerting an equal influence on geographic structure in all regions. In the case of resource-oriented industries, for example, agglomeration advantages tend to be of minor importance since these industries by their very nature tend to display dispersed locational patterns and are unrelated to the locations of other types of economic activity. In a similar vein, industries for which low cost labor is a significant location factor tend to avoid large population concentrations and frequently locate in small urban centers where the competition for labor is considerably less severe. Consequently, a region in which either of these two types of industries predominate would tend to have a relatively low level of concentration in its geographic structure.

It might also be added that over time agglomeration economies associated with a particular concentration can change significantly, and that for certain industries they may become negative, i.e., the benefits of agglomeration become more than outweighed by such disadvantages as congestion and high costs of land and labor. Faced with such a situation, firms in these industries may decide to relocate their operations in other regions. However, there is also a tendency for firms to shift their productive capacity to small outlying centers in the same region where the disadvantages of agglomeration are minimal, but to retain within the metropolitan concentration their managerial, financial, and technical functions for which the advantages of agglomeration are still

important. This tendency seems particularly strong in cases where production requires unskilled labor, is highly standardized, or involves long production runs.

THE NODAL RESPONSE OF REGIONAL GROWTH

In addition to the forces of concentration resulting from large scale production or the spatial juxtaposition of firms, there is a further factor which can materially influence the configuration of regional development. Imagine for the moment that during a particular period of development, economic activity within a region is distributed at numerous locations throughout a region. This would tend to be the case where the basis of regional growth consisted of agriculture or resource-based activity. Under such conditions there would probably be some response in the formation of regional centers including a dominant regional center, serving the needs of the agricultural or resource sectors in terms of interregional transport, ancillary industries, wholesale distribution, retailing, etc. Summarizing this situation in terms of the export base theory, the bulk of the regional export base would tend to be located in the hinterland, with the bulk of the local sector located at the regional core or node, and the remainder located at regional sub-centers and at lower level centers on the urban hierarchy. In this sense, it is possible to attribute the growth of the regional nodes of Denver and Salt Lake City during the second half of the nineteenth century to the development of regionally-oriented activities, as a response to agricultural and mining development throughout the Mountain States. An earlier example would be the development of Chicago and St. Louis from 1830 to 1880, much of which was a consequence of the agricultural development of the Midwest. On a smaller scale, the recent development of dry farming and irrigated agriculture in the Columbia Basin has tended to stimulate the growth of Spokane, Washington, and less directly, the growth of Seattle. This growth in the hinterland, which induces a nodal response, need not be confined to primary production. Much of the post-war industrialization of the Southeastern States has been dispersed throughout that region as a result of orientation to low cost labor or raw materials. The growth of Atlanta, the central node for that region, has been largely a response to regionally dispersed growth. The position of the expanding economy of Dallas could be considered the counterpart of Atlanta for the Southwestern Region.

The concept of nodal response can also be extended to consider the process of import substitution by which a good or service comes to be supplied within the region for the purposes of regional consumption. If the process of import substitution involves service activity, the dominant node or *central place* will be a likely choice of location, being the location of other high order regional services. In the case of import substitution involving industrial activity, the dominant central node may still be a likely location. Such a center would offer the various advantages of centrality within the region for purposes of distribution, relatively convenient assembly of inputs for production, and the urbanization economies of a developed center.

Regional Development on a National Scale

The two previous sections have focused attention on the region itself, and have attempted to review some of the principal determinants governing the growth and structure of the individual region. Yet the region itself is only a single element in the system of regions which comprises the nation. This discussion of regional development would be lacking if it did not consider certain aspects of the subject in this broader context.

The Core-Periphery Problem and Balanced Regional Development

In virtually every nation it is possible to apportion the economic landscape, or the economic regions of the nation, into two broad divisions: the core and the periphery. In general, the regions which comprise the *core area* are the most dynamic ones within the nation. They tend to have a disproportionately large share of manufacturing and service activities and invariably an even more disproportionate share of the national economy's growth sectors. The core area contains the centers of decision-making, financial control, and administrative and governmental organization. It is composed of a complex of specialized and interrelated urban foci which collectively comprise a highly diverse economic structure. Furthermore, the core area tends to be the center of invention and innovation and this factor, combined with its diverse structure, enables it to adjust relatively easily to economic change.

The regions which constitute *periphery* on the other hand are usually areas of relatively slower growth and lower per capita incomes. In each of these peripheral regions the export base is specialized and is

frequently oriented to agriculture or resource exploitation. In the periphery, change occurs more slowly and traditional methods and values are more deeply entrenched than in the core. A serious handicap of the periphery is the considerable leakage of potential income from these regions, not only in terms of the flow of profits to the core which may have supplied the capital for development, but also in terms of the import of goods and services produced in the core area. As a consequence, the regional multiplier effects of growth in the export sectors tend to be small relative to their magnitude within the core area.

This short characterization of the core-periphery dichotomy represents a broad generalization.[10] In actuality, the situation varies considerably from country to country. In developed countries, the core-periphery contrast is not nearly as stark as that described; however, in certain underdeveloped countries it may be at least as serious. In fact, the degree of severity of the core-periphery problem can be regarded as a fairly reliable indicator of overall national levels of economic development. In the United States, for example, the core-periphery contrast, although undeniably present, does not constitute a major problem in regional development. Indeed, there are signs that the regions of the core area (an area approximately bounded by the cities of Minneapolis, Boston, Washington, D.C., and St. Louis) are beginning to record slower growth rates than some of the peripheral regions in the South and the West. By contrast, in the underdeveloped countries of Latin America, for example, the core-periphery problem tends to be particularly severe. The core areas such as Buenos Aires, Rio de Janeiro-São Paulo, Caracas, and Lima are relatively prosperous, and contain many of the characteristics of highly developed economies in terms of industrial development, infrastructure, and the availability of specialized commercial services. Their respective peripheries, on the other hand, have very low levels of per capita income and frequently represent the primary concentrations of economic backwardness.[11] In some underdeveloped countries the core-periphery dichotomy is the geographic manifestation of a dual society: the modern, industrializing, technologically sophisticated, externally-oriented sector coexisting, though not geographically, with the traditional, non-commercial agrarian sector.

The core-periphery problem is one of the fundamental causes behind the regionally unbalanced development which occurs so often in underdeveloped economies and much less frequently in developed ones. This

imbalance has been of considerable concern to many national governments for at least two reasons. The first involves the excessive concentration and economic attraction of the core regions. This may lead to severe overcrowding which may necessitate high capital expenditures in order to provide even rudimentary standards of housing, sanitation, and social services. It may also encourage the out-migration from peripheral regions of the most skilled and talented manpower, frequently a basic resource requirement for more rapid economic development. A second reason is that the reality of large differences in regional growth rates and per capita income levels could engender considerable dissatisfaction in the less prosperous regions, leading to political demands for a more equitable share of national economic growth. For a variety of reasons, therefore, there exist great pressures on national governments to encourage a more balanced pattern of development among the regions. It has been argued that such an emphasis is in the interests of long-run national economic growth, but it is not at all clear whether this will always be the case. Rapid economic development may frequently require emphasis on investment within the core area, particularly in the short-run. However, given the existence of political pressures, the government may feel obliged in such cases to sacrifice a measure of national economic growth in favor of a more even distribution of growth among regions. The governments of many developing countries are currently faced with this kind of dilemma in the geographic allocation of their scarce financial resources.

Regional Differences and National Economic Development

An important facet of regional development, and one which is related to the core-periphery problem, is the relationship between variations in per capita income among regions and the overall level of national economic development. In general it can be observed that within economically advanced nations per capita incomes display relatively small variations among regions, while in the developing nations such variations tend to be substantial by comparison. However, the relationship between regional income differences and national development levels is more complicated than this. One statistical study undertaken in this connection employed an index which summarized the extent of regional differentials, a high value of the index indicating large differences in regional per capita income and a low value signifying relatively small ones.[12] This index was computed for a series of nations at various times in their development.

It was found that at low levels of economic development (during the subsistence or pre-industrial periods) differences in per capita income levels tended to be small. With the onset of rapid economic growth regional income differentials tended to increase. They increased still further with national economic development, but a point of maximum differentiation was eventually attained; however, continued national development was associated with declining differences in regional incomes.[13] When these results were plotted on a graph, with the level of the index measured on the vertical axis and time (indicating the process of national economic development) measured on the horizontal axis, a curve in the shape of an inverted "U" was revealed, at least in the case of the advanced countries. In terms of this analysis, it appears that many of today's developing countries are still on the ascending portion of this curve, i.e., are in the phase of widening regional income differences. It is, of course, during such a phase that the core-periphery contrasts tend to be particularly strong.

The Depressed Area Problem

In the economically advanced nations, the primary regional development problem is not one of regional differences in income levels or growth rates (although this can sometimes be a serious issue), but the existence of pockets of economic distress. These are frequently termed "depressed areas" and are generally characterized by such features as below average per capita incomes, above average unemployment rates, stagnant or declining levels of economic activity, and a low quality of the infrastructure. i.e., transport facilities, public utilities, and municipal services including education. Many industrial depressed areas were at one time areas of economic growth, or at least in a state of economic equilibrium. Although the emergence of their depressed condition is due to a variety of causes, one general explanation for this emergence is that an area becomes depressed as a result of a long-run decline in its export base. Due to such factors as competition from other regions, resource depletion, or the growth of substitute products, the external demands for the area's exports decline. Such a problem becomes particularly acute if export activity is concentrated in one or a few sectors. For example, the export base of the Central Appalachian Region of West Virginia and Eastern Kentucky was concentrated primarily in the coal mining industry, so that with the shift to alternative sources of fuel many of these areas found themselves subject to severe economic

stress. In the case of rural depressed areas, a frequent cause of their condition has been the growing efficiency of agriculture which arose from mechanization and more productive farming methods. In this case, the export base *per se* may not have declined but its capacity to support a labor force at its former level undoubtedly did.

The explanation for depressed areas in terms of the export base theory is only a partial one. Many areas have suffered a severe loss of export income and, although this may have caused temporary difficulties, they did not emerge as depressed areas. The central New England area, and parts of upstate New York, have suffered considerable losses in their export base as a result of textile plants closing down and transferring operations to the Southeastern States in order to take advantage of low cost labor. In these areas, however, the loss was partially offset by the growth of new industries, such as electrical engineering and electronics assembly. Thus, a fundamental cause of the depressed area condition is the inability of a regional economy to adjust to changing economic conditions and, to a great extent, this inability can be explained in terms of supply factors.

In the New England case, the manual dexterity of labor in the textile industries proved to be an attraction for industries such as electronics assembly. By contrast, coal mining labor in areas such as Central Appalachia was very specific and not readily suited as a source of labor supply for other industries that might have been willing to utilize it. A similar contrast could be drawn between the two regions with regard to the physical plant associated with each dominant export base. A textile mill may have a couple of decades of useful commercial life left in it and could thus be occupied by other industries, probably at a very low cost. However, there appear to be very few alternative uses for an abandoned coal mine.

The accessibility and geographic structure of a region may also play a role, as supply factors, in causing its depressed condition. Accessibility with respect to external markets may have been adequate for the original industry upon which the area developed, but if such an industry declines, few other industries, which could replace this lost export base, may find the area a viable location in terms of accessibility. Good accessibility, on the other hand, may enable the region to avoid a depressed area condition. The geographic structure of a region may also exert influence in terms of the ease with which the region can pass from one stage of development to the next. Regions in the stage of

agriculture and resource specialization tend to have both dispersed populations and a poorly developed urban structure, reflecting the resource-oriented nature of such economic activity. Manufacturing activity, on the other hand, tends to require concentrations of labor and infrastructure, particularly if elaborate industrial linkages are involved. Therefore, if as a result of changing external conditions the demand for resources declines, a shift into manufacturing specialization would require a wholly different geographic structure within the region, involving more emphasis on relatively larger centers which would be able to provide satisfactory urbanization economies. If this externally induced change occurs slowly, then the transition and restructuring of the region may be accomplished with relative ease. Rapid change, on the other hand, may render a region incapable of making such a structural adjustment and thus cause it to become depressed.

The problems associated with depressed areas can be dangerously self-reinforcing. The loss of export income, and the initial inability to replace it, is likely to lead to reduced tax revenues and, as a result, fewer public services or reductions in their quality. This, in turn, makes the area less attractive for new economic activity which might have contributed to an easing of the problem. Such a process may continue in a downward spiral. There is a range of possible public policy responses to the depressed area problem, but in view of the vicious circle already alluded to, these require organizational and financial assistance from outside the area, in the form of intervention by an authority of state or federal government.

Three broad alternatives exist, the first being the encouragement of migration from the depressed area. However, there seems to be a pronounced reluctance to migrate on the part of the existing residents. Moreover, since outmigration is generally selective, involving the most skilled and talented elements of the labor force, it may merely exacerbate the problem unless, of course, outmigration is total, which it seldom is.[14] A second alternative involves the stimulation of new economic activity within the region. Such an approach can either involve the granting of subsidies or tax credits to firms willing to move into the region, or it might be directed toward job retraining programs and improvements in the region's infrastructure. The first alternative represents a direct attempt to expand the region's export base, or even to encourage import substitution, while the second is an indirect attempt aimed at the improvement of the supply factors which influence both

types of regional growth. However, unless the region is particularly large, the possibilities for import substitution will be generally limited. A third alternative represents, in some measure, a combination of the first two. Attempts may be made to stimulate economic activity, but it is encouraged in locations within the depressed area which have the best potential for supporting it. This may frequently involve migration or relocation of population to relatively few locations within the region. Several West European nations have adopted this approach in their policies toward depressed areas.[15]

The very existence of depressed areas, in an otherwise prosperous economy, has the effect of drawing attention to their condition, and thus tends to create pressures for their elimination. As has been shown, developing nations may be faced with economic problems which have a geographic aspect to them, but the governments of these nations are usually preoccupied with problems of a more general nature, such as those relating to the balance of payments situation, the attainment of higher productivity levels, and the encouragement of a more rapid rate of income growth. It seems, therefore, that once a country has achieved a high level of development, it can devote increasing attention to regional economic problems. Moreover, under such conditions, the economic resources at the disposal of a country are usually sufficiently large that it may feel that it can indulge in the luxury of eliminating problem areas and fostering a more balanced geographic distribution of wealth and economic growth, even at the expense of a more rapid rate of national development.

FOOTNOTES

[1] A most useful, though slightly dated, discussion of regionalization problems is contained in Whittlesey, D. "The Regional Concept and the Regional Method." in James, P. E. and Jones, C. F., editors. *American Geography: Inventory and Prospect*. Syracuse: Syracuse University Press, 1954. Chapter 2, pp. 19-68.

[2] For an excellent outline of this theory, see North, D. C. "Location Theory and Regional Economic Growth." *Journal of Political Economy* 63:243-258; No. 3, June, 1955; and Tiebout, C. M. *The Community Economic Base Study*. New York: Committee for Economic Development, 1963.

[3] Perloff, H. S. *How a Region Grows: Area Development in the U.S. Economy*. New York: Committee for Economic Development, 1963.

[4] For a more detailed account of this theory see Hoover, E. M. and Fisher, J. in Universities-National Bureau Committee for Economic Research. *Problems in the Study of Economic Growth*. New York: National Bureau of Economic Research, 1949.

[5] In any stage, other than the first, several specializations are possible, but each stage is associated with a dominant specialization.

[6] Alonso, W. "Location Theory." in Friedmann, J. and Alonso, W., editors. *Regional Development and Regional Planning.* Cambridge, Mass.: M.I.T. Press, 1964; and Estall, R. C. and Buchanan, R. O. *Industrial Activity and Economic Geography.* London: Hutchinson, 1961 describe the influence of these factors in industrial location decisions.

[7] An account of the role of supply factors in metropolitan centers is given by Chinitz, B. "Contrasts in Agglomeration: New York and Pittsburgh." *American Economic Review* 51: 279-289; No. 2, May, 1961.

[8] A more detailed exploration of the role of amenities is provided by Ullman, E. L. "Amenities as a Factor in Regional Growth." *Geographical Review* 44: 119-132; No. 1, January, 1954.

[9] For example, see Hoover, E. M. *The Location of Economic Activity.* New York: McGraw-Hill, 1948. This work contains an interesting discussion of agglomeration economies.

[10] The core-periphery problem is admirably discussed by Ullman, E. L. "Regional Development and the Geography of Concentration." *Papers and Proceedings of the Regional Science Association* 4:179-198; 1958; and Friedmann, J. "Regional Economic Policy for Developing Areas." *Papers and Proceedings of the Regional Science Association* 11:41-61; 1963.

[11] Hirschman, A. O. *The Strategy of Economic Development.* New Haven: Yale University Press, 1958.

[12] Williamson, J. G. "Regional Inequality and the Process of National Development." *Economic Development and Cultural Change* 13:3-84; No. 4, Part 2, July, 1965.

[13] The market mechanisms by which equality in regional incomes may be brought about are reviewed in Chapter 10 of Hirschman, *The Strategy of Economic Development.*

[14] The outmigration problem is examined in greater depth by Parr, J. B. "Outmigration and the Depressed Area Problem." *Land Economics* 42:149-159; No. 2, May, 1966.

[15] For a review of these policies see U.S. Department of Commerce, Area Redevelopment Administration. *Area Redevelopment Policies in Britain and the Countries of the Common Market.* Washington, D.C.: Government Printing Office, 1965.

Chapter 6

Spatial Interaction

Douglas K. Fleming

This chapter heading might mystify the layman. It is difficult to imagine interaction without spatial dimensions. Is the adjective vaguely redundant, or does it modify missing words — "aspects of"? "effects of"? Actually it reflects a desired emphasis. Understandably, the chemist or the psychiatrist, for example, is not always particularly interested in the spatial specifics of his scientific observations.[1] Geographers, however, are trained to interpret patterns of distribution and of movement. They are concerned with relative locations, directions, distances, and with the types of interaction in which these variables play significant roles. The theme of "spatial interaction," popularized in geographical literature over the past two decades, preserves the geographer's traditional dimensional focus but suggests, essentially, a *geography of change.*[2]

The general case of commodity trade will be examined below. Material trade flows are tangible and directional, usually moving over distinct networks between separate, identifiable places. Networks and flows have discernible patterns. Obviously, a number of the spatial variables are measurable and, presumably, have measurable effects on ... Yet commodity trade is really a product of human interaction. ...muli must be interpreted in the light of human needs, aspirations,

and attitudes. The mechanics of trade require human communications. This implies less-tangible, less-visible information networks and flows. "Information," itself, ranging from vague impression, or rumor, to precise knowledge, energizes the systems of trade.

A *systems* framework is, in fact, appropriate for an overview of the generating conditions, networks, flows, and effects of trade. The trading system — and we often employ this terminology without considering its formal meaning — is a complex structure of interdependent elements. Places, people, objects, institutions, ideas, and their various temporal and spatial dimensions, are parts or partial characteristics of the structure. Changes in the position or nature of any one part tend to reverberate throughout. From this perspective of the complex whole, it is evident that the significance of one part depends on its relationships with others — that is, on connections and processes which link and alter the parts.[3]

The eye — or mind's eye — is irresistibly drawn to unit parts or partial characteristics of the trading system. Detailed description, explanation, and (partial) analysis require this narrower focus. Moreover, it is sometimes useful to "close" a system which, in reality, remains open to outside influences.[4] Even though these adjustments of perspective and focus are apparent in the remainder of this chapter, the intention is to present a balanced picture of the *complex whole*.

Preconditions for Interaction

Hypothetical Development of a Trading System

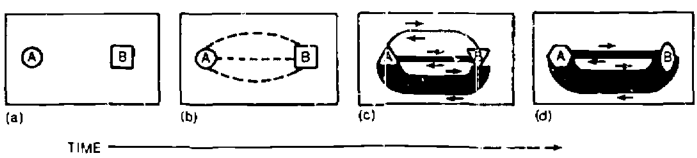
A typical trade relationship which develops between identifiable places is graphically generalized in Figure 1.

Even the static, descriptive studies which are not particularly fashionable in geography today cast light on the milieu for interaction. Having rejected the crudities of physical determinism (applied to human behavior), many geographers in Germany, France, and America became absorbed with the detailed uniqueness of places and human systems. Studies of areal differentiation, which Hartshorne considered the essence of geography,[5] do illuminate "surpluses and deficits" — in physical and human terms — varying over the earth's land surface.

Variations in natural physical characteristics, and in human occupance and use of earth space, generate certain interaction potentials. In barter exchange, a primitive type of trade, material surpluses are exchanged for material deficits. The most elementary theories of trade

FIGURE 1

Temporarily closed interaction system



LEGEND:

GEOMETRICAL SHAPES, e.g. A B, REPRESENT DIFFERENT PLACE CHARACTERISTICS.

--- REPRESENTS TOTAL TRANSPORT AND INFORMATION NETWORKS.

⇄ REPRESENTS TOTAL TRADE FLOW IN BOTH DIRECTIONS OVER A GIVEN TIME PERIOD. WIDTH OF FLOW LINE REFLECTS SOME MEASURE OF TRADE VOLUME OR VALUE.

HYPOTHETICAL DEVELOPMENT STAGES

(a) One of the possible preconditions for interaction is established by different characteristics of places A and B. There is no connectivity between A and B.
(b) Information and transportation networks are established. Natures of A and B change.
(c) Trade flows are tangible manifestations of A-B interaction. Natures of A and B change.
(d) Network connections change. Magnitude of trade flows change. Natures of A and B change.

focus on areal differences of physical and human endowments. These variations, of course, should be interpreted in the light of human tastes and aspirations as well as basic needs. Human desires also vary geographically. In some instances, human differences are so profound that the urge to interact simply does not exist. Considering different ways of life and standards of value, neither area may have anything to offer that the other really wants.

The conditions for British colonial trade in the eighteenth and nineteenth centuries can be placed in the context of areal differentiation. Quite obviously, there were surpluses and deficits, spatially identifiable by the British traders, at least. Frequently these trade potentials could be traced to natural environmental differences — soils, vegetation, mineral deposits, etc. However, "naturally" similar areas may specialize differently. Consider the development of market centers in the midst of productive agricultural areas. Here the potential for interchange also arises from areal differentiation, but the differences are largely man-made, not natural.[6]

According to classical trade theory, areal specialization can be a cause and effect of unfettered trade.[7] Growth of trade may imply increasing *specific* areal differences, but the construction of a complex trading system also implies development of certain *general* similarities. In such considerations, the level of generalization is particularly important. For instance, one of the greatest international trade flows in volume, value, and variety is generated between eastern United States and northwestern Europe. The two regions have well-known natural and human differences. However, there are even more striking similarities: high educational levels, advanced industrial economies, quite similar political systems, cultural backgrounds, and tastes. Similar products are produced, consumed, *and* traded. The interchange of Fords, MG's, and Volkswagens, for example, is explained as much by *general* similarities in tastes and economic capabilities, as by slight but specific differences in products, prices, and individual tastes.

It is tempting, but frequently misleading, to place commodity trade in the economist's supply-demand framework. Human needs, as mentioned cannot always be suitably evaluated in economic terms. This is even more apparent in the types of interaction giving rise to human migration. Labor migration may have strong economic motivation. Yet history abounds with examples of migratory flows stimulated by social, spiritual, and other non-economic attitudes and aspirations. Sometimes there is simply the psychological rejection of a societal system in one place, and the search for a substitute elsewhere.

Information Networks

Specific differences or similarities between places create impressions from which attitudes toward places are built. Trade flows and human migrations are preceded and accompanied by impressions, attitudes, ideas, and, frequently, by human negotiations. Information networks and the media for communication are, therefore, vital preconditions for spatial interaction.[8] Conceivably there are some spontaneous, unplanned movements, but these are exceptional.

In defense of earlier geographers who have been disparaged as "mere describers,"[9] they assembled information and impressions, constructing and disseminating attitudes toward places. Many of the great flows of goods and people in post-Columbian history were stimulated by these impressions.[10]

Recent interest in information networks, and in the spatial behavior of information flows, brings a new realism (and complexity) to the geography of spatial interaction. The diffusion of ideas is today an active field of geographical research (Chapter 2) to which increasingly sophisticated techniques (Chapters 7 and 8) are applied.

Within the trading system, networks and paths of information can sometimes be traced. Information interchange is a crucial part of trading negotiations, as described later.

TRANSPORTATION NETWORKS

Another obvious prerequisite for material trade (or for flows of people) is some type of physical connectivity between "homes" of interacting factors. There must be a medium for, and a means of, transportation.

In spatial interaction research, considerable attention has been accorded to network patterns. Early studies of highway, railroad, and canal routes tended to emphasize network morphology. There was particular interest in environmental explanations of route patterns.[11] Spatial variables were prominently noted, sometimes only in relationship to the perspectives and problems of the network builder in surmounting barriers to transport.

There are other perspectives and lines of inquiry which have proved fruitful. A number of geographers have recognized that networks and flows are intimately related variables so that either (or changes in either) gives rise to the other (or changes in the other). Others have investigated distortions of "natural" route orientations for non-physical and non-economic rea. .s. Others, utilizing geometrical and abstract models, have been intrigued with ideal connectivity and the minimization of necessary network mileage from a theoretical viewpoint.[12] Within the interaction system each of these perspectives has relevance, as a reexamination of Figure 1 might suggest.

DISTANCE

The concept of distance is emphasized in many spatial interaction studies. If we are concerned with interaction of phenomena in separate, locatable places, the connective networks represent only partial conquest of intervening distance. In the trading system, for example, the network is a physically permissive factor. If interaction translates to tangible physical flows, the size and behavior of the latter appear to be at least partially dependent on (some measure of) distance as well as on the

nature of the interacting factors. Obviously, distance is usually a crucial consideration of the transportation carrier if not of the "traders" themselves.[13]

The distance that *does* affect the physical manifestations of interaction is not necessarily distance measured in miles or a regular fraction or multiple of it. Thus, geographers (and others) have developed concepts of economic distance, social distance, political distance, perceived distance, and so forth. With a multitude of adjustments, Newton's gravity model is still a popular descriptive tool for interaction studies. It must be used with caution however, since the effects of distance in terms of magnitude and direction of flows in the interaction system are by no means constant.[14]

INTERVENING OPPORTUNITIES

Given two "places" with a propensity to interact, connecting information and transport networks, a mode of transportation and surmountable intervening distance, the basic framework of the interaction system is constructed.[15] If the system is then closed one might expect developments generally similar to those illustrated in Figure 1, in which change occurs only through endogenous differences.

However, practical experience suggests that very few trading systems *are* closed. There are alternatives or, to emphasize the spatial dimension, "intervening opportunities."[16] Places A and B (Figure 1) may have stronger reasons to interact with C or D outside the A-B system. The transportation carrier may have alternative routes and cargoes. For specific interaction to occur between specific places, giving rise to specific flows, distance and intervening opportunities must be conquered.

* * * *

In the conceptual framework presented above, the propensity of places to interact, the connecting networks and the modes of movement are permissive factors. Distance and intervening opportunities are impediments. To illustrate, an empirical (but simplified) case of long-distance trade is considered below:

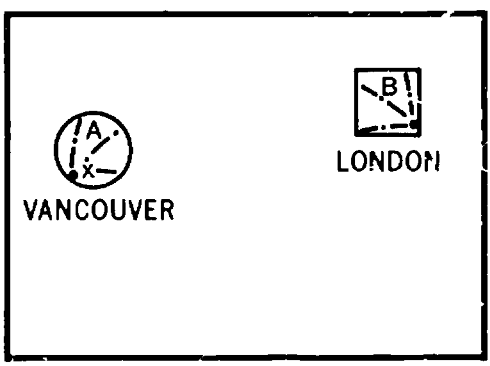
An Illustration —
Wheat Trade: Western Canada to the United Kingdom[17]

THE NATURE OF PLACES: PROPENSITY FOR INTERACTION

Region A (Figure 2) includes the western portion of the wheat-producing Canadian prairie provinces, served, in this instance, by the

FIGURE 2

Propensity for interaction



LEGEND:

—·—·— INTRAREGIONAL NETWORKS
x SUPPLY OF WHEAT AT VANCOUVER
A GRAIN PRODUCING REGION
B BREAD EATING REGION

port of Vancouver, British Columbia. Region B contains the major grain-consuming centers of England, served, let us say, by the port of London. Regions A and B each have internal connectivity in the form of their own regional transportation and communications networks. A and B have an exact mileage separation (both as the crow flies and as the most direct ships steam) and, for practical purposes, exact locations. These spatial specifics remain unchanged.

Comparatively sparsely populated, extensively farmed region A produces annual surpluses of wheat for international export. Densely populated, highly industrialized, bread-eating region B has limited wheat-growing capabilities. It specializes in other forms of economic activity for which it is relatively better suited, and requires voluminous grain imports.

Despite obvious differences of physical environment and types of human activity, there are numerous social, political, economic, and

general cultural similarities which have encouraged close trading relationships between A and B (in which case Figure 2 without A-B connections is obviously incomplete).

Assume, specifically, that region A has produced 15,000 tons of quality "x" wheat, delivered to a Vancouver dockside grain elevator, pending export. Assume that region B requires within two or three months at least 15,000 tons of quality "x" wheat. For the moment rule out the possibility of alternative regional supply sources or markets.

Information Networks

The development of a trading system between A and B required, historically, certain basic human attitudes. Those in A and B, and those elsewhere who might be involved in A-B trade, must have at least a rough knowledge of the "nature of the places," and a willingness for trade to develop.

There must also be information flows between wheat producers, shippers, transportation carriers, receivers, consumers, and their respective negotiators. These individuals, or companies, may have widely separate locations. Only the actual producer and the actual consumer need be situated in A and B, respectively. If there are workable communications channels, actual distances and locations may have relatively small bearing on volume of information flow.

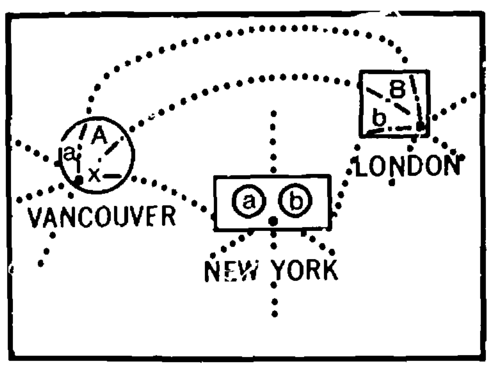
For simplification, assume that wheat producer, shipper, and seller are synonymous (perhaps part of the same trading house or corporate enterprise) with headquarters in region A and identified as "a".[18] Assume that wheat buyer, receiver, and consumer are synonymous, located in B and identified by "b" (Figure 3).

Over a relatively long history of interchange, rapid communications (telephone, teletype, cable, etc.) have developed within A, within B, and between A and B. Seller "a" and buyer "b" also maintain communications with traders and negotiators elsewhere. Assume that negotiations on sale and movement of quality "x" wheat will take place in New York, "a" and "b" using New York negotiators ⓐ and ⓑ, respectively (Figure 3).[19]

Through information flows, seller, buyer, and negotiators are generally, and often specifically, aware of attitudes and needs of one another. Since the A-B system is not really closed, there are also a multitude of connections with other regions, cities, companies, individuals (Figure 3).

FIGURE 3

Information Networks



LEGEND:

—·—·—·	INTRAREGIONAL NETWORKS
···········	INTERREGIONAL NETWORKS
a	SELLER
b	BUYER
(a)	SELLER'S NEGOTIATOR
(b)	BUYER'S NEGOTIATOR
x	SUPPLY OF WHEAT

TRANSPORTATION NETWORKS

There are, in fact, a number of alternative routes for wheat flows from Western Canada to Britain by various truck, rail, and steamship combinations. For simplification, consider only the Vancouver/London ocean route via the Panama Canal.

Steamship company "c", headquartered in Oslo, is capable of providing the physical connection for transporting wheat from Vancouver to London. One of "c's" tramp vessels (Y) is properly positioned in time and space, of adequate size and speed, fitted for grain, uncommitted to other business, and suitable in all physical respects for carriage of a full cargo of quality "x" wheat. As part of a customary

operating pattern, steamship line "c" intends to work vessel "Y" back to Europe from the Pacific. Company "c" uses negotiator (c) in New York (Figure 4).

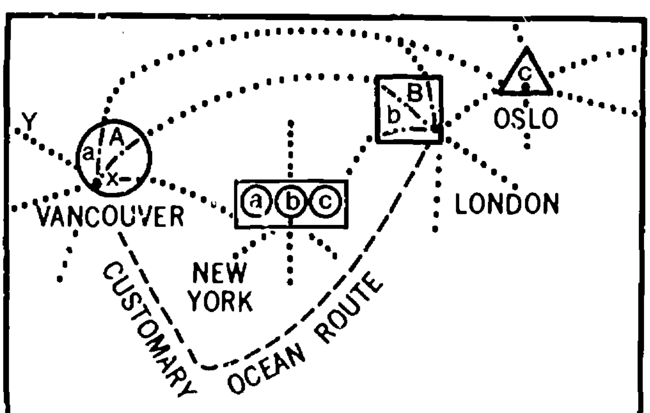
The physical connection is now "potential" but available to "a" and "b" only if sales and freighting negotiations are successful.

DISTANCE

A and B are separated by thousands of miles. The shortest feasible ocean route from Vancouver to London via Panama is 8822 nautical

FIGURE 4

Information-Transportation Potential



LEGEND:

—·—·—·—	INTRAREGIONAL NETWORKS
············	INTERREGIONAL INFORMATION NETWORKS
— — — — —	OCEAN TRANSPORT ROUTE
a,b,c	SELLER, BUYER, STEAMSHIP OPERATOR, RESPECTIVE
(a)(b)(c)	NEGOTIATORS FOR a,b,c, RESPECTIVELY
x	SUPPLY OF WHEAT
Y	C-OPERATED STEAMSHIP

miles. Prior experience with ocean transportation (substantiated by historical records of freight rate levels) indicates that Vancouver/London wheat freight rates are sufficiently low, under normal conditions, to make this distance surmountable in cost terms.

Assume that export sales of wheat from region A are "c.i.f." (insurance and freight charges to be borne by the wheat shipper). Seller "a" will therefore be responsible for freighting arrangements, and "a's" price quotation to "b" will include allowance for total transport costs. In this case "a" and his negotiator *perceive* distance in cost terms. Actual mileage is not directly relevant to their perception. Buyer "b" and his negotiator are primarily concerned with the sales price of wheat delivered in London. They need not perceive distance at all, unless there is an important time element involved. In this case they would tend to convert distance to time-in-transit terms.

The actual steaming distance happens to be crucial to steamship line "c" and its negotiator, since actual distance strongly affects voyage costs and is, therefore, a major determinant of freight rate quotations.[20] Even so, this physical distance is converted in "c's" mind to time and cost dimensions.

Assume that free market conditions exist for export sales of wheat and for negotiation of ocean freighting arrangements. Assume that there are no quota, tariff, foreign exchange, or other prohibitive restrictions to A-B wheat trade. Assume that close relationships exist between "a" and "b", between "a" and "c", and between their respective negotiators — i.e., there exists a climate of mutual experience and trust sufficient to permit negotiations. Each of these assumptions has relevance to "distance" according to various behavioral interpretations.

Intervening Opportunities

Inside and outside the A-B trading system there are alternatives which could easily prevent a specific sale of 15,000 tons "x" wheat by "a" to "b", and its movement from Vancouver to London on "c's" vessel "Y".

There are alternative markets for seller "a", perhaps in India, China, Japan, or even in region B. The wheat surplus of region A can be absorbed elsewhere.

There are alternative supply sources for buyer "b", perhaps in Argentina, Australia, the United States, or even from another seller in region A.

There are alternative cargoes and trade routes available to steamship line "c". Moreover, seller "a" might be offered alternative vessel space by another steamship operator.

For illustrative purposes (Figure 5), assume that the following specific alternatives are presented:

Market D (Japan) can absorb 15,000 tons of "x" wheat.

Grain region E (Australia) can supply 15,000 tons of "x" wheat.

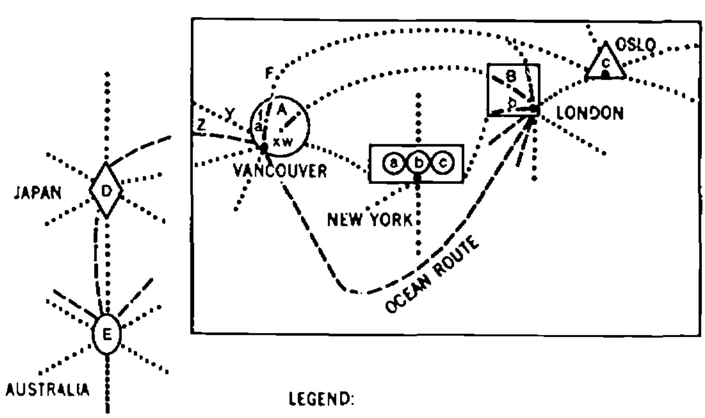
Another steamship line has vessel "Z" available off Vancouver.

Another producer-shipper "f" has possible cargo "w" for vessel "Y".

Each of the alternatives must be considered by the various negotiators and their principals. Each alternative actually strengthens the bargaining position of one as it weakens the position of another. For

FIGURE 5

Open Interaction System: Some Possible Alternatives



LEGEND:

—·—·—	INTRAREGIONAL NETWORKS
·········	INTERREGIONAL INFORMATION NETWORKS
– – – –	OCEAN TRANSPORT ROUTES
A,E	GRAIN PRODUCING REGIONS
B,D	BREAD EATING REGIONS
a,b,c	SELLER, BUYER, STEAMSHIP OPERATOR
ⓐⓑⓒ	NEGOTIATORS FOR a,b, c, RESPECTIVELY
f	COMPETITIVE SELLER IN REGION A
x,w	ALTERNATIVE SUPPLIES OF WHEAT IN REGION A
Y,Z	ALTERNATIVE VESSELS AVAILABLE FOR WHEAT CARGO

example, alternative market D in Japan bolsters seller "a" and (a), while it weakens buyer "b" and (b), and so forth.

The activation of a specific flow of "x" wheat on vessel "Y" from Vancouver to London depends (to put it negatively) on the relative unattractiveness of the alternatives.

Operations of the Interaction System

At a higher level of generalization, the Canada-United Kingdom wheat trade long ago reached stages (c) and (d) of Figure 1. The natures of regions, networks, and flows change. Each change triggers other changes. Furthermore, the A-B trading system is not closed (as in Figure 1), but open to exogenous influences (as in Figure 5). Causes and effects are no longer clear-cut or easily quantified.

The operation of a trading system requires some knowledge of processes — not only the processes of human interaction which permeate trade negotiations, but also the processes of transportation. A thorough understanding would necessitate forays into information theory and into economic principles of transportation. Until recently these particular interdisciplinary ventures have been infrequent.[21]

TRADE NEGOTIATIONS: HUMAN INTERACTION

Region A has wheat. Region B needs wheat. Region A needs vessel space — the physical means of trading with B. Steamship Y, which can "construct" the route and carry the flow, needs cargo. A trading system and tradition of trade has been previously established between A and B. Communications channels exist. "Distance" and "alternatives" are impediments to the specific flow of wheat "x". Human interaction in the form of negotiations must precede commodity flow.

Despite the existence of information networks, it cannot be assumed that all pertinent information is thoroughly disseminated. Negotiators keep secrets and act on imperfect knowledge. Each negotiator, with the limited information at his disposal, must evaluate the bargaining strength of his own and of his "opponent's" positions. Each must appraise the various alternatives. Each must consider past and future "favors" — i.e., the values of specific corporate and individual relationships.

Negotiator (a) wears two hats, since he must bargain with (c) on ocean freighting arrangements and with (b) on the wheat sale. (Again this is a simplification since (a)'s dual function may be performed by

separate brokers. With a normal risk, the timing of negotiations need not and often cannot be either simultaneous or in a prescribed sequence.)

Often principals give their negotiators a bargaining range of tolerable prices — or of freight rates — as the case may be. The ranges of opposing negotiators may overlap. The overlap defines effective bargaining limits. Obviously the "seller" (of wheat or of vessel space) seeks the top, and the "purchaser" the bottom of these ranges.

A great deal of amateur psychology is applied in such negotiations. Attitudes, however, are based on imperfect knowledge of one another's real strengths and weaknesses, personal and situational. A point of emphasis here is the profound importance of the individual human element in any one particular transaction. This might not seem especially significant in negotiations which affect one small part of a traditional pattern of interaction. Yet individual negotiators have established or broken geographical connections which, occasionally, involve movements of millions rather than thousands of tons. Moreover, the negotiators are responsible for more than sales prices and freight rates. There are many additional negotiable terms of trade which can have appreciable effects at the point of origin, the destination, and along the paths of physical transfer.[22]

The Physical Flow: Tangible Manifestations of Interaction

In the A-B trading system, assume that the specific negotiations involving 15,000 tons of "x" wheat are successfully consummated, with vessel "Y" chartered for the ocean voyage. Alternatives were less attractive. Barring unforeseen (but entirely possible) disruptions, a specific physical flow will occur. Presumably this is only one portion of a longer term periodic movement of wheat from A to B over a trackless ocean surface. The exact route and time enroute will be subject to the captain's navigating discretion, to the weather conditions, to fueling requirements enroute, to the vessel's occasionally unpredictable behavior, as well as to the terms of the specific freighting arrangement. The *exact* route will be unique for this one voyage.

This small flow of wheat has direction, velocity, and volume, and it traces a mappable path on the ocean's surface. Each of these flow characteristics can be measured, but they are only of momentary significance. The long-term flows between A and B are of more general

interest. These can be statistically verified. A combination of unique routes can be cartographically generalized into one flow line, the width of which reflects the annual (for example) volume of movement. Unfortunately, this frequently-used depiction does not reveal the periodic, interrupted, transitory nature of material movements.[23]

Within an established trading system there is sometimes a tendency to perpetuate traditional flows beyond the point at which trade becomes unprofitable for the traders. In part this can be attributed to non-economic (e.g. political) considerations, in part to situations analogous to "industrial inertia." [24] The tradition of trade between two regions creates "habit" and a sizeable investment in the trading system. The capital outlays for overland transportation systems — for instance, railroads and pipelines — are more obviously impressive. However, ocean transportation can also require large fixed investment. Complex shipping and trading transactions require a multitude of specialized offices and personnel. Altogether a large, complicated, and expensive framework is sometimes built around specific commodity trades. There may be a lag in the convertibility of these frameworks to accommodate different commodities, carriers, ports, and routes.

THE PROCESS OF TRANSPORTATION

As vessel "Y" transports 15,000 tons of wheat from A to B a unique route is "constructed" for this one voyage. The temptation, then, is to consider network and flow simultaneously and, perhaps, leap to the conclusion that the sole meaningful determinant of network and flow is a supply of wheat in Vancouver and a demand for it in London.

The exact route is unique and often unpredictable. The general routes and volumes of flow are determined by trading negotiations. These negotiations are, in turn, generally determined by a specific supply-demand situation for quality "x" wheat.

However, transportation is a business for the carrier (unless the carrier is rigidly restricted to provide a subsidized public service, or unless the carrier is owned or effectively controlled by the commodity shippers or receivers). Independent steamship line "c" had the initial prerogative of making or breaking a geographical connection between A and B. It is entirely possible that "c" and others of his ilk can *induce* commodity flows. For example, in the A-B trading system example, vessel "Y" could have just completed a lucrative voyage and, free of cargo, might have been amenable to a very low freight rate for onward

cargo to a desired general geographic destination — i.e., Europe. The low freight rate might have encouraged a specific commodity sale which would not otherwise have occurred. On the other hand, if "c's" vessel "Y" had numerous promising alternatives, the high freight rate aspirations might temporarily disrupt a traditional sale and flow.

If a large segment of world shipping space is involved, these situations can be magnified a hundredfold. Many heavy commodity flows — for instance, relief movements of grain — are sporadic, triggered by sudden announcements and negotiations on large volumes for immediate shipment. Shipping space tends to cluster geographically in response to high freight rate prospects on urgent movements. Elsewhere there develop shortages of shipping space which can disrupt traditional flows or divert them to other networks.

The habit of trade is important, however. A trade flow of relatively steady volume and direction, over long periods of time, generates habits among shippers, carriers, and receivers. To guard against spatial dislocations of shipping space, large traders often guarantee themselves regular geographical connections by owning and operating their own fleets, or by engaging regularly scheduled liner space. Even so, it is a mistake to think in terms of a closed trading system. There are too many alternatives and too many exogenous influences which affect shipper, carrier, and receiver.

RELATIONSHIP OF NETWORKS TO FLOWS

Figure 1 suggests some sort of causal connection between networks and flows (sequences b, c, and d of Figure 1). The building or prior existence of networks might stimulate flows, and the potential or actual flows might encourage the construction of new or alteration of old networks. Intuitively we are quite certain that these relationships exist, but we are seldom given the closed system in which such effects can be isolated and quantified.

For a single interaction sequence in the A-B wheat trading system, involving a single voyage between two points, an analysis of network-flow relationships would be meaningless. Even for descriptive purposes, a wider perspective must be adopted.

Vessel "Y" is part of a large fleet of periodically participating ocean carriers. Y's route is a rough approximation of a general, well-traveled route. The 15,000 tons of wheat are part of a much larger yearly volume. Extending the view geographically, an extensive worldwide ocean net-

work pattern can be observed. Vessels proceed along various segments of this network, sometimes loaded, sometimes in ballast, in constant quest of most profitable voyage combinations. (This quest is of immediate concern to uncommitted tramp vessels, but certainly also a long-range consideration of all vessels.) There are factors quite exogenous to the A-B trading system which affect the availability of steamship service from A to B. Spatial dislocations of shipping space are commonplace. There may be an abundance of space in British Columbia since there was, shortly before, an abundance of cargo moving to Japan, followed perhaps by heavy trans-Pacific cargo flows.

If the Western Canada-United Kingdom ocean route fits the larger pattern of numerous carriers' operations, wheat flows may be stimulated by reasonably low freight rate levels. There is equal reason to claim that steady, dependable wheat flows in the A-B system may attract additional steamship service to British Columbia, stimulating flows in *other* trading systems if these flows position vessels geographically for the wheat flow.

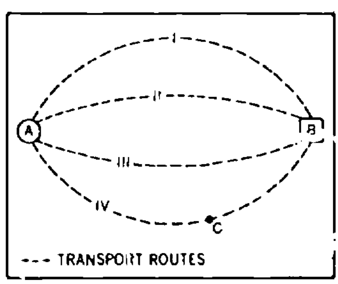
Ocean network analysis has been generally neglected by geographers.[25] Ironically, of all types of transportation carriers, the steamship perhaps has the most frequent opportunities to "construct" networks. Air transportation, particularly in its infancy, also involves frequent network additions and alterations.[26] The construction of these networks, regardless of their somewhat illusory nature, is profoundly significant to the carrier. Most attempts at network analysis by geographers have been applied to overland transportation routes.[27]

The relationship of route networks to physical and human environment has captured the attention of certain geographers.[28] Essentially, here, the network builder's point of view is adopted. Another significant line of inquiry concerns actual paths and volumes of flows, given network connections between places which provide several alternatives. In some instances, the actual path is dictated by the transport carrier's requirements. At other times, the commodity shipper's desires might prevail. Sometimes the commodity receiver has the upper hand. Here then are four perspectives on choice of route: network builder's, shipper's, receiver's, and carrier's, illustrated in Figure 6. (In the case of ocean transport, of course, network builder and carrier would be synonymous.)

This illustration implies that the carrier has rate-setting powers, and that operating costs are reflected in his rate quotation. It also implies

FIGURE 6

Overland Network Perspectives



ASSUME: SHIPPER LOCATED IN PLACE A, RECEIVER IN PLACE B.

ROUTE I. NETWORK BUILDER'S ORIGINAL CHOICE: EASIEST TERRAIN; CHEAPEST TO BUILD; LONGEST IN MILEAGE DISTANCE; LONGEST TRANSIT TIME; HIGHEST FREIGHT RATES

ROUTE II: SHIPPER'S USUAL CHOICE: * MODERATELY EXPENSIVE TO BUILD; MODERATELY SHORT IN MILEAGE DISTANCE; MODERATELY FAST TRANSIT TIME; LOW FREIGHT RATES (SAME AS ROUTE IV)

ROUTE III. RECEIVER'S CHOICE IF SPEED NECESSARY: * DIFFICULT TERRAIN; MOST EXPENSIVE TO BUILD, SHORTEST; FASTEST TRANSIT TIME; MODERATE FREIGHT RATES (SHORT HAUL BUT HIGH CARRIER OPERATING COSTS)

ROUTE IV. CARRIER'S USUAL CHOICE: MODERATELY EXPENSIVE TO BUILD; MODERATELY LONG, RATHER SLOW TRANSIT TIME, A TO B, BUT CARGO POTENTIAL AT C, ENROUTE; LOW FREIGHT RATES (SAME AS ROUTE II).

* NOTE: IF SHIPPER SELLS ON A DELIVERED PRICE BASIS (EITHER "c i f" OR "c and f") HE IS MORE LIKELY TO CHOOSE ROUTE II OR ROUTE IV TO LOWER TRANSPORT COSTS. IF RECEIVER TAKES DELIVERY OF GOODS AT SHIPPER'S PLANT (e.g. AN "F O B" PURCHASE) HE IS FREE TO SELECT ROUTE III FOR FASTER TRANSIT (AT SOME ADDITIONAL TRANSPORT COST)

that Route I might be abandoned unless it provides essential way-stop service of some kind. These assumptions might be unrealistic, but the point here is to emphasize that there are different perspectives.

THE CHANGING SYSTEM

In the dynamic structure of a trading system, change is an inevitable characteristic. The components of the system — people, institutions, attitudes, commodities, networks, flows, for example — are functionally related and truly variable. Spatial distributions of components, relative locations, and separating distances might appear to have more permanence, but the *significance* of these dimensions are also variable, particularly if one thinks in terms of "perceived distances" and "effective distances." Because of the intimate functional relationships, one change provokes chain reactions. This has been noted above in the network-flow relationships.

Impulses for change may arise within the system. For example, trading institutions may be reorganized, networks altered, flows timed differently, and transport carrier's fleet and facilities modernized for the purpose of enhancing efficiency of the trading system. Increased efficiency may stimulate increased trade volume (especially if efficiency is accompanied by declining unit transfer costs). Deterioration of efficiency implies a reverse effect.

More frequently, perhaps, exogenous influences provoke change. Intervening opportunities and alternatives, previously mentioned in the A-B trade example, can profoundly affect specific interaction in the A-B system. The "openness" of this system is accentuated by the fact that the A-B information and transportation networks are small parts of much more extensive connections. A-B is really a *sub-system*, nested in a complex hierarchy.[29]

Changing characteristics of places obviously affect interaction between them. These changes also arise endogenously (within the A-B system) and exogenously. A long-term interruption of networks and flows could conceivably modify the patterns of activity in regions A and B (a bit far-fetched, perhaps, in this particular wheat trade example). Certainly the nature of supply and demand conditions in A and B changes periodically for numerous reasons. Over long periods of time changes can be profound. Consider, for example, the changing characteristics of eastern United States and England, from the colonial

period to the present, and, then, the changing composition of trade between them.

Alterations of information connectivity can have drastic effects upon the operations of the trading system. Refinements of internal communications channels tend to encourage heavier flows. Development of new or improved external information channels may have the reverse effect by introducing an increased awareness of intervening opportunities.

In certain political and economic circumstances, communications networks can be totally disrupted. Recall the destruction of the Cuba-United States sugar trade after the rise of the Castro regime. The supply-demand situations remained and the physical networks were potentially there. One major permissive factor, human communication, was removed. Interaction ceased. Viewing it in a different perspective, this could also be explained in terms of distance. The perceived distance, effective distance and political distance, from Cuba to the United States became insurmountable. In this sense the alternatives to both countries were more attractive.

Political circumstances (exogenous to the trading system) can also introduce tangible impediments to networks and flows. The 1956 and 1967 Suez Canal blockages had (and still have) direct effect upon physical routes and effective distances in the Persian Gulf-Western Europe oil trade.[30]

General economic developments resulting in multitudes of artificial trade restrictions — quotas, tariffs, exchange controls, etc. — have equally strong effects upon networks and flows, and upon economic distance between places in specific trading systems. The transport carriers' subtle role in shaping networks and flows has been noted above. The carrier, too, looking beyond one particular trade, is confronted with changing economic circumstances.

Viewing world trade in broad perspective (the giant system which includes but dwarfs the A-B sub-system), general increases of interaction are normally the rule. This implies increased material flows, increased network connectivity, and, probably, increased alternatives for the participants of each smaller trading system.

Finally, the human elements in these interaction systems undergo change. Human attitudes, individual knowledge, experience, fancies, strengths, and weaknesses are not constant. Individually and collectively these alterations affect other components of the interaction sys-

tem. Perhaps this is an understatement since the human element dynamizes the entire system.

Maximization of Interaction

Theories of regional economic development (Chapter 5) are particularly concerned with effects of spatial interaction upon regional economic growth. An implicit assumption is that growth requires increased interaction. One of the most publicized prerequisites for progress of a lesser-developed area is the opening up of channels of interaction.[31] Regional scientists, armed with increasingly sophisticated techniques, examine linkages of economic activities. The repercussive and feedback effects of new industrial injections into the regional system are investigated. In the selection of types of industries for "problem regions" there are numerous non-economic guidelines, as well, but the desire to maximize regional outputs generally involves an expansion of the interaction systems.[32] A second objective, with important spatial implications, is to maximize linkages *within the region*, retaining the maximum benefits of increased interaction for the region.

The "maximization of interaction" philosophy is accompanied by the suggestion that increasing rates of change might be important for economic growth. This requires a proliferation of rapid communication channels, of physical transportation networks, and of flows. The nature of places changes more rapidly. Acceleration of the interaction process inevitably places a strain on the human element. (It is debatable whether the modern communications revolution is *really* an alleviating factor.)

Atmospheric Change

There is another general effect which is seldom considered in spatial interaction studies. With the processes of interaction, the "atmosphere" (as humanly perceived) of places, perhaps slowly, but surely, is modified. Whether or not this phenomenon falls within the geographer's disciplinary realm, it is something we all observe and with which we are all concerned. Historians and geographers have recorded cultural change in temporal and spatial frameworks. The processes of cultural diffusion induce atmospheric alterations along the diffusion-paths. Geographers have also been intrigued with the impact of human migrations upon the social and economic fabric of places.[33]

There are many striking manifestations of the atmospheric effects of trade and travel on focal points. What has the air age contributed to the atmosphere of fortunately located network hubs? What gives American railroad towns and American railroad stations an air of decay and neglect? What gives port cities their peculiar image?[34] To understand the atmosphere and, in fact, the history of certain transportation centers, one must understand the growth or, sometimes, decline of connectivity.

Conclusions

Trading systems are dynamic organizational structures which "come to earth," often at widely separate places. Geographers are especially interested in the points where the structures "touch ground," in the lines of connections between these points, in the flows of goods, people, and ideas along the lines of connection, and in the distances, variously measured, between points.

Specific differences and, sometimes, *general* similarities between places generate attitudes and impulses for interaction. The systems must have connectivity. Communications *and* transportation networks are required for virtually all commodity trade (and human migratory) flows. Human needs, desires, and whims, expressed individually or collectively — often in the form of corporate or governmental behavior — animate and manipulate the interaction structure. Once the system is established, changes injected into any part of it have repercussive effects on all components. From within and without, places, people, institutions, networks, flows, locations, distributions, directions, and distances may be modified.

The intention is not to paint a picture of chaos and unpredictability.[35] Trading systems are often beautifully constructed, organized, and operated, but they are, in fact, complex and open. Complexity and openness have not discouraged the interested investigator. Certain variables can, with considerable realism, be held constant. For example, over the short term, the nature of places, effective distances, and physical networks between them may remain relatively unchanged. For descriptive and analytical purposes, interaction systems can be closed and shrunk — i.e., "alternatives" can be temporarily eliminated. The number of variables can be reduced, sometimes by simple processes of "lumping together." Perspectives and levels of generalization can be shifted, depending on the desired focus.

Obviously, there is no single perfect model of the trading system. There is something about the behavior of information flows which suggests analogies to heat or energy systems.[36] There is something about trading negotiations and choice of alternatives by traders which suggests the applicability of "games theory." [37] There is something about the effects of distance on interaction which popularizes the use and adjustment of Newton's gravitational model. There is something about the unpredictability of the paths of ideas and information which suggests the relevance of probabilistic "laws" and models.[38]

Most of these models have been made to fit certain types of interaction in certain instances. They are, then, useful descriptively and, perhaps, for limited predictions. The model-builder is usually aware of the limitations of his product. The layman — let us say the student — is not always "clued in." The assumptions, parameters, and biases of perspective are not always explained. Economists can hide the "friction of distance" in the supply curve of their supply-demand schedules.[39] Geographers, preoccupied with distance, can hide the uncertainty of human behavior with strategic adjustments to the gravity model.

The major illustrative example of wheat trade in this chapter is designed for descriptive, explanatory purposes. It borrows its basic framework from Ullman's rationale for spatial interaction.[40] Its details may be tested against empirical observations. Very little theoretical originality or predictive value can be claimed for it. It treats the interaction complex as an open system, *which it really is.*

FOOTNOTES

[1] In the observation of chemical reactions or of personality interplay, the spatial and temporal prerequisites might be described with casual terms such as "proximity" and "sufficient time."

[2] The view of geography as "spatial interaction" obviously introduces an element of dynamism. In his philosophical discourse on themes of "areal differentiation" and "spatial interaction," Hartshorne admitted that (Ullman's) emphasis on spatial interaction "is a welcome reaction against a previous overemphasis . . . on morphology of areas, on forms and patterns at the expense of flows and function." Hartshorne, R. *Perspective on the Nature of Geography*. Chicago: Rand McNally, 1959. p. 19, footnote 7.

[3] This paragraph borrows and sometimes rephrases ideas from: (a) Ackerman, E. A. "Where Is a Research Frontier?" *Annals of the Association of American Geographers* 53:429-439; No. 4, December, 1963; (b) Chisholm, M. "General Systems Theory and Geography." *Institute of British Geographers, Transactions No. 42*, December, 1967. pp. 45-52; and (c) *A Systems Analytic Approach To*

Economic Geography. Commission on College Geography, Publication No. 8. Washington, D.C.: Association of American Geographers, 1968. The systems framework for spatial interaction or for ecological relationships is certainly not a *new* concept. Systems analysis (not attempted in this chapter!) has received great recent impetus from its proven practical utility in and outside the academic world, particularly with the development of computer and quantitative techniques which facilitate the handling of multiple variables. See E. A. Ackerman, Note 3a above, and Chapter 7 of this Yearbook.

4 Closed systems are "those which possess clearly defined closed boundaries across which no import or export of materials or energy occurs." Closed systems tend toward a state of maximum entropy, change only occurring through innate or given differences within the system. See Note 3c above, p. 8.

5 Thus, Hartshorne claims, "spatial interaction can only mean relations between phenomena in different places, and these phenomena, whether in place or in movement through space, form a part of the character of each area concerned." See Note 2, p. 19.

6 The development of concentric rings of land use around a central market place was observed by von Thünen. von Thünen, J. H., *Der Isolierte Staat in Beziehung auf Landwirtschaft und Nationalokonomie*. Jena 1st Edition 1826. The differences of land use between successive rings have a significant relationship to transport costs varying regularly (in von Thünen's model) with distance from the market center. Initially, "natural" characteristics (soils, terrain, etc.) are assumed to be uniform throughout the area.

7 Ellsworth describes, in lucid terms, the development of the concepts of areal economic specialization and comparative advantage in the works of Adam Smith, Ricardo, and J. S. Mill. Ellsworth, P. T. *The International Economy*. New York: Macmillan, 1963. Chapter 4, pp. 58-69.

8 Ackerman, p. 437, claims that connectivity within a system is its most important characteristic and, in contrast to Hartshorne's emphasis (Note 5, above), that "areal differences are significant *only* insofar as they help to describe and define the connectivity or 'information' flow." It should be mentioned that Hartshorne did not think primarily in terms of "systems."

9 In an editorial for *Economic Geography*, Klimm begins, "'Description' has become a dirty word," then proceeds to argue that non-theoretical description *should be* respectable. Klimm, L. E., *Economic Geography*, 35:ii; No. 1, January, 1959.

10 Interesting hypotheses on the motivations of new world explorers have been recently presented by Carl Sauer and Earl Hanson. Sauer, C. O. *The Early Spanish Main*. Berkeley: University of California Press, 1966; and Hanson, E. P., editor. *South from the Spanish Main*. New York: De... orte Press, 1967.

11 In a monograph on transportation geography, Appleton discusses the various lines of inquiry in network and flow analysis. Appleton, J. H. *A Morphological Approach to the Geography of Transport*. Hull: University of Hull, 1965.

12 Peter Haggett, with abundant references, considers these lines of inquiry, and the models which have been applied, in his recent book on locational analysis. Haggett, P. *Locational Analysis in Human Geography*. New York: St. Martin's Press, 1966. Chapter 3 (Networks), pp. 61-86.

13 As mentioned later, actual mileage distance is a rather direct determinant of carriers' operating costs, fuel costs, etc.

14 A review of distance as a spatial variable in human interaction, of the ways geographers have treated it, and of the varying perceptions of distance, can be found in Olsson, Gunnar. *Distance and Human Interaction. A Review and Bibliography*. Bibliography Series Number Two. Philadelphia: Regional Science Research Institute, 1965.

15 This framework reflects only a slight modification of Ullman's bases for interaction. Ullman, E. L. "The Role of Transportation and the Bases for Inter-

action." *Man's Role in Changing the Face of the Earth*. Chicago: University of Chicago Press, 1956. pp. 862-880.

16 The concept of "intervening opportunity" was popularized by sociologist Samuel Stouffer. Stouffer, S. A. "Intervening Opportunities: A Theory Relating Mobility and Distance." *American Sociological Review* 5:845-867; No. 6, December, 1940.

17 There is no special significance in the selection of this example. The places and their general characteristics are "real." Today, the Vancouver/United Kingdom wheat movement is not particularly voluminous. The important role of the Wheat Board in the purchase and allocation of Canadian grain is not considered in this example.

18 Again the role of the Wheat Board is not considered.

19 The only special significance in the selection of New York for this example is that it happens to be a major center for chartering and bulk commodity transactions. However, negotiations might easily be handled in more direct fashion.

20 For an examination of various aspects of voyage cost determination and freight rate quotations see, for example, Fleming, D. K. "The Independent Transport Carrier in Ocean Tramp Trades." *Economic Geography* 44:21-36; No. 1, January, 1968.

21 Information theory is especially relevant to systems analysis. Geographers have shown little interest in the processes of information flow until quite recently, and very little interest in the processes of transportation viewed from the carrier's perspective.

22 Typical negotiable points in a voyage charter, for example, include timing and quantity of commodity movement, allowable route deviations, penalties for delays, choice of loading and discharge berths, stevedoring costs and arrangements, brokerage commissions, allowable substitutions of vessels, etc.

23 Cartographic depiction of flows has always presented problems. How should the time intervals be selected? How should directions be shown? Should flow lines reflect value or volume of trade, etc.?

24 As expressed by Alexander, industrial inertia is a psychological factor, as well, very difficult to measure, but real enough in maintaining industrial momentum in regions where factories continue to operate, sometimes long after one would expect. Alexander, J. W. *Economic Geography*. Englewood Cliffs, N.J.: Prentice-Hall, 1963. pp. 401-402.

25 Major exceptions are: Sargent and Siegfried, British and French geographers, respectively. Sargent, A. J. *Seaways of the Empire*. Second edition. London: A. C. Black, 1930; and Siegfried, André. *Suez and Panama*. New York: Harcourt Brace, 1940.

26 Van Zandt in 1944: Van Zandt, J. P. *The Geography of World Air Transport*, Washington, D.C.: Brookings Institute, 1944, and Sealy in 1957: Sealy, K. R. *The Geography of Air Transport*. London: Hutchinson, 1957 and 1966, make general analyses of air networks and flows.

27 There has been particular interest in railroad patterns.

28 See, for instance, Appleton, J. H. *The Geography of Communications in Great Britain*. London: Oxford University Press, 1962.

29 Ackerman, p. 437.

30 Actually, steamship firms discovered that the route via Cape of Good Hope was not unattractive, considering the avoidance of canal tolls, and the increasing size, carrying capacity, and low daily operating costs of supertankers.

31 Transportation networks, for example, are part of the necessary "infrastructure" for economic advancement. See, for instance, Taaffe, E. J., Morrill, R. L., and Gould, P. R. "Transport Expansion in Underdeveloped Countries. *Geographical Review* 53:503-529; No. 4, October, 1963.

32 Essentially regional scientists also use a systems framework in which the elements are dynamic and interdependent. See, for example, Thomas, M. D.

"Regional Economic Growth and Industrial Development." *Papers and Proceedings of the Regional Science Association* 10:61-75; 1963.

[33] Lowenthal and Comitas have described the effects of migration upon "sending" areas in a fascinating study of decline versus growth. Lowenthal, D. and Comitas, L. "Emigration and Depopulation." *Geographical Review* 52:195-210; No. 2, April, 1962.

[34] Novelists frequently capture these elements. Katherine Anne Porter paints a vivid (if derogatory) picture of Vera Cruz in the 1930's, for example. Porter, Katherine Anne. *Ship of Fools.* Boston: Little, Brown, 1945.

[35] August Lösch, eminent German economist who died in 1945, pleaded that "a rational economic order is not only conceivable, but realizable" and that economics "must not become a science that describes chaos instead of preaching order." Lösch, A. *The Economics of Location*, Science Editions Paperback, New York: John Wiley and Sons, 1967. pp. 363-364; first published as *Die räumliche Ordnung der Wirtschaft.* Jena: Gustav Fischer Verlag, 1940.

[36] Peter Haggett, p. 17.

[37] This was suggested to the writer by British geographer, J. P. Cole.

[38] Peter Haggett, pp. 25-27.

[39] Walter Isard complained of the economists' "Anglo-Saxon bias," which refers to their former preoccupation with the time dimension and neglect of the role of space. Isard, W. *Location and Space Economy*. New York: John Wiley and Sons, 1956. pp. 24-27.

[40] Ullman, p. 871.

Chapter 7

Systems, Model Building, and Quantitative Methods

George W. Carey

Ten years ago, a debate which was raging within the field of geography concerning the usefulness of quantitative methods in geographic research had reached its apogee. During its course, "quantifiers" and "non-quantifiers" alike seemed often to be driven to polarized positions which were equally indefensible. On the one hand assertions were encountered that the level of abstraction essential to statistical methodology undermined and obscured the effort to understand the delicate processes of spatial order and adjustment so central to the work of geographers. And, indeed, the quantitative methods employed initially by pioneer practitioners trying to break new ground were often blunt tools, and sometimes clumsily used. But equally, the other side might have been accused of irrationally rejecting any study founded on non-quantitative research as trivial.

Happily, in retrospect, as the techniques of quantitative geography have matured, and been refined, the need to defend them has vanished, and in retrospect much of the rhetoric of a decade ago appears nothing more than quaint. Three fine books have emerged which have synthesized the field of quantitative methods for the profession,[1] and few graduate departments of geography feel that they can meet their responsibilities to the student and the profession without offerings in this field.

It will not be the purpose of this essay, therefore, to develop a taxonomy of mathematical-statistical techniques available to geographic

research, with operational comments. Others have already charted that ground at finer scale than that available here, and with satisfying clarity — and sometimes elegance.[2] Instead, it might be appropriate to glance at some developments in geography which are taking place in the wake of the establishment of quantitative methodology: the growth of an interest in theory; the related concern with the properties of geographic systems; the ensuing appreciation of the need to comprehend the findings of the behavioral sciences in the interpretive framework of the geographer: and, finally, the elaboration of synthetic statistical models to compare theory to reality for the purpose of evaluation and — potentially — prediction.

On What Geographers Do

The world available to men's senses exists in time and space, and everything in it has the properties of extension and duration. In reality, these two attributes are inextricably dependent on each other, and to consider the phenomenal world solely under the aspect of one or the other is to violate it. Yet the very structure of English language, cast into the mold of the sentence with its subject and predicate, perpetually makes it easier, indeed habitual, to base thought in a time-oriented causal structure.[3] Thus there arises in scholarship of the Western European tradition something akin to what Isard has called the Anglo-Saxon bias.[4] That is to say, the intuitive notion that the role of time is more fundamental in understanding the phenomenal world than that of space.

But, as language tempts us to neglect spatial relationships in favor of temporal, it also subtly encourages us to structure temporal relationships into simple chains of cause and effect, after the manner of A begat B, B begat C, C begat D, etc. Dialectical philosophies such as those of Hegel and Marx based on this structure have been of great importance in the world. Much more difficult to express verbally is the kind of process represented by an automobile engine, where numerous interacting and parallel sub-processes are going on simultaneously and where, furthermore, through electrical and mechanical feedback (the generator and ignition subsystem, and the belt-cam subsystem, for instance) these sub-processes regulate each other's activities.

Instinctively, in endeavoring to describe such a phenomenon which incorporates many complex, interacting and parallel (even circular) causal chains, one turns to engineering plans, diagrams, and equations to make it clear. This reliance on plans (like the geographer's tool, the map) is both an acknowledgment of the importance of spatial juxta-

positions, relationships, and organization, and of the limitation of language to cope with describing them.

How much more complex is any inhabited region of the world than an internal combustion engine, and how much more challenging is the effort to grasp the processes by which it is organized? Geographers have been preoccupied with the spatial order of things from the earliest days, and the invention and refinement of the map as a symbolic method of representing reality apart from language has been a central organizing theme. But few dimensions of variation may be accommodated on the map: latitude, longitude, elevation, and some selected cultural or environmental features.

In the context of the increasing availability of areally located data — Haggett and Chorley have called it the "explosion of the data matrix" [5] — where not only the number of categories of data (which would form the column headings on a hypothetical table), but also the number of micro-areas for which data is collected (forming the rows, say, of our table) are expanding with every local and national census, the cartographic representations, which long ago satisfied a data-poor world, are inadequate. Merely consider the case of the geographer concerned with studying the variation of socio-economic neighborhoods in New York City. In the city alone, excluding the functionally related suburbs, there are more than 2,000 subdivisions called census tracts for which over 200 categories of information are available from the census. Our data table may be represented as follows:

TABLE I

Census Tracts for New York City

TRACT	CATEGORY 1	C 2	C 3	------	C 200
1					
2					
3					
|					
|					
2000					

There are 2,000 x 200 = 400,000 data items symbolized by this matrix.

Such a table is called a *matrix*, i.e. a rectangular array of numbers. Since it represents census tract data, it is a *data matrix*. Each categorical column is often termed a *variable*, and each row, representing a specific case, a *subject* or *observation*. There are 2,000 observations and 200 variables, and it is therefore a (2,000x200) matrix.

How might the cartographic geographer undertake the study of this matrix? He might prepare a base map of the city, and obtain 200 copies. He might then take each variable (column) and map it separately. Yet, after preparing his 200 maps laboriously, he would still have no idea as to how the variables relate to each other.

To find this out, he would have to compare maps. Fastening map 1 to a light table, he overlays maps 2 through 200 sequentially, taking notes on whatever relationships appear between pairs of variables. That task concluded, he fixes map 2 to the light table. Since he has already compared maps 1 and 2, he now needs to make only 198 instead of 199 comparisons. A formula from combinatorial mathematics tells us that the number of paired comparisons he must make in order to study all pairs of maps is given by

$$(1)\quad C = \tfrac{1}{2}\, N(N-1)$$

where N is the number of variables. Since N is 200 in this case, C turns out to be 19,900!

The poor cartographer, after preparing 200 maps, and making 19,900 comparisons, finally destroys himself, because it dawns on him that some relationships among variables may occur not in pairs, but in variables taken 3 at a time, or 4, or 50 — and it is beyond his endurance to go back and study all *triples* of his maps, let alone quadruples and miscellaneous multiples!

For the purpose of attacking this kind of a problem, quantitative methodology becomes a very powerful instrument.[6] Not only is mathematics (like cartography) adaptable to analytical work free of the "Anglo-Saxon bias" of language, but it is also unlimited, at least theoretically, in the number of dimensions of variation which may be simultaneously studied. The map, as we have seen, is not.

Fortunately for our distraught researcher, techniques have been devised which will cluster the descriptive variables into a much smaller number of independent dimensions which, after a relatively short period of computer time, may be used systematically to classify the

tracts by their similarities or differences along these dimensions thus constructing regional patterns of variation with considerable rigor and relatively little drudgery. If desired, the end product may be mapped.

Such a structure is a statistical model, which happens, in the case of our example, to fulfill a classificatory and descriptive need. This is not to say that this is the only role which a model may play, or that a statistical model is the only kind of model which may be useful to the geographer. *Iconic models*, such as aerial photographs, and river basin or shoreline tanks which actually attempt to represent a portion of the real world in a scaled down and somewhat abstracted verisimilitude, have been in use for many years, and are vitally helpful in the solution of many problems. *Analog models*, such as the slide rule which represents the process of multiplication by the adding of line segments structured to be analogous to the field of base 10 logarithms, are also useful. Berry, for example,[7] has constructed line segment nomographs to enable the interested student to estimate local changes in commercial structure in Chicago arising from various economic, geographic, and demographic changes which may occur. The digital computer has given the greatest impetus to the formation of statistical models, however, and so it is with that class of model that we will be chiefly concerned.

Aside from considerations of classification and regionalization set forth above in the example of the data matrix for New York City, statistical models may also represent processes which are extended in space and which are ongoing in time. Morrill[8] has provided us with such a statistical model of the spread of Negro population from a ghetto area in Seattle to adjoining areas, according to statistical rules formulated within the framework of the concepts of mathematical probability and based upon cultural and economic constraints which apply to Negroes in their quest for housing, along with observed demographic and behavioral characteristics of Negro families in this context. Such models may be most instructive, because they permit the student to extrapolate a process of geographical regional expansion into various future states, predicated upon the assumption that the conditions which form the structure of the model remain unchanged. In other words, the following question may be rigorously analyzed: "What are the most likely lines of expansion of the Seattle ghetto, provided (1) that the conditions of the past persist into the future, and (2) that the conditions

of the model truly represent the most powerful influences upon ghetto expansion?"

It is at this point that geographers become acutely aware of the need for theory. For one may ask whether the behavior of the population of the Seattle ghetto is unique, whether there are elements in the case at hand which are general to all such cases, and whether the present case is independent of other cases. This problem may be formulated in terms of the tension between the idiographic (or unique) and the nomothetic (or theoretically general).[9]

The powerful development of mathematical techniques for the construction of statistical models in geography has cast this question into sharp relief. Can nomothetic theories of spatial processes be constructed in geography, or must quantitative (and other) methodology be concerned with the uniquenesses of the specific case?

In a curious way one's thoughts at this juncture may be drawn back to reflect upon the medieval debate between the school of Roscellinus (c. 1050–1122) on the one hand, and that of William of Champeaux (c. 1070–1121), on the other. Roscellinus took a position close to that of the later *nominalists*. Essentially this was to contend that each object in the world was discretely unique, and that categories of objects (i.e. Man, as against men) might have reality only in the mind. This was less extreme than the position later taken by the nominalists that universal and general categories cannot exist *even* in the mind.

William, in passionate revulsion against Roscellinus' views, took the position of extreme *realism*, i.e. that the universal alone is real, which implies that every man is but one manifestation or modality of Man for example. Each occasion of the genus is but one limited expression of the collective reality.

As Watts[10] has pointed out, the mainstream of nineteenth-century scientific positivism leans more to a position close to the kind of nominalism preached by Roscellinus than to the realism of William of Champeaux — the theoretic whole, framed in the mind, arises out of the sum of the analysis of the discrete cases which constitute the parts. Yet increasingly today — and especially, perhaps, in fields influenced by biological ecology — the whole is coming to be seen as somewhat more than the sum of its parts; the shade of William is more substantially with us.

In medicine, for example, now that the scourge of the contagious diseases has largely been controlled by the germ theory which stipulates that there is one unique causative microörganism for each specific ailment, we find that mankind's health problems are more than merely the sum of all ailments. Indeed, the importance of whole interrelated classes of ailments such as chronic afflictions, allergies, auto-allergies, psycho-somatic ailments, neuroses, psychoses, and the like has been unmasked and underlined by the alleviation of the simpler contagious diseases.

This group has caused Dubos [11] to call for the reexamination of the germ theory of disease! For the interaction of people with each other and their environment, in social aggregates subject to psychological and environmental stresses, and the conflicts among different processes occurring within the body of the same individual, all have a powerful bearing on this new dimension of health to which we have become sensitized. One cannot usefully understand the manner in which the case behaves without simultaneously understanding its relationship to the various wholes of which it is a part.

Within the general process of Negro population growth and movement in our country, we have a right to ask to what extent the growth of the ghetto in one place is interrelated with Negro population movements in all other places. In this way we may be led to seek for a theory of Negro settlement pattern which will form a universal having the Seattle case, for example, as a modality.

A branch of endeavor which seeks to express wholes in terms of the interactions of all of their parts, and thus, as it were, reconcile Roscellinus and William of Champeaux, is the general theory of systems which has its origins in thermodynamics and statistical mechanics, and is becoming of great importance not only to the biological, but also to the social sciences including geography.

On Systems and Their Properties

A system may be simply defined as a whole composed of parts which interact. The parts are called *elements* of the system. This definition is extremely broad. Billiard balls in motion on a table constitute elements of a system, and collisions represent an important class of interactions. The dynamic interplay of the parts of the internal combustion engine likewise form a system. A set of simultaneous equations

constitute a system whose elements are represented by such symbols as x, y, z, and whose interactions are symbolized by various mathematical operations, such as summation and multiplication. A river basin containing watersheds, tributaries, distributaries, and variations in lithology is also a system,[12] as is a metropolitan region composed of neighborhoods and suburbs, interacting through population flows, and a set of cities interacting through the flows of commerce and industry.[13] Indeed, and in general, the spatial patterning of the social systems of man constitutes the essence of geography.

The power of systems analysis resides in the opportunity which it presents for rigorously controlled analogy. Systems may be classified into various types, and all cases of a given type will contain some common properties. If the student of a certain aspect of a system of cities discovers that it belongs to a class of systems called "open systems," for example, he has at hand an already developed body of knowledge related to open systems to aid him in interpretation, and is able to substitute a simpler open system — of equations, say — for the more complicated open system which is his object of study. By manipulating the equations (his model of the phenomenological system) he is able to experiment with the object system in ways which would not be possible otherwise.

Let us now put forward a typology of systems according to the work of Foster and his associates.[14] Three broad classes of phenomenological systems may be distinguished: isolated, closed, and open systems. An isolated system is construed as one with an impermeable boundary. Neither matter nor energy may pass it. A perfect thermos flask, perfectly sealed, world constitute such a system. In reality, perhaps, the physical universe is an isolated system, although the cosmologist Hoyle [15] feels that even it is not.

A closed system is one which permits energy to pass the system boundary, but not matter. The earth in space, for periods at a human — although possibly not a geological — time scale may be thought of as a closed system, insofar as the amount of matter gained and lost by the planet is extremely small compared to its mass.

Open systems permit a transfer of both matter and energy across the system boundary. Clearly most great earthly physical systems are open systems, as are most natural ecological systems, and much research has gone into the study of such phenomena as rain forests from the

standpoint of how matter and energy transfers are related to their maintenance.[16]

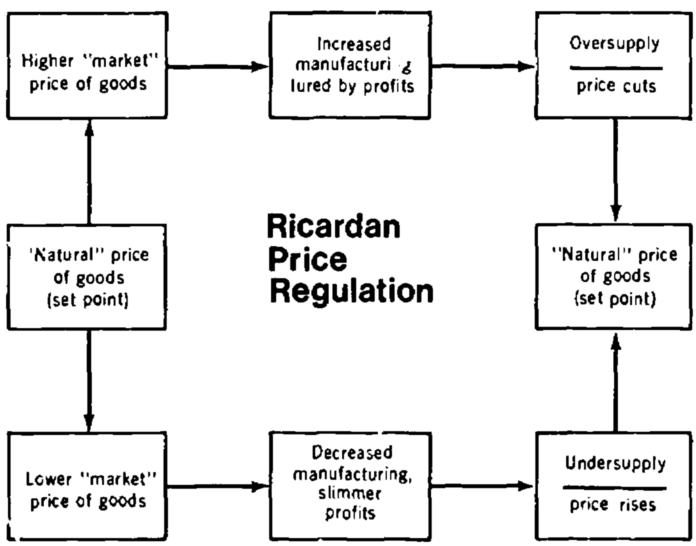
At this point, the reader should be cautioned that there exists some confusion of terms in the literature. Some writers dispense with the term *isolated system,* and apply to the impermeable system the term "closed." These writers then frequently class what we have called closed and open systems as two species of open systems.[17] Usually, however, the context will make the usage plain.

Most real systems are open systems — such as the reader and the writer, for example. By far the most important kind of open system is called a *self-regulating* system. The classical example of self-regulation is that of the thermostatically controlled central heating system of a house.[18]

The elements of the system are air molecules, a thermostat, and a furnace, with suitable connectors. Suppose the thermostat is set at 70°F, on a cool day. The air temperature in the room begins to drop; that is to say, the individual air molecules lose energy, and the average molecular velocity lessens. A device in the thermostat senses the lessening average impact of air molecules, and closes a switch, starting a furnace which reheats the air.

As the air temperature rises above the system's *set point,* the increasing average impact of air molecules on the sensing device causes the thermostat to turn off the furnace. This kind of system is called a *self-regulating* or *homeostatic* system. It comprises the system elements, a regulator, and a process for feeding back information about the state of the system to the regulator. But most important, the system is so designed that the feedback of information causes the regulator to act in a direction opposite to that of the deviation. That is to say that when the room temperature deviates upward, the feedback causes the regulator to act to lower the temperature, and vice versa. Because the action of the feedback on the regulator is opposite in direction (i.e. negative) from the deviation, this is called *negative feedback.* All self-regulating systems must have built-in regulators, or regulatory processes, which operate through negative feedback.

As Hardin [19] has pointed out, the classic theory of price regulation put forward by the celebrated economist Ricardo, is an example of a self-regulating system, which may be symbolized by the following diagram.



The reader will appreciate that Malthusian population dynamics, along with many other models of man-resource systems, is also a self-regulating system.[20] Such systems tend towards a set point which is often unfortunately called equilibrium. One prefers to distinguish between the concept of equilibrium in systems and that of *steady-state*. The temperature of a room controlled by a thermostat is in *steady-state*. It oscillates above and below the set-point in a manner dependent upon the sensitivity and "stickiness" of the regulator, and the efficiency of the feedback process. It is rarely *at* the set-point, and then only briefly.

If the heating system were turned off completely, the room temperature would approach the environmental temperature, equilibrium would prevail, and the system would become indistinguishable in temperature characteristics from its environment. Especially in the social sciences, steady-state is often unfortunately termed "equilibrium," a usage which may be confusing. The mature adult man is in steady-state. Equilibrium is death — the case when the system merges with the environment.[21]

Among urban geographers, the growth of city systems within nations has been studied within the tradition of Christaller, Losch, and von Thünen — that is to say, as Central Place Theory. Some scholars have

pointed out that the phenomenon, aspects of which were noted by Jefferson, Auerbach, and Zipf.[22] known as the rank-size rule, whereby cities decrease in size from the largest to the smallest in a system of cities by a regular logarithmic relationship, is related to Central Place Theory, on the one hand, and the steady-state in open systems on the other.[23]

The well-known body of theory in physical geography which stipulates how the actions of streams tend to reshape the form of their drainage basins until a stable profile (i.e. steady-state) is reached is another example of steady-state in an open spatial system.[24] The so-called "climax" states of natural ecology also exhibit the properties of steady-state. All aspects of human geography require research into such problems as the following: to what extent are human geographical systems self-regulatory; what tendencies to steady-state exist; what are the regulators and the feedback paths which exist; how are their set-points determined; what feedback properties do the information media possess as they pass impressions of environmental events on to individuals; and how do persons individually and collectively respond to these stimuli so as to correct deviations in a negative feedback sense?

Indeed, one of the great problems immediately before our nation is how to effectuate social change within a system which resists many changes very strongly, perhaps as much through such cybernetic self-regulatory deviation-correcting processes as we have been considering as through conscious policy formation. Land use issues of vital concern to the geographer, such as the regulation of suburbanization, the social and geographical aspects of urban renewal, the geographical workings of racism, environmental quality control, and resource management, all involve the serious consideration of how society is to change existing "set-points" and formulate new ones. The celebrated "checks and balances" aspect of our national Constitution might be regarded as negative feedback processes within an important regulator whose initial set-points were established in the 18th century. Writers such as Deutsch, Meier, and Beshers[25] have begun to explore these questions in a most penetrating way.

Negative feedback is not the only possibility in open systems. Consider a tank of water with a faucet, a drain, and a float. If the float were attached to a regulator set at a certain depth, the excessive flow of water into the tank would close the spigot. A dearth of water would open it. This exemplifies negative feedback. But suppose the feedback were positive?

In that case, if the water level rose, the spigot would be *opened*. Clearly the water would rise higher, the spigot would be opened more, and eventually a flooded bathroom would result. If the initial deviation were in the direction of less water, the spigot would close, and the tank would empty. This process incorporates the principle of positive feedback, which *amplifies* initial deviations instead of reducing them. Obviously this species of system does not have any set-point, and does not tend toward steady-state.

Deviation amplifying systems are nevertheless important to social scientists. Wilkens [26] has analyzed the process of the formation of drug addicts in terms of deviation amplification, where the sanctions imposed on the addict by society operate to drive him further into the drug subculture. The formation of some kinds of urban social areas, such as "hippie" neighborhoods, privately rehabilitated old brownstone neighborhoods, and ethnic and racial enclaves may also arise from powerful social forces acting so as to "precipitate" colonies of social uniformity around small initial foci.[27] Likewise, in the field of urban economic geography the establishment of specialized commercial districts may be analyzed through positive feedback processes. Pred [28] and Berry [29] have each given us a study which suggests the positive feedback effects between resident population structure and commercial structure: the former in the context of the influence of Negro population on commercial structure, the latter in terms of the mechanism of commercial blight as related to socioeconomic downshifts in population status. Many phenomena called "cycles," vicious or otherwise, are usefully analyzed in this framework.

In complex systems such as that of the metropolis, numerous positive and negative feedback effects occur simultaneously, as in natural ecology. The process of evolution through natural selection is, as Maruyama [30] has pointed out, a positive feedback, deviation amplifying process resulting in the creation of new species which fill new niches in the natural ecology. The overall ecological community may require the new species to attain steady-state, however. The evolution of organisms of decomposition, for example, facilitates the recycling of dead matter and helps to maintain the ecological steady-state, but the process through which evolution works is deviation-amplifying. Subsystems developed by positive feedback processes may, when developed, contribute an overall negative feedback (self-regulatory) effect to the system of which they form a part.

The complexity of a real, living, open system with its positive and negative feedback mechanisms, its deviation amplifying and diminishing processes, and its congeries of evolving subsystems, is a very subtle and often baffling thing to analyze. In particular, complex self-regulating systems often seem uncanny. Despite all kinds of efforts on the part of interested governmental and private groups, through the application of public and private policies, the problem of altering the patterns of areal differentiation between city and suburb, slum and fashionable neighborhood, segregated black and sequestered white district, differentiation in the direction of class, ethnic, and racial uniformity, remains intractable and the process continues. Remarkably enough, numerous cities, initially quite different in their characteristics, have separately converged toward the same kind of present state, with the same kinds of areal problems, as they have grown.

No wonder the unsophisticated victims of the process, who are at a loss to understand how it could happen otherwise, are willing to accept theories involving various kinds of conspiracies — of left and right, black and white, rich and poor, to explain this kind of thing. Finding a demon against which to express oneself in rebellion is easier than grappling with the complexity of the system. Think of how a person from a neolithic culture might be baffled by a central heating system. No matter how cold the outdoors, no matter what the fluctuation in the inside temperature, the house always returns, magically, to its set-point. This kind of system behavior (called *equifinality*) has an uncanny goal-seeking aspect to it which may tempt the unwary to try to explain the operation of what is really a cybernetic system by attributing its behavior to an unseen guiding intelligence. Many persons behave as animists towards computers, just as many people attribute the problems of their community exclusively to a "they," who "run city hall," or the state, or the nation, or the world.

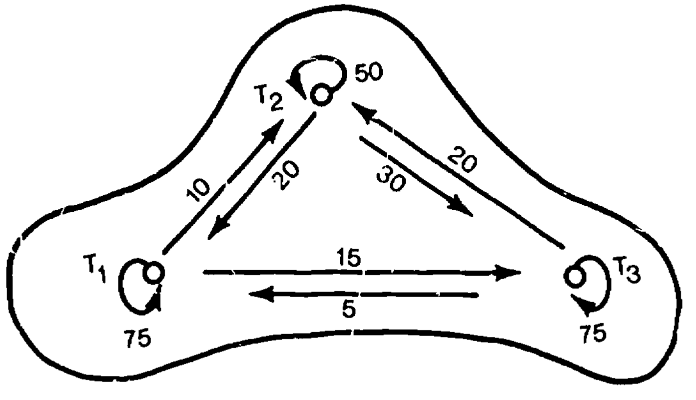
Mathematical Techniques

It is frequently useful to analyze a system by means of mathematics. While a comprehensive discussion of how this may be done is clearly beyond the scope of this chapter, perhaps several simple illustrations will suffice.[31]

On an island, there are three settlements called T_1, T_2, and T_3. Owing to local conditions, such as employment opportunity and economic health, we notice that some people in each city tend to move and to stay every year. Figure 1 represents the situation:

FIGURE 1

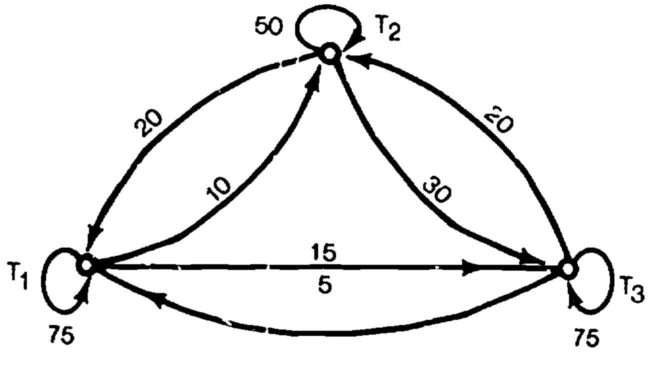
Migration Tendencies on a Hypothetical Island



The numbers next to the arrows represent percents moving. Thus ten percent of the population of T_1 moves to T_2 every year. The circular arrows represent stayers. Seventy-five percent of T_1's population stays in T_1 every year. The "map" of Figure 1 may be redrawn in the manner of a directed graph, or *digraph*.

FIGURE 2

Digraph of Migration System



This is analogous to the circuit diagram of an electrical network, and presents to us the elements of the system: the nodes $\{T_1, T_2, T_3\}$ and the various loops. Each loop symbolizes an interaction.

Every digraph, and in particular the digraph of Figure 2, may be represented as a matrix of interactions [32] thus:

FIGURE 3

Interaction Matrix of Migration System

From \ To	T_1	T_2	T_3
T_1	.75	.10	.15
T_2	.20	.50	.30
T_3	.20	.05	.75

Notice that the rows and columns in the matrix symbolize nodes in the digraph and the cells represent loops. As one would expect, summing along each row totals 100 percent. This is tantamount to saying that moving to another city, or staying, are the only alternatives in the model.

Suppose that in a certain year the population of T_1, T_2, and T_3 is given as follows:

FIGURE 4

Initial Population of Migration System

	POPULATION
T_1	3000
T_2	2000
T_3	5000

This chart has only one column. Such an array of numbers, with only one column or one row, is a special kind of matrix called a *vector* in mathematics. Figure 4 is the vector which defines the initial state of our system.

If one year goes by, what will be the new population of T_1? The seventy-five percent of T_1's population who remain will be joined by twenty percent of T_2's population and 20 percent of T_3's population. This is equivalent to equation (2). In this equation the small zeros and the digit one written before T_1, T_2,

$$(2)\ {}_1T_1 = .75\,{}_0T_1 + .20\,{}_0T_2 + .20\,{}_0T_3$$

and T_3 refer to time periods zero and one. For the whole system as it makes the transition from time period zero to time period one, we may write:

$$(3)\ \begin{cases} {}_1T_1 = .75\,{}_0T_1 + .20\,{}_0T_2 + .20\,{}_0T_3 \\ {}_1T_2 = .10\,{}_0T_1 + .50\,{}_0T_2 + .05\,{}_0T_3 \\ {}_1T_3 + .15\,{}_0T_1 + .30\,{}_0T_2 + .75\,{}_0T_3 \end{cases}$$

A simple calculation shows that after the first year, the new state vector is given by:

$$(4)\quad \begin{pmatrix} {}_1T_1 \\ {}_1T_2 \\ {}_1T_3 \end{pmatrix} = \begin{pmatrix} 3650 \\ 1550 \\ 4800 \end{pmatrix}$$

Clearly, the population of T_1 has risen, while that of T_2 and T_3 has slipped. It seems obvious that if the same migration tendencies prevail indefinitely, everyone will wind up living in T_1 just as some people have predicted that migration to Los Angeles will ultimately seriously erode New York. Or is it so obvious? Actually we must not forget the negative feedback loops which quietly work *against* this tendency, those from T_2 and T_3 back to T_1, for instance. Let us use the vector of expression (4) as our initial state vector in order to see what the state of the system will be after a second time period. We may write:

$$(5)\ \begin{cases} {}_2T_1 = .75(3650) + .20(1550) + .20(4800) \\ {}_2T_2 = .10(3650) + .50(1550) + .05(4800) \\ {}_2T_3 = .15(3650) + .30(1550) + .75(4800). \end{cases}$$

In turn this yields us

$$(6)\quad \begin{pmatrix} {}_2T_1 \\ {}_2T_2 \\ {}_2T_3 \end{pmatrix} = \begin{pmatrix} 4008 \\ 1380 \\ 4612 \end{pmatrix}$$

after rounding off so as to preserve the total population at 10,000. The change in the population of T_1, which was 650 in the first time period, has slowed to 358 in the second. If the reader has the perseverance to carry the calculations on yearly for a decade, he will find

that the population of the system tends to level off near 4450 for T_1, 1310 for T_2, and 4240 for T_3.

Remarkably enough, thereafter the population will always oscillate close to those figures. The system has reached its steady-state and will hover near the set-point represented by vector (7):

$$(7)\quad \begin{pmatrix} {}_sT_1 \\ {}_sT_2 \\ {}_sT_3 \end{pmatrix} = \begin{pmatrix} 4450 \\ 1310 \\ 4240 \end{pmatrix}$$

Even more remarkably, *no matter what the initial population of T_1, T_2, and T_3 was,* the steady-state of the system will always find about 45 percent of the population in T_1, 13 percent in T_2, and 42 percent in T_3! That final distribution vector is called the *ergodic* vector for the system [33] and can be written as:

$$(8)\quad \begin{pmatrix} {}_eT_1 \\ {}_eT_2 \\ {}_eT_3 \end{pmatrix} = \begin{pmatrix} .45 \\ .13 \\ .42 \end{pmatrix}$$

It represents a mathematical expression of the concept of *equifinality,* discussed earlier.

Now, of course, our simple illustrative example does not include births, deaths, and either inmigration or outmigration with respect to the total system. It is, therefore, not realistic to that extent. However, in order to develop more realistic models, more powerful mathematical methods are required — particularly in such fields as topology, finite mathematics, and matrix or linear algebra.[34] At the present, however, matrix algebra and computer science are being introduced into many senior high schools and the number of students competent to study these matters may be expected to increase. In the future, work involving these concepts may even be introduced, ultimately, into secondary school programs which stress the social scientific applications of mathematics. For our present purposes, however, we only refer the reader to the population models worked out in sophisticated detail found in such sources as Rogers and Miller,[35] and Rogers.[36]

One might mention that if the interaction in our example were dollar sales transactions between economic sectors, a similar kind of linear statistical model, well known to economists and economic geographers, may be derived. It is called an Input-Output mode.[37] Zobler and colleagues [38] have used a model of the same sort to simulate the pattern of transfers of potable water from one water agency to another in the

New York Metropolitan Region. In the latter case the nodes are water agencies and the links are millions of gallons of water transferred per day. Other subjects for study include road networks [39] and river and canal network.[40] Haggett and Chorley [41] have recently published a volume dedicated to the study of networks in geography.

Before passing from this topic, we might remark that any matrix, such as the one in Figure 3, which has the property that the rows all add to 100 percent (or unity, when the elements are expressed as decimals), has a special name. It is called a *stochastic* or *transition probability* matrix,[42] and it refers to probability in the statistical sense. For instance, if a person resides in T_1, the chances are .75, or three chances in four, that he will reside there in the following year, but only .10, or one chance in ten, that he will move to T_2. The term stochastic, which crops up occasionally in recent geographic literature, has a precise mathematical definition, even though it is sometimes used loosely.

It is but a short step from our example of a migration system which is self-regulating and possesses the property of equifinality to another set of considerations. Utilizing our model, we may make certain predictions of population adjustment in the system which, in turn, enable us to plan for the predicted changes. Suppose the "goal" which the system is "seeking" (represented by the ergodic vector) is not a goal which the society as a whole regards as desirable.

Suppose, for example, that for reasons of a political or social nature, the society desires that city T_3 grow to a clearly dominant position, embracing 55 percent of the population, while city T_1 diminishes to 35 percent. This eventuality clearly cannot happen as the model is presently constituted.

We are here drawn into the area of evaluating society's norms and goals and making policy decisions to implement them. We might ask how does the steady-state of the present system differ from the steady-state which our society holds as a goal? This in turn leads us to redesigning the relationships among the system's components to achieve that goal, and into creating a structure of policy incentives, subsidies, tax penalties, tax relief schemes, and the like to modify the environment of our system so that the pattern of interactions will change towards one which will more closely approximate our ends.

Linear programming is a mathematical technique, based on matrix methods, which aims at finding *optimal* solutions to various problems in this vein. Yeates [43] has studied the pattern of school district lines in

Grant County, Wisconsin with respect to the distances travelled from their homes to their schools by bussed students. Assuming that a low bussing bill is a goal of the community, and that the bussing bill is related to distances covered by the busses, Yeates then poses a problem which, in essence, asks how school district lines may be redrawn in order to minimize the costs of bussing, and thus achieve a policy goal for the community. This problem is then solved by the linear programming technique.

The theory of games is another field of inquiry, closely related to linear programming in its mathematical formulation, which aims to get at workable solutions when there is not unanimity with regard to goals. If there are two or more participants involved in the behavior of a system, and they each have their own optimal set of goals which are, to a certain extent, in conflict with the others, game theory is interested in ascertaining whether a possible strategy may be found for each participant which allows the behavior of the system to approach jointly as closely as possible to the partly conflicting goals of the participants.

Gould[44] has used game theory within the framework of a problem which regards man and the environment as competing "players" in an agricultural region. The farmer has certain strategy choices regarding the amount of land which he allocates to various combinations of crops, and the environment responds to each kind of crop with varying degrees of support or hostility. While the farmer, in the context of his economic system, might wish to plant exclusively crop "A", the environmental hazards involved might be such as to court disaster. The game theoretic approach provides a solution which is economically viable (although not optimal) for the farmer, and at the same time provides as much security as possible with respect to the environment.

The implications of both of these techniques, and others which space will not permit us to mention here, are most exciting in geography, as in the other social sciences. Theoretical bridges are being built between the subjective realm of man's aspirations and behavior to the realm of the social and physical environment in which he lives. Time, space, and human attitudes and choices can be given expression within a unifying framework. The individual on the one hand, and the aggregate on the other, form part of an intelligible system which may be amenable to constructive planning. A recent volume of essays which attempts to explore the relationship between individual behavior and

statistical aggregates in the realm of political ecology in a penetrating analysis is a step in that direction.[45]

Caveat Formator: The New Utopians

Lest the foregoing seem too euphoric at present, when our feet are set at the beginning of what is surely a long and contorted path, or network, it is fitting at this point to consider what Boguslaw [46] has called the "New Utopians."

Our civilization has a long tradition of utopian literature and efforts to create utopian communities which range in a fine unbroken line from Plato's *Republic*, through Thomas More and the Owenite and Fourierist efforts, to the contemporary hippie commune. Are the theorists who have embraced the equation and the computer as their tools only new Utopians building cerebral cloud cuckoo lands with no congruence to reality like many of the literate philosophers of the past?

There are at least two major pits yawning beneath the feet of geographers today. If one might be called pathological nominalism, the other is pathological realism.

The pathological nominalist is the factual nut-gatherer who regards each problem and phenomenon as unique, and fills the hollow log of his filing cabinets with the odd nuts and berries which he gleans from the world around him. He may know the dimensions of the highest elevation in the world, or the deepest ocean trench, but have little knowledge of the processes which link them. He may know the nature, value, and quantity of the chief exports of Botswana, but have little idea of the properties of the distributive, production, and consumption systems in which they move. Like little capsules filled with cotton, wool, or other items glued to a great product map, they stand immobile, isolated, and statically filed in his mind. To him applies the celebrated aphorism of George Bernard Shaw to the effect that he comes to know more and more about less and less until he eventually knows everything about nothing.

The pathological realist is of another breed. The abstract system constructed in the mind becomes the cherished reality, and where the phenomenological system from which it was abstracted fails to fit it, his tendency is to accept his own creation as real and to defend it against the world. He is sometimes even led to build models out of models instead of phenomena. Whitehead [47] has called this kind of behavior the fallacy of misplaced concreteness. So, perhaps, it is the pathological

realist turned ideologue who is the greater danger. The nominalist nut-gatherer is often easy to identify, criticize, caricature, and dismiss. The realist ideologue can be dazzlingly brilliant and exhibit virtuosity in bending the shape of the world into a fit with his dogmatically-asserted theoretical structure.

What is wanted is a synthesis of both, the modern Abelard, who in the medieval world reconciled the positions of William and Roscellinus. Theory is of vital, indeed crucial, importance to geography, and the systems theoretic approach offers much promise, but there is danger whenever the overarching reach of theory straining for generality exceeds the potential of data to verify it. Beshers, who has written one of the seminal books with respect to the formation of a theory of social systems,[48] warns us in another place of the inadvisability of building general models of models cut off from the anchor of data:

> Although I have a general approach to model building, I am quite skeptical about the notion of a general model. What is needed is a tool kit for model construction. Actual models should be built for specific purposes.
> These purposes may be described from a social science point of view. They may also be described in terms of the users' intentions, e.g., forecasts and population projections, analysis of data, and policy simulations. These intentions influence the specific criteria used in building models; in particular, they guide the use of empirical data in building models.[49]

For, as von Wright[50] tells us in his study of inductive inference, three problems are involved in developing a theory from induction: the problem of discovery, the problem of analyzing the inductive mechanism itself, and the problem of justification. The first problem is beyond the scope of this chapter. The second may be attacked by formal symbolic logical and mathematical means, and results in a model free of internal inconsistencies and self-contradictions. It may, however, be absurd. Which leads us to the third problem, that of justification. This involves asking whether the model fits reality according to the prevailing set of scholarly canons, and within the limits of acceptable error. It is a crucial step, and can only be approached through the skilled use of data. And until a model is *justified*, it is surely premature to consider the possibility that it may be *true*.

Through the use of systems theory, and quantitative methodology, in the generation of justified and coherent models of geographic processes, there is every reason to think that geography will make even more rapid strides in the near future than it has in the recent past.

But it must be a soundly disciplined and solidly based effort, embracing the essence of these methods, and not merely the rhetoric.

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Chapter 8

Trends in Cartography

Phillip C. Muehrcke

Introduction

A prevailing cartographic theme has been to reduce mapping time and costs while producing more and better maps. Pursuing this goal, cartographic development has paralleled general technological and informational advances. Surges in cartographic activity have followed inventions which allowed cartographers to transcend previously insurmountable obstacles (e.g., printing press, lithography, aerial photography, scribing, computer graphics, etc.), or developments which created an increased demand for maps (e.g., exploration, war, nationalism, etc.).

This discussion is limited to only the most recent trends in cartographic development.[1] In particular, changing emphasis and technique in this decade have significantly accelerated the growth of cartography and laid the foundation for potentially unlimited future development. Cartographic trends during this period can be attributed to at least four broad, interrelated factors.

First, in recent decades there was a rapid "scientification" of those disciplines most associated with map use. This major transformation of technique has been described as the "quantitative revolution." The change in emphasis from a qualitative to a quantitative approach com-

prises the assumption that *subjective* map analysis is not sufficiently rigorous to provide the foundation for a scientific discipline. The "quantifiers" responded by borrowing a host of statistical procedures from other fields for *objective* (i.e., repeatable) analysis of spatial distributions. Due to uncertainties surrounding the potential and role of both graphics and statistics it is still not clear when the use of one or the other technique is more appropriate, or what the most judicious mix of the two approaches should be. Probably the most important cartographic development to arise from this so-called revolution is an increased concern for the role of maps, or, more generally, graphics, in scientific argument. The literature of cartography, graphic communication, and scientific model building all become significant. Cartographers have been forced to evaluate their methodology and adjust to a more sophisticated approach to research.

Secondly, in the last two decades *communication* and *information* captured the attention of scientists. Ramifications from the communication and information theoretic approaches now permeate most scientific endeavor. The development of a general theory of communication was bound to have important consequences for cartography since maps are essentially information transmitting devices involving the basic rules of graphic communication. Although cartographers have not been able to couch their subject matter in formal communication theory terms, there has been an increased emphasis on the information aspects of cartography as evidenced by our jargonized literature (e.g., note the use of such words as *signal, noise, bit, channel capacity,* and others). Probably the most important consequence of these new scientific perspectives on communication has been the explicit recognition that cartographic processing is, in fact, an active feedback system involving data collection, information display, and image processing. This systems approach is slowly replacing a historical tendency to consider cartography as essentially a "mapping" problem. The new approach has also caused a major rethinking of cartographic methodology, and opened vast areas of potential research and development. It particularly emphasized the general nature of information and led cartographers to a consideration of more abstract forms of data.

Thirdly, recent decades have witnessed the coming of *computers* and *automation*. The development of computers and peripheral equipment has had an immeasurable effect on contemporary cartography and the future outlook. Cartographic technique has been radically

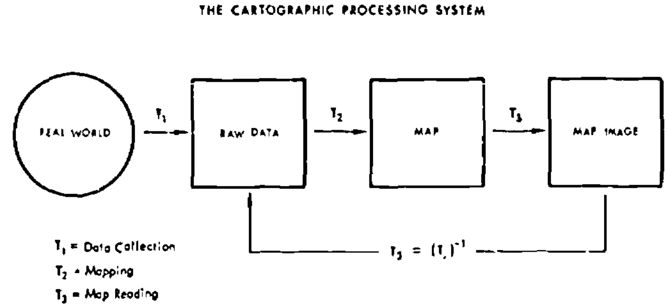
transformed in two ways. On one hand computers made feasible much more rapid and sophisticated statistical manipulation of data sets. This, in turn, led to higher levels of scientific model building. In order to continue producing a useful product, cartographers have had to map these more abstract and often complex notions. On the other hand, remote sensors, automated stereocompilation machines, optical scanners, computer-directed line-printers and plotters, cathode ray tube (CRT) displays, and other devices, have begun to replace manual map compilation techniques. One result has been a phenomenal increase in compilation speed, accuracy, and the flexibility of data manipulation and display. A second consequence derives from the fact that computer-assisted cartography must be based upon a logical scheme of unambiguous rules or instructions. Cartographers have been forced to answer questions heretofore considered only implicitly by intuitive procedures.

Finally, a wide range of drafting and reproduction media have been developed in recent years which require or encourage entirely new approaches to traditional problems. Plastics, sensitized papers and films, and new nonprinting processes have had a particularly great impact on cartography. Preprinted materials, which only require map positioning, are now ubiquitous aids in cartographic laboratories. These materials permit the preparation of higher quality maps with less manual labor and in less time than was possible with previous methods.

Taken together, the recent changes in cartographic emphasis and technique have revitalized and reoriented a discipline founded upon convention. Specific developments are seen in best perspective when organized in the theoretical context of cartographic processing. For this purpose it is convenient to characterize the cartographic process as a series of transformations (Figure 1). Data are selected from the real world (T_1), the cartographer transforms these data into a map (T_2), and information is retrieved from the map through an interpretative reading process (T_3). A measure of the communication efficiency of the cartographic system is related to the amount of transmitted information, which is simply a measure of the correlation between input and output information. The cartographer's task is to devise better and better approximations to a transformation, T_2, such that output from T_3 is equal to input to T_2; i.e., $T_3 = T_2^{-1}$. This conceptual simplification is not meant to imply, of course, that the transformations themselves are either simple or unrelated.

FIGURE 1.

Schematic representation of the cartographic processing system viewed as a series of transformations.



Data Collection

The first transformation (T_1 in Figure 1) involves data collection. Recent developments in the data collection phase of cartographic processing can be conveniently grouped under the headings: "automation," "type of data," and "sampling."

Automation

Classic cartographic production methods are being replaced rapidly by new automated procedures.[2] Most high-speed digital computer systems require numerical input. If the areal relationships of phenomena are the object of study, or where this information is to be handled by data processing equipment in the automated preparation of maps, it is also essential that data are spatially ordered, or identified, by suitable locational coordinates.[3] To meet these demands, standard data collection procedures are being modified to record or convert data into spatially ordered digital forms. For example, high-speed digitizers are being incorporated into conventional data acquisition systems. Portable digitizing equipment, which can be carried into the field, is being developed so that observations can be recorded directly as digits, or converted immediately into digital form. In any case, information may be stored on computer compatible punched cards, punched paper tape, or magnetic tape. Existing tabular data sources must also be transferred to computer compatible cards or tapes. This may be done directly by using a typewriter-like device.

In many instances, information exists only in graphical form such as on charts, maps, or photographs. These geometric data must be converted into a digital record prior to computer processing. A large number of digitizing instruments and techniques have been developed for this task. The general procedure is to fix the graphic image to be digitized on a rigidly flat surface equipped with a vacuum hold-down to keep the copy flat and unmoving. An operator then traces or points relevant information on the image, using a manually manipulated reading head connected with an X-Y coordinate recording system. By linking the coordinate digitizer to a full alphanumeric keyboard similar to a standard typewriter keyboard, an operator may record map annotations and X, Y, Z values fast and accurately on punched cards, punched paper tape, or magnetic tape, for direct input to computerized data processing systems.

Automatic digitizing machines have been developed, but their use has been restricted to digitizing world outlines, contour lines, highways, and similar curves. An operator sets the coordinate recording interval and positions an electric eye on each curve to be traced. The light point then automatically traces out each line and stores X-Y coordinates at the chosen interval. Additional information, such as alphanumeric annotations, must be manually entered through a keyboard.

An even faster method of automatic digitizing is to use a combined optical-mechanical scanning and digitizing device to process the original graphic image. Aerial photographs, or orthophotographs, have been successfully scanned and converted to a matrix of digits (numerical map) representing tonal values. Automatic scanning-digitizing of maps has proved less useful, particularly because it is generally non-selective and is restricted to displayed graphic forms — that is, additional information is not easily added.

TYPE OF DATA

The trend involving data input to the cartographic system is toward the use of more conceptual or abstract forms of information. For example, aerial survey has long been a major source of distributional information, yet until recently so-called "remote sensing" of the environment was limited to conventional black-and-white photography and the visible-light portion of the electromagnetic spectrum. In recent years a wide range of revolutionary methods has been developed which not only refines our ability to acquire (record) visible informa

tion, but which also effectively extends aerial survey into the invisible spectrum.[4] New remote sensing techniques include several forms of true-color photography, false-color infrared photography, thermal infrared imagery, side-scanning radar, and gamma ray spectrometry. When these techniques are combined with multiband cameras and multiband optical-mechanical scanners, simultaneous sensing throughout the spectrum is made possible. Obviously this new array of materials and equipment can be matched to almost any survey requirement.

In addition to the trend toward mapping invisible phenomena (i.e., those phenomena which physically exist but occur beyond the visible spectrum), there is increasing emphasis on mapping intangible distributions. The most influential development has been the definition of a geographical "volume" described by a statistical surface.[5] This concept permits researchers to treat inherently discrete data (e.g. population) as continuous and differentiable for purposes of analysis. The power of the technique lies in its ability to permit much greater analytical sophistication. In addition, the unlimited potential of topical mapping is exposed by simply substituting such general notions as "amount," "value," "density," "significance," or "pressure," in place of the conventional "altitude" in studies of spatial variation. Recognition of this technique has led to the mapping of density surfaces, potential surfaces, demand surfaces, and others.

It is not necessary that distributional information originate directly with observed phenomena. Abstract data may be synthesized from arbitrary generating rules, such as those associated with esoteric scientific models. Spatial scientists rely ever more heavily on these data as their repertoire of theory grows and begs evaluation. Map input may only consist of abstract descriptions of mathematical functions. On the other hand, the development of electronic computers has made large-scale data generation feasible, and it is now common, for example, to find computer simulations of abstract population and innovation diffusion models.

A related, but conceptually different, example of intangible distributions exists in the spatial images held in the human mind. In recent years a new field called "environmental perception" has emerged in response to a growing interest in the way people conceive geographical space. Increasingly, attempts have been made to ascertain and map various parameters of these mental spaces or images, giving rise to a category of information commonly labeled "mental maps." Individual

responses to personal interviews, standard questionnaires, or questions requiring subjective estimates, when taken collectively, have constituted the data used as map input. Representative research topics include spatial preferences, city images, attitudes toward the landscape, and estimates of geographical distance, direction, size of area, and location.[6] The highly abstract nature of all mental map data makes it especially critical that suitable graphic expressions are provided to aid in their interpretation. (See Chapter 3 of this Yearbook.)

A final important trend concerning types of data is that away from mapping raw data, and toward portraying the results of increasingly more sophisticated quantitative analysis. One explanation is that the sheer magnitude of present and future data inputs easily overwhelms conventional data presentation methodology. It has become mandatory to devise techniques which greatly increase the limited information-carrying capacity of maps. A partial solution to this problem has been to map more compact forms of information, such as statistical summary measures. Thus various indices, ratios, coefficients, etc., are becoming more common map input. Secondly, there has been a trend toward greater use of statistical analysis in geography and related fields which employ maps in their research strategy, particularly due to a growing interest in theory formulation in these disciplines. Maps, although they have well served the generation of hypotheses from raw data in the first "level" of analysis, must be integrated into ever higher levels of model building as spatial theory becomes more sophisticated if the full potential of graphics (in other words, visualization) is to be realized. Maps of the results of statistical preprocessing of data must, therefore, be created. The shift is from earlier mapping of descriptive statistics and univariate analysis to a recent concern with statistical inference and multivariate analysis. To satisfy the need for visualization at these higher levels it is becoming more common to find maps depicting residuals, trend surfaces, spatial derivatives, probability surfaces, component scores, factor scores, potential surfaces, and similar concepts.

SAMPLING

In the past it was often standard practice to attempt to collect *population* data — that is, information consisting of all conceivably or theoretically possible instances or observations of a given phenomenon. The recent trend is toward using *samples* (population subsets) drawn from populations as the source of distributional information. Since

spatial analysis based upon sampling requires generalizations which go beyond the data, an important feature of the recent growth of spatial analysis has been a shift in emphasis from methods which merely describe (i.e., descriptive statistics) to methods which make inferences (i.e , inductive statistics).

Points, quadrats, and traverses have been the standard sampling units employed in studies involving spatial distributions.[7] Common procedures for selecting unbiased sample units include *random designs*, where sample elements are drawn independently with equal probabilities using random number tables; *systematic designs*, where sampling follows a consistent and orderly scheme throughout; *stratified designs*, where the sample is proportioned out to a stratification of area based upon existing knowledge of the population; and *hierarchical designs*, where sampling detail changes as a function of the level of population organization.

Sampling raises cartographic problems not encountered when using population data. An interesting question is whether confidence limits regarding the reliability of a sample have a comparable interpretation in the case of subsequent map depictions.[8] More specifically, what is the minimum size sample required for each sample design and each type of distribution which will give a true representation of the spatial characteristics of a population?

Mapping

The second transformation (T_2 in Figure 1) involves data portrayal or mapping. The medium of graphics is used to create a two-dimensional representation of a phenomenon for the purpose of visualization. The map itself is a graphic model interpretation of the original distribution. It is convenient to view trends in the mapping phase of cartographic processing as they relate to the topics "projections," "symbolic representation," "map construction," and "map reproduction."

Projections

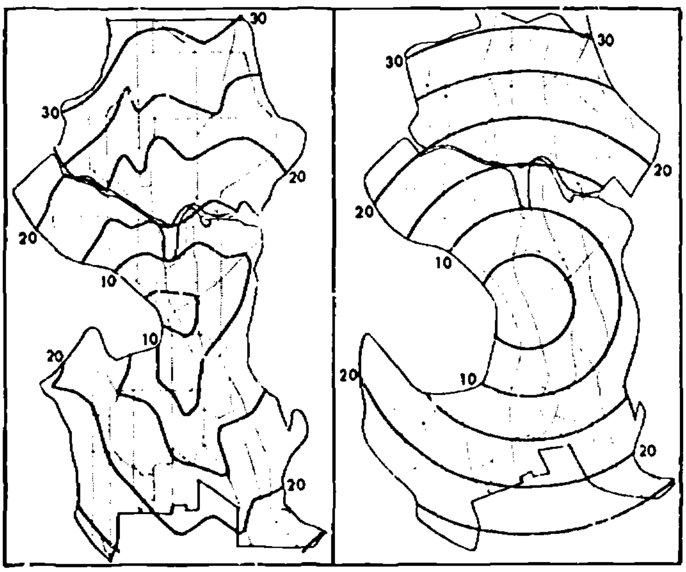
All maps are compiled within the structural framework of a map projection. Recent trends include automation and novel map transformations. The calculation and plotting of map projection grids, and the subsequent compilation of map information within these formats, has always been one of the most tedious and time-consuming of cartographic tasks. Fortunately, it is admirably suited for automation. In

the past decade a wide range of physical (world outlines, hydrographic data, etc.) and cultural (population distributions, communication networks, etc.) features have been digitized and identified by coordinate location so as to provide acceptable input for computers. At the same time, most commonly used map projections have been programmed for computer execution. Therefore, it has become a simple matter to rapidly and effortlessly create any combination of projection, scale, mapped information, and projection orientation, when the proper information is computerized. The result is a dramatic reduction in the time and effort involved in mapping, and an unprecedented flexibility in the choice of projection parameters. Thus, automation should lead to tailor-made projections designed specifically for particular map needs and thereby reduce the tendency to use maps for purposes for which they were not intended.

Although it is conventional for maps to be scaled in measures of physical distance (e.g., miles), many geographical problems are scaled in something other than metric space.[9] Two types of map transformations which contain deliberate distortion have been created to simplify the solution to this problem. For certain purposes, *functional distance* measured along established routes, or between known points, may be the primary concern of the map user. For example, a person interested in the time it would take to travel between two points on a standard map must first calculate the mileage and then divide by the estimated average rate of travel. Obviously this is inefficient since it is conceptually simple to scale maps in other measures such as time-distance, and so on (Figure 2). In fact, an increasing demand for these nonmetric map scales in recent years has posed new and difficult problems for cartographers. The most serious limitation on distance transformations is the inability to map non-Euclidean space by conventional methods without losing valuable space relationships. For example, although topological relations are generally preserved, most time-distance maps are only valid when "distances" are read out from one center point.

A second form of map transformation which is gaining in popularity involves the deliberate distortion of area. Cartograms provide a familiar example of this technique (Figure 3). In this case, the map area of regions (e.g., countries) is scaled in proportion to some areal quality (phenomena) in contrast to the normal geographic area. An attempt is generally made to preserve the shape and contiguity relations of

FIGURE 2.

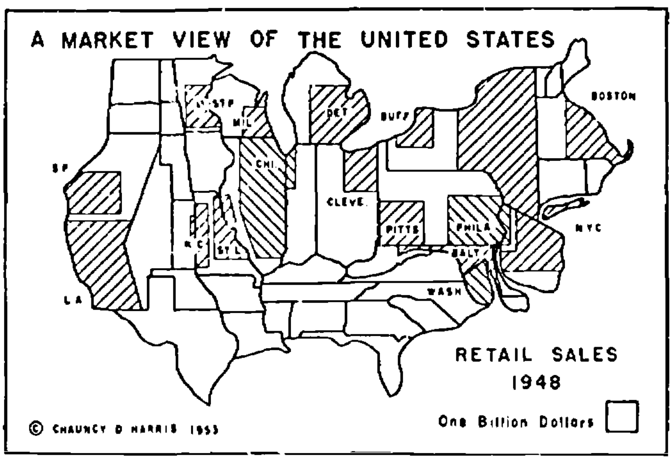


Conventional map (left) showing peak hour traffic time in minutes from a point in downtown Seattle and a "real" time distance map (right) created by transforming the isochrone lines on the left map into concentric circles. From W. Bunge. *Theoretical Geography*. Lund, Sweden: Royal University of Lund, 1962. p. 55. (Courtesy W. Bunge)

areal units while working within the size and shape format of the original map. Even with these restraints there is still an infinite number of solutions to the problem. The aim of cartograms is to produce visualization with impact. The technique is especially useful where great inequalities in the distribution of a phenomenon exist from one region to the next. Cartograms are generally considered to be "expressive," but not particularly academic map renditions, due largely to the uncontrolled nature of their construction.

On the other hand, geographical theory often includes a "uniform plane" assumption, in spite of the fact that a homogeneous distribution is seldom, if ever, encountered over large enough areas in reality to provide suitable empirical tests of spatial models. This inability of testing theoretical models empirically has led to the systematic creation

FIGURE 3.



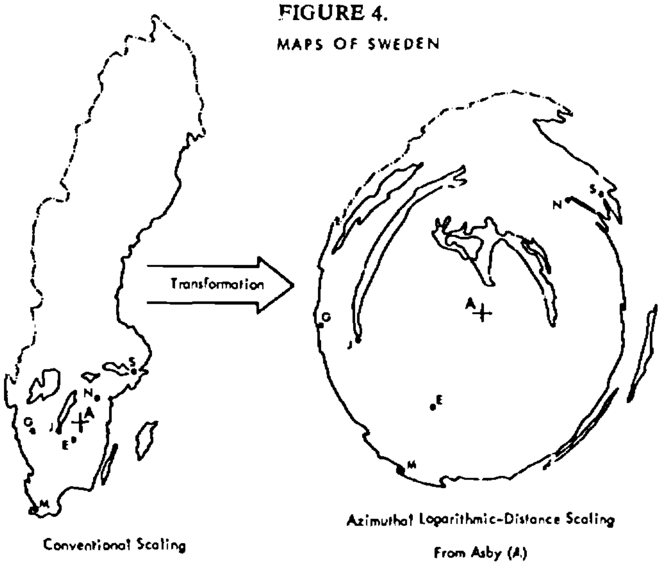
Cartogram in which the areas of the cities and states are shown in proportion to their retail sales. From C. Harris, "The Market as a Factor in the Localization of Industry in the United States." *Annals of the Asociation of American Geographers,* 44: 1320; No. 4, (1954), p. 320. (Courtesy C. Harris)

of uniform density regions through controlled mathematical distortion of distance units in a continuous fashion (Figure 4). Such modification of the geometry of geographical space, in order to smooth the variation in a spatial distribution, is particularly appropriate because once models have been evaluated an inverse transformation restores the original geographical background. Unfortunately cartographers have serious problems to resolve before this powerful technique becomes generally operational.

Symbolic Representation

The cartographer must make two interrelated creative decisions before beginning actual map construction. On one hand he must choose the graphic, or combination of graphic, techniques which will best portray the desired information. Although it might seem obvious that the diverse map portrayal techniques are not equally effective graphic communicators, in the past the cartographer had only intuitive guidelines, such as mapping discrete phenomena with discrete symbols, and portraying continuous phenomena with continuous patterns. An important

FIGURE 4.
MAPS OF SWEDEN



Map of Sweden showing the effect of an azimuthal-logarithmic distance transformation. After T. Hägerstrand. "Migration and Area." December, 1954. *Migration in Sweden*. Lund, Sweden: Royal University of Lund, 1957. p. 73. (Courtesy T. Hägerstrand)

recent development has been the breakdown of this discrete-continuous distinction and the conceptual treatment of all statistical distributions as geographical volumes described by a statistical surface.

In practice, cartographers traditionally have chosen specific graphic representations by using intuitive notions of how particular phenomena should be depicted and by considering the construction technique which was most compatible with the materials, tools, finances, and compilation time available. With rare exceptions only one of a multitude of different possible graphic versions of a statistical distribution was ever made, and this map stood unchallenged in the sense that its communication effectiveness was not evaluated against other map versions of the same data. As the reader will note in the next section on automation, computers can make a wide variety of graphic interpretations of a data set equally available and, thus, are forcing cartographers to evaluate objectively the relative effectiveness of the various graphics. Although

few definite guidelines have been established by recent psychophysical research, we may expect major developments in the near future.[10]

On the other hand, it is seldom practical to map individual observations with unique, discrete symbols, and a data classification, or generalization, scheme must be chosen. Whereas this procedure has been guided historically by subjective rule-of-thumb principles, there is a trend toward more objective map generalization techniques. One problem is how to provide an accurate map representation of the data, using a limited number of classes. The cartographic transformation involves deciding on the number of classes and establishing a criterion for the selection of class intervals. Recent research suggests that a wide range of solutions to this problem exists and that no single procedure is best for all situations.[11] The trend is toward tailoring a classification procedure to an individual spatial distribution, in light of the purpose of creating that particular map. For example, class intervals may be established on such diverse criteria as constant or variable increments on a numerical scale (e.g., arithmetic, logarithmic, geometric, etc.), natural groupings in the data, critical values with special meaning, maximizing between class variance while minimizing within class variance, and so forth. The number of classes chosen is largely a function of the degree of generalization desired.

A related problem in map generalization involves the detail of linework such as contours, outlines, networks, etc., at different map scales. Although the literature on the subject is large and growing, the exact nature of map generalization still remains vague. In the past, the simplification (smoothing) of linework was largely an individual matter of intuitive judgment of what looked right at each scale. The problem of subjective generalization becomes especially acute with the advent of computer-assisted cartography, since automated plotting devices require explicit, unambiguous instructions. Several interesting experiments in computer map generalization, based upon various rules, have been conducted, but there are still few general guidelines.[12]

Map Construction

The process of creating a map image with pen, ink, and paper has rapidly disappeared from all except small mapping operations. One reason for this trend is that a large variety of high-quality *preprinted materials* have been made available at relatively low cost to cartographers. These adhesive-backed, stick-up materials now include letters, num-

bers, symbols, lines, and stipple patterns, in a wide variety of types and sizes.[13] The cartographer has only to position the chosen materials in the proper map format.

A second reason for the trend away from ink drafting is the recent development of *scribing*.[14] This process of engraving lines and symbols into an opaque-coated, dimensionally stable plastic sheeting (e.g., *Scribecote*) permits the cartographer to prepare a negative map image which can substitute for a film negative in reproduction processes. The advantage of scribing is that extremely high-quality map negatives can be prepared at reproduction size with significant savings in effort and cost over ink construction techniques. It also takes less time and expense to train people to scribe than it does to train them to draft with ink.

Presensitized scribecoat materials have greatly simplified the preparation of color tint masks. The previously tedious task of preparing open window negatives by hand can now be replaced by a photoetch process (e.g., *Striprite* or *Peelcoat*) which involves three simple steps: (1) transferring the original negative image by photographic contact to the presensitized scribecoat; (2) chemical etching of the image on the scribecoat; and (3) removing or lifting out the scribecoat in the areas where the color tint is to appear.

Probably the most exciting and influential recent development in map construction is the trend toward computer-assisted mapping. Digital computers and other automatic data processing devices have proven indispensable in meeting demands for more rapid production of wider varieties and greater volumes of maps. Much of the drudgery of routine compilation and the preparation of reproduction copy can now be automated.[15] In addition, automatically prepared maps can generally be produced more accurately and rapidly and at less expense than their manually constructed counterparts.

Input to automated systems consists of alphanumeric data or symbols communicated directly through an on-line terminal or recorded on Hollerith-type punched cards, punched paper tape, or magnetic tape. Computer-generated mapping consists of adding data to a preprinted base map, or reproducing a map on blank recording media such as paper, plastic, film, or cathode ray tube (CRT). The bulk of automated equipment and associated techniques performs the task of positioning symbols by relative location.

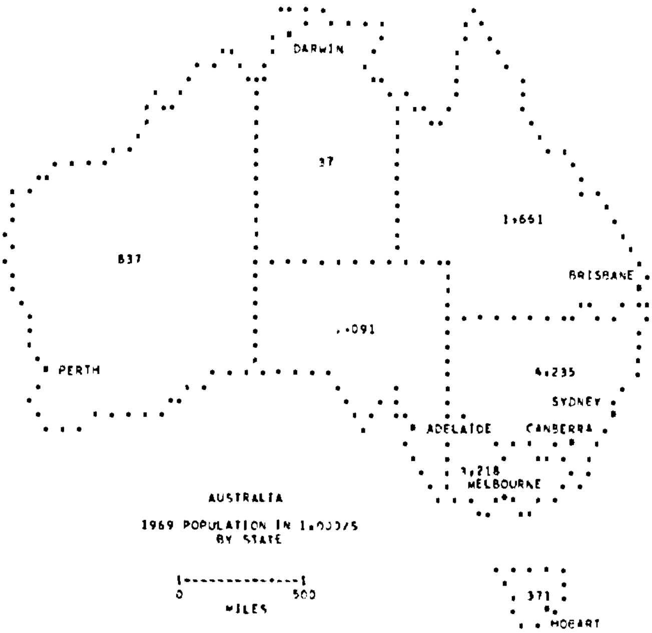
A primitive class of computer mapping devices consists of common computer printout equipment, which yields crude maps using only those symbols found on most standard typewriters. The computer can be programmed in two ways. The simplest, but least flexible, procedure is to provide a complete set of instructions which prespecify each printing position. For example, map elements to be printed may be punched on Hollerith cards in their proper spatial format and the card deck listed on a printer. The disadvantage of this technique is that a new set of instructions is required for each variable, and the projection and scale cannot be changed. An alternate approach is to identify information by locational co-ordinates and then create a map-printing computer program to prepare its own printing position specifications. This technique has the advantage that the program can be used to select variables, alter projection and scale, and change plotting symbols. A large number of standard mapping programs of this second type are now available and widely used in diverse disciplines.[14]

Common line-printer created map formats include outline maps annotated with census data, contour-like symbol strings or bands, isopleth or choropleth appearing symbol fields, and plots of discrete observations (Figure 5a). Although these printer maps have proven extremely useful, they are limited to discontinuous symbols and are further restricted by: (1) the inability to center these symbols between column positions across the page, or between line positions down the page; and (2) the fact that significant directional distortion can accrue due to the rectangular form of printer positions.

A second class of mapping machines is the coordinate plotter. The more flexible systems possess several operating modes. For example, by using interchangeable instrument heads, the output format can be an ink-drawn (using ball point, wet ink, or nylon tip pens) or printed original on paper, a scribed negative, or an exposed film positive image. Primitive coordinate plotters — that is, those which only plot symbols — can draw, scribe, print, or photographically expose data, symbols, and alphanumeric annotations at specified coordinate positions. These plotters have the same application as computer printers, but possess the advantage of finer resolution, larger choice of symbols and image field, color capability, and greater selection of drafting base materials (Figure 5b).

The more sophisticated continuous-curve plotters display even greater flexibility in application. In addition to plotting symbols, these ma-

FIGURE 5a.

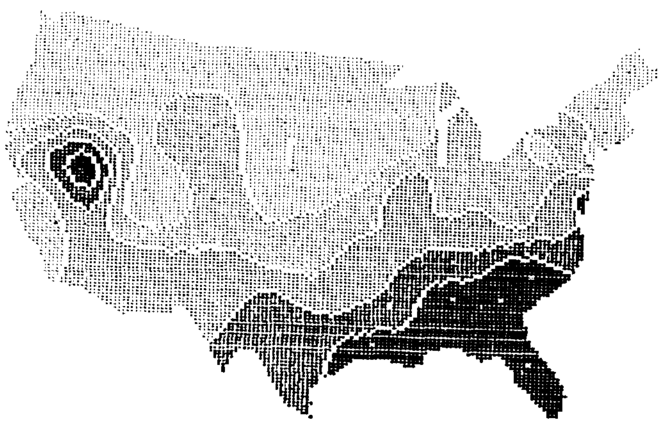


Simple mapping of geographic data by listing a deck of formated cards containing outline and census information.

chines can draw, scribe, or photographically expose continuous straight-line segments connecting strings of points which are identified by coordinates (Figure 6). In this fashion, a straight-line approximation of any curve can be produced at tolerance levels unmatched by manual plotting methods. Acceptable gray tone patterns for areal shading have also been produced by these plotters (Figure 7). Another high speed continuous-curve plotter uses a laser optical system. A reflected laser beam plots the map image, line by line, on photographic film or paper. The extremely fine resolution permits high density of lines and patterns, and thus makes a wide range of gray shades possible.

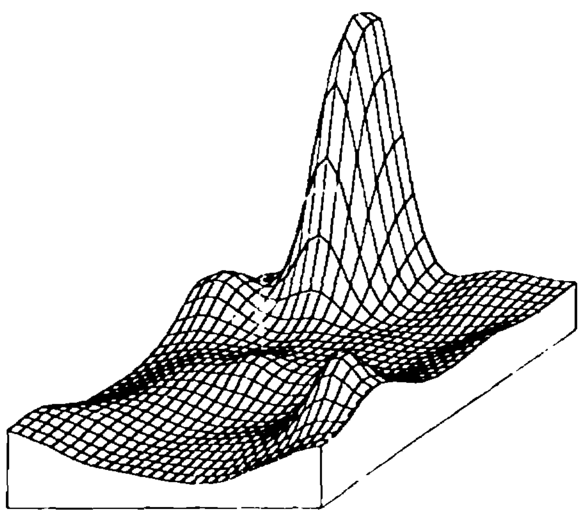
Common cartographic applications of continuous-curve plotters include drawing map projections, grid reference systems, world outlines, political and census tract boundaries, perspective diagrams, isolines,

FIGURE 5b.



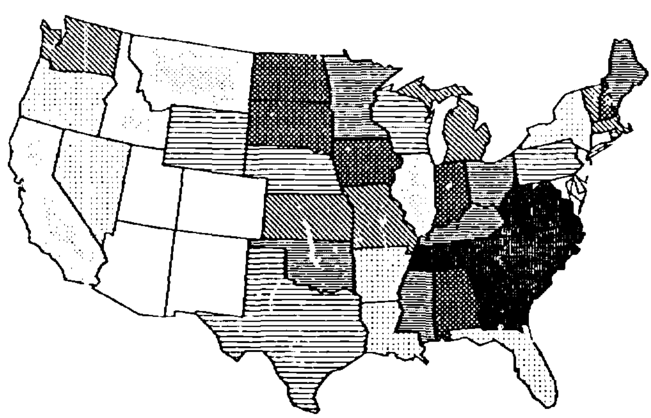
Isopleth map produced using the SYMAP program. (Courtesy J. Kilcoyne, University of Washington, Seattle.)

FIGURE 6.



"Statistical surface," viewed obliquely, drawn on a line-plotter using the SYMAP program. (Courtesy of the Laboratory for Computer Graphics and Spatial Analysis, Harvard University.)

FIGURE 7.

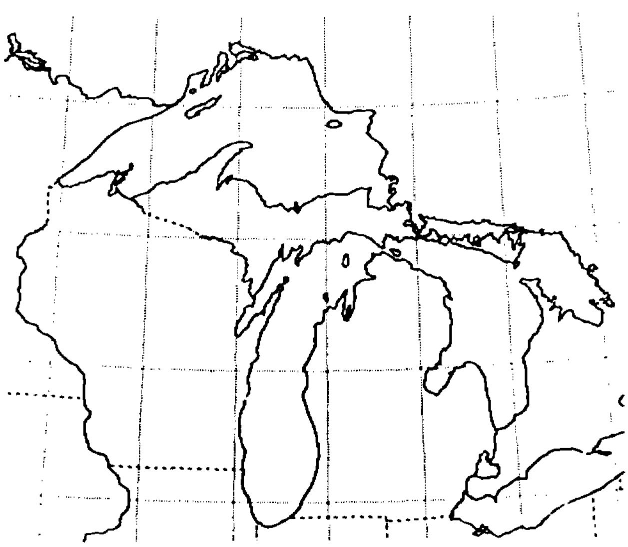


Experimental choropleth map produced on a line-plotter. (Courtesy of R. Cartwright, Laboratory for Computer Graphics and Spatial Analysis, Harvard University.)

transportation networks, and river systems. In most cases the symbol plot capability is used in conjunction with continuous-curve plots.

A third class of automated map drawing devices is the computer-controlled electronic mapping system. Map features are traced electronically and displayed by means of a CRT electroluminescent/thermochromatic display, or similar directly viewed device. CRT's have the symbol plotting capability (black-and-white or color) of continuous, dashed, or dotted lines of variable width; alphanumerics; and programmed graphic symbols of variable size and orientation (Figure 8). This so-called temporary presentation technique has the advantage of extreme flexibility, high speed, and relatively low cost. Dynamic CRT displays make it possible to almost instantaneously change information content (including map updating and correction), symbol type, projection, and other map parameters. When employed as interactive computer consoles, CRT devices appear particularly well-suited to cartographic experimentation since they permit the researcher to view in near real time the progressive effects of these parameter alterations. In addition to direct viewing, it is possible to graphically record CRT output. One procedure is to use a camera lens system to project the CRT-display onto 16mm or 35mm film and then enlarge the film image using

FIGURE 8.



Cathode ray tube outline map of the Great Lakes region (reduced). From A. Hershey, "The Plotting of Maps on a CRT Printer," NWL Report 1844, U.S. Navy, Dahlgren, 1963. (Courtesy A. Hershey)

a microfilm reader-printer. A different technique is to use a CRT to expose photographic film or paper in narrow strips. Similar hard copy can be prepared by other methods, such as direct conversion of electrical signals into Xerox prints. The computer can also instruct a microfilm plotter to generate photographic images in either black-and-white or color. The fine resolution and precise control available with this direct electron beam-to-film transfer make considerable photographic enlargement of the output feasible. Although electronic systems are dynamic, and have the advantage of speed over mechanical systems, they are still inferior to mechanical procedures for the production of large maps with extreme accuracy.

Computer systems have also been used to transform and analyze aerial photographs.[17] Automated stereocompilation machines can now reduce a stereoscopic pair of aerial photographs to a single picture

possessing true planimetry. These so-called orthophotographs may be mosaicked to broaden areal coverage. Grid and fiducial marks can be automatically superimposed on aerial photographs. Earth and moon photographs have been vastly improved by both optical and computer picture transforming procedures that enhance images. Contrasts can be changed, "edges" (boundaries) can be enhanced, images can be crispened, obscuring "noise" can be deleted, and so forth. In most cases computer processing has proved faster and cheaper than conventional optical techniques in those instances where both methods were applicable (particularly image crispening).

A useful by-product of orthophotograph processing is a contour map (line graphic) portraying the third dimension. Orthophotomosaics can be processed by phototone and photoline techniques and important features enhanced by adding line and symbol overprinting, to produce a black-and-white or color-tone orthophotomap. Computers have also been used to transform selected attributes on continuous tone aerial photographs to line drawings (which can be maps). Another successful attempt at picture processing by computer is the portrayal of relative relief using single (monocular) moon surface pictures.

A fourth class of "mapping machines is that used to produce raised relief maps. The first step is to carve a three-dimensional representation of a statistical surface from a solid block of material, using a computer-controlled 3-axis milling device and digitally stored data. The resulting relief model can be hand "finished" and serve as the end product, or it can be used as a form in the production of relief maps.

Reproduction

Most map reproduction involves printing by lithography or letterpress.[18] Several changes have occurred, such as the use of scribed negatives which eliminate the photographic step in the printing process, and the replacement of halftone screens by easier-to-use contact screens for continuous tone printing. But probably the most revolutionary development in map reproduction in recent years has been the trend toward use of nonprinting processes.[19] These methods are relatively slow, but have the advantage of low initial cost compared to printing methods and, therefore, are ideal for short runs (i.e., when only one or several copies are needed). A second advantage of nonprinting processes is that extensive photography and darkroom facilities are not required. Since the wide variety of nonprinting procedures are not sim-

ply classified, only those techniques which cartographers have found to be commonly available and most useful will be mentioned. One general process produces direct contact positives (trade name Diazo or Ozalid) and negatives (similar to standard blueprints). Sensitized printing papers are used and the copies necessarily are the same size as the original map. A range in paper and print color is possible. A second general process, called photocopying, actually refers to a number of processes based on a modification of the principle of conventional photography. The best known photocopying methods utilize sensitized paper and include the "autopositive," "transfer," and Photostat (trade name) processes. The "autopositive" technique is a contact method which directly produces a positive image. The "transfer" technique is a contact method which requires an intermediate negative step. The Photostat technique involves an intermediate photographic procedure which produces a negative image and permits reduction and enlargement of the original. A third general method, Xerography (trade name Xerox), is an extremely fast electrostatic process which does not require chemicals or sensitized printing paper. A positve copy may be produced in several colors, and reduction and enlargement is possible. A fourth class of so-called proofing materials has been developed which can be used to produce color proofs and contact positives or negatives under standard cartographic laboratory conditions (i.e., without darkroom facilities).[20] Since these are contact processes, reduction and enlargement of the original are not possible. These processes combine the various negative originals by photo-composition to produce a proof copy which facilitates review and editing prior to final map printing.

Map Reading

The third transformation (T_3 in Figure 1) involves image processing or map reading. From a communications point of view the logical goal in cartographic design is to produce the most efficient and effective graphic communicator. It has already been mentioned that the tools and materials of the map maker introduce random and systematic distortions into cartographic information processing. In addition, by virtue of inherent or acquired limitations, the map user exhibits an inability to read a map without further distorting the flow of information. The quality of a map is here taken to mean its interpretability. The idea is to minimize the discrepancy between the intended message and the retrieved information. In other words, the map reading trans-

formation (T_3) should be the inverse of the mapping transformation (T_2); i.e., $T_3 = T_2^{-1}$. It is convenient to divide trends in map reading into procedures based upon visual perception, quantitative analysis, and optical techniques.

PERCEPTION

The description, analysis, and comparison of maps have traditionally been executed visually and produced a mental map or image. The essential nature of the actual map was synthesized in the mind and verbalized through subjective statements concerning the original distribution. Conclusions were of the form "appear to be random," "seem to be moderately associated," "the pattern looks dense," and so on. The most serious limitation of these conclusions is that they are not objective. The results obtained from visual pattern analysis are asserted to be imprecise, or inconsistent, and often more apparent than real. The findings of several researchers cannot be effectively compared. To minimize this problem, researchers have gone to quantitative forms of spatial analysis to supplement or substitute for visual analysis. Two advantages of the quantitative approach over visual estimation are that the former permits the detection and appreciation of smaller differences and provides a sounder basis of judgment of the significance of these differences.[11] Cartographers have found the various statistical models for spatial analysis to be useful standards against which to evaluate visual map reading. The latest research suggests that the ability to visually analyze maps varies from graphic to graphic as a function of map complexity and the degree of association between maps.[12] The bulk of research problems remains unexplored, however.

A second drawback of the visual technique is that the perceptual mechanism is limited by the complexity and amount of information it can assimilate efficiently. Subtle interrelationships among variables seem beyond the powers of human perception, especially as the number of variables gets large. Recently researchers have circumvented this problem by mapping the results of preliminary statistical data analysis rather than the original data themselves. This technique still remains to be evaluated.

A third criticism of visual map analysis is that the subjective judgments appear to vary significantly from absolute value symbol scaling. With proportional point symbols it has been repeatedly found in recent years that as the areal or volume symbols get larger the perception

of its magnitude deviates more and more below absolute scaling.[23] It has also been demonstrated that the estimated inked density of pre-printed shading screens follows a gray-scale curve quite different from the absolute value function.[24] It has been shown that dot density is increasingly underperceived as the pattern gets dense. In addition, various field effects have been noted with both proportional and dot symbols which alter (distort) size and density impressions.

Cartographers have shown a confused response to the problem of apparent versus absolute value scaling, and they have left no clear indication of how they intend to proceed. The options available are quite obvious, however. Map symbols could be scaled according to the appropriate apparent value function so that they would actually be perceived in terms of absolute scaling. With the exception of relief modeling, cartographers appear reluctant to accept this procedure in spite of numerous suggestions to do so. On the other hand map readers could be cautioned that their perceptions of map symbols are probably under- or over-estimating the data by some specified amount or function. Considering the role of graphics in scientific argument, this approach appears inefficient and, in fact, there is no indication that this procedure will be adopted. Finally, the cartographer could search for new symbols, or ways of presenting spatial data, which may be more directly perceived in true fashion than existing symbols under question. This seems to be the most popular response.

Quantitative Analysis

The trend toward the use of quantitative methods in spatial analysis has been mentioned.[25] It is common but inefficient to conduct quantitative analysis of maps, since statistical models require numerical data as input. This procedure continues because many data are available only in map form. Picture processing by computer is not yet refined enough to analyze maps automatically, except in a crude fashion. However, numerical data can be manually extracted from maps using the sampling techniques described previously simply by superimposing the sampling design on the map instead of on the earth's surface. The statistical consequences of compounding sampling error and bias in this fashion are poorly understood in spite of recent research findings, but are sufficiently important to warrant future attention.

Once data have been extracted from maps, the next step is to choose an appropriate statistical model from the numerous methods available.

The choice should be based upon theoretical notions concerning the distribution of the phenomena and the known characteristics of the statistical models. This is seldom a simple decision since little is known about the expected character of various spatially distributed phenomena, and the characteristics of the numerous statistical methods are often poorly understood by researchers using them. A considerable body of spatial process theory must be developed to satisfy the first deficiency. The second deficiency will be alleviated when practitioners of the spatial disciplines understand the nature and applicability of various quantitative techniques before using them. This is particularly true regarding "canned" computer programs.

Statistical models which have proven meaningful and useful in spatial analysis include tests of randomness (quadrat counts or nearest neighbor analysis), network analysis, regression analysis, trend surface analysis, factor analysis, and others.

Optical Analysis

In recent years attempts have been made to process maps and aerial photographs directly using optical computing systems.[26] Extremely simple lensless optical devices have been used to obtain "intensity distributions" equivalent to spatial auto- and cross-correlation functions. More powerful and versatile optical configurations, utilizing lenses and laser beams, are capable of performing spectral analysis, matched filtering, auto- and cross-correlation, and other linear operations. Of these capabilities, cartographers have found spectral analysis and spatial filtering to be most interesting. Optical spectral analysis appears to provide a way of overcoming the problems of computational difficulties and lack of adequate data associated with mathematical analysis. Perhaps an even more interesting feature of optical systems, however, is that the input image may be modulated when in spectrum form and a filtered version (transformation) of the original image reconstructed. The technique has proved successful in improving image quality and could, conceivably, be used to eliminate imaged information considered superfluous, and, therefore, distracting to particular interpretative problems.

Since only sketchy experimental information is available at this time, the future role of optical devices in cartography is largely a matter of speculation. However, optical techniques do possess the advantage that graphic input is directly analyzed with spatial parameters left

intact in all ways. The major disadvantage of optics as an analog computing technique is the problem of interpreting a graphic interpretation of a graphic.

Prospect

To adequately interpret future cartographic development it is necessary to predict the consequences of contemporary trends as well as foresee specific cartographic responses to general technological and theoretical advances. An essential question involves the role of graphic representation in an age increasingly dominated by computers. In the past, computers have required numerical input and were dominated by mathematics. Will numbers and mathematical notation suffice in the future? To answer this it is necessary to understand that the pursuit of scientific enquiry is cyclical in nature. The scientist proceeds from precisely identified problems, to accurately described facts, to hypothesis formulation, to the development of theory and models, and finally to testing the logical consequences of these "explanations" of reality against empirical evidence. The degree and relationship of agreement between predictions (expected facts) and observed facts is studied and the cycle commences again in an unending quest for still "better" models of reality.

Both mathematics and graphics are used to manipulate data experimentally in an attempt to reveal their internal relationships or underlying structure. The language of mathematics serves the more preëminent role in this pursuit of science, largely because it provides a powerful logical framework upon which to build theory. In contrast to the well-developed methods of mathematical analysis, graphic presentation survives in science largely due to its perceptibility — graphics serve the important function of visualization. Because of the relative relation of mathematics and graphics in the gradient between abstraction and reality, the language of graphic representation involves less intermediate transcription than the language of mathematics and, thus, permits more direct scrutiny and utilization in many instances. Abstract and complex spatial relationships such as grouping, classification, correlation, etc., can often be immeasurably clarified or simplified when presented in graphs, diagrams, or maps. For this reason maps can play an integral role throughout scientific enquiry if pre-processed, as well as raw data, are used as input information. Maps are particularly suited for inductive hypothesis generation and model refinement, whereas

quantitative techniques are more appropriate for deductive model testing.

The treatment of large quantities of data by electronic computers is not a final solution in scientific enquiry since the myriad precise answers generated must still be deciphered. Experience suggests that it is often useful to construct visual display matrices in addition to, or in lieu of, presenting numerical summaries. The concern with graphic computer output, particularly the development of interactive computer consoles, is a good example. Visual inspection of a graphic display of data is often sufficient to provide good "first solutions" which can then be improved through programmed iterative procedures. The vast literature on automatic pattern recognition, or picture processing by computer (both digital and optical), suggests a trend toward graphic computer input as well. The essential question, then, is not a choice between graphics or mathematics, but rather a concern with the nature of the role of graphical representation compared to mathematical notation. The conclusion is that graphics, including maps, facilitate quick estimates or judgments, while numbers serve as precise indicators. But future development of optical computing configurations may tend to blur this distinction.

The increased speed, accuracy, and flexibility in cartographic processing brought about by computers and related devices was discussed in previous sections. In future years we can expect an accelerated application of automation in the preparation and processing of maps. New forms of maps will be produced automatically by entirely new procedures. For example, we can already see an increased interest in truly dynamic or "animated" map forms which have been made feasible through automation. Properly equipped and programmed space vehicles, in conjunction with appropriate ground-based data processing systems, will inevitably produce an impressive array of "instant maps" on command. For many purposes it will become convenient to replace conventional "hard copy" maps with temporary or readily disposable map images. New display media, such as cathode ray tubes and interactive computer terminals, will become standard research equipment for cartographers. These, and similar machines, will greatly increase the number of choices open to the cartographic researcher. For example, consider the freedom in being able to manipulate data in near real time while sitting at an interactive computer console equipped with a visual display device. Design problems, symbol type and size, class

interval selection, screen values, and other critical decision-making will particularly benefit from this capability to alter map parameters with near instantaneous feedback. Thus the previously laborious — and generally avoided — task of systematically altering map parameters in search of "best fit" solutions in adjusting specific graphic techniques to individual distributions will become simple and relatively effortless. When these devices become commonly available, we should, therefore, expect significant breakthroughs in creating more effective graphic pattern descriptions. The only restrictions will be on generating meaningful (i.e. testable) hypotheses — a task which will remain the exclusive domain of human imagination. Dynamic visual displays of numbers, graphs, maps, and so on, will only aid the creative intuition needed to continually advance the level of analysis.

Drafting and reproduction processes have always had a major influence on map design. More flexible procedures are continually being developed. Scribing will undoubtedly continue to replace ink drafting in the future. Preprepared materials should continue to benefit both large and small mapping projects. New photographic nonprinting reproduction techniques will be refined and extended. The conclusion is that in the future less manual effort will be required to prepare higher quality maps at even greater speed than is possible today. As the cartographer is freed from the tedium of laborious map compilation, he will be able to devote more attention to creative tasks.

Since the distinction between "map making" and "cartography" is becoming ever more apparent, it is inevitable that the future cartographer should be more than a skilled cartographic draughtsman. He must learn to deal with graphic communication (both psychological impact and the laws of graphic transcription) with the rigour and logic of the mathematician. Only in this way will the full potential and integration of quantitative and graphic techniques be realized in the analysis of spatial variation. Understanding of graphic communication will advance far beyond the few extant studies concerning the psychophysical relationships of map symbols. The day may come when a cartographer will know the proportion of map readers which can be expected to retrieve a given amount (e.g., 95 percent) of the mapped information from a particular graphic depiction of each general type of distribution, and be able to choose his technique accordingly. Psychophysical information should also help alleviate the strain of increasing information overload in cartographic processing by providing information which

can be used to: (1) train people or develop machines to perform more efficient map analysis and, thereby, increase the relative effectiveness of map reading; and (2) design symbols which are more effective graphic communicators and, thus, expand the limited information capacity of the map surface.

FOOTNOTES

[1] The reader will find it helpful to become familiar with one of the standard textbooks on cartography, such as Robinson, Arthur H. and Sale, Randall D. *Elements of Cartography*. Third Edition. New York: John Wiley and Sons, 1969.

[2] See, for example, Oliver, J. G. "Automated Cartography." *Survey Review* 19:139-141; No. 145, July, 1967; Robinson, J. C. "The Symap Programme for Computer Mapping." *The Cartographic Journal* 4:108-113; No. 2, December, 1967; Gaites, G. M. "Thematic Mapping by Computer." *The Cartographic Journal* 6:1-20; No. 1, June, 1969; Voisin, Russell L. "Automation in Private Cartography." *Surveying and Mapping* 28:77-81; No. 1, March, 1968; and Williams, N. L. G. "The Oxford System of Automatic Cartography." *Cartography* 6:17-20; No. 1, 1966.

[3] Kao, Richard C. "The Use of Computers in Processing and Analysis of Geographic Information." *Geographical Review* 53:530-547; No. 4, October, 1963; Berry, Brian J. L., Morrill, Richard L., and Tobler, Waldo R. "Geographic Ordering of Information: New Opportunities." *The Professional Geographer* 16:39-43; No. 4, July, 1964.

[4] Colwell, Robert N. "Remote Sensing of Natural Resources." *Scientific American* 218:54-69; No. 1, January, 1968; Harris, David R. and Cooke, Ronald U. "The Landscape Revealed by Aerial Sensors." *Geographical Magazine* 42:29-38; No 1, January, 1969; Estes, John E. "Some Applications of Aerial Infrared Imagery." *Annals of the Association of American Geographers* 56:673-682; No. 4; December, 1966.

[5] Robinson, Arthur H. "The Cartographic Representation of the Statistical Surface." *International Yearbook of Cartography* 1:53-63; 1961.

[6] Gould, Peter R "On Mental Maps." Discussion Paper No. 9, *Michigan Inter-University Community of Mathematical Geographers*. Ann Arbor: University Microfilms, 1966; Lynch, Kevin. *The Image of the City*. Cambridge, Mass.: M.I.T. Press, 1961; and Lowenthal, David and Prince, Hugh. "English Landscape Tastes." *Geographical Review* 55:186-222; No. 2, April, 1965.

[7] Berry, Brian J. L. and Baker, Alan M. "Geographical Sampling." in Berry, Brian J. L. and Marble. Duane F., editors. *Spatial Analysis: A Reader in Statistical Geography*. Englewood Cliffs, N. J.: Prentice-Hall, 1968. pp. 91-100.

[8] Rattray, M. "Interpolation Errors and Oceanographic Sampling." *Deep-Sea Research* 9:25-37. 1962; Greenwalt, C. R. and Schultz, M. E. "Principles of Error Theory and Cartographic Applications." *ACIC Technical Report No. 96*. St. Louis: U. S. Air Force, Aeronautical Chart and Information Center, 1962; and Stearns, Franklin. "A Method for Estimating the Quantitative Reliability of Isoline Maps." *Annals of the Association of American Geographers* 58:590-600; No. 3, September, 1968.

[9] Tobler, Waldo R. "Geographical Area and Map Projections." *Geographical Review* 53:59-78; No. 1, January, 1963.

[10] Muehrcke, Phillip C. "Visual Pattern Analysis: A Look at Maps" (unpublished Ph.D. dissertation, University of Michigan, 1969). Copies may be obtained from University Microfilms, Ann Arbor, Michigan.

[11] Jenks, George F. "Generalization in Statistical Mapping." *Annals of the Association of American Geographers* 53:15-26, No. 1, March, 63; Jenks, George F. and Coulson, Michael. "Class Intervals for Statistical Maps." *International Yearbook of Cartography* 3:119-134; 1968: and Jenks, George F. "The Data Model Concept in Statistical Mapping." *International Yearbook of Cartography* 7:186-188; 1967.

[12] Lang, T. "Rules for Robot Draughtsmen." *Geographical Magazine* 42:50-51; No. 1, October, 1969; and Tobler, Waldo R. "Numerical Map Generalization." Discussion Paper No. 8, *Michigan Inter-University Community of Mathematical Geographers.* Ann Arbor, University Microfilms, 1966.

[13] Preprinted materials are widely marketed under the trade names: Zip-A-Tone, Contax, Artype, Craftone, Pre-Tape, Chart Pac, and others. Most graphic arts supply outlets handle preprinted materials from one or more companies and will supply catalogs on request.

[14] Moore, Lionel C. *Cartographic Scribing Materials, Instruments, and Techniques.* Technical Publication No. 3. Second edition. Washington, D. C.: American Congress on Surveying and Mapping, Cartographic Division, 1968.

[15] See references noted in 2 above.

[16] Probably the most widely used automated mapping system in this country is the SYMAP package produced by the Laboratory for Computer Graphics, Harvard University. Although SYMAP has been used primarily as a line-printer program, it does have plotter options which are presently being expanded.

[17] Harmon, Leon D. and Knowlton, Kenneth C. "Picture Processing by Computer." *Science* 163:19-29; No. 3875, April 4, 1969.

[18] Merth, J. S. and Monsen, Gordon L. *Photomechanics and Printing.* Chicago: Mertle, 1957; and Dentsman, Harold and Schultz, Morton J. *Photographic Reproduction: Methods, Techniques and Applications for Engineering and Graphic Arts.* New York: McGraw-Hill, 1963.

[19] Nelson, Charles T. "Modern Methods of Graphic Reproductions." *Engineering Graphics* 3:8-19; No. 10, October, 1963; and "Solving Your Copying Needs." *Reproduction Review* 17:29-33; No. 8, August, 1967.

[20] These materials are marketed under the various trade names: General Color-Guide, 3M Colour-Key Proofing Film, Brite-Line, Kwik-Proof, Watercote, Proof-Kote, Kodagraph Wash-Off Contact Film, and others.

[21] This concept has provided the justification for numerous discipline-oriented textbooks on quantitative methods. For an extensive listing of sources on this topic see the Reference section of Chapter 7.

[22] In addition to reference 10 above, see McCarthy, Harold H. and Salesbury, Neil E. *Visual Comparison of Isopleth Maps as a Means of Determining Correlations between Spatially Distributed Phenomena.* Iowa City: State University of Iowa, 1961.

[23] Clark, John I. 'Statistical Map Reading." *Geography* 44, Part 2: 96-104; No. 204, April 1959; and Ekman, Gosta, Lindman, Rolf, and William-Olsson, W. "A Psychophysical Study of Cartographic Symbols.' *Perceptual and Motor Skills* 13:355-368; No. 3, December, 1961.

[24] Williams, Robert L. "Map Symbols: Equal-Appearing Intervals for Printed Screens." *Annals of the Association of American Geographers* 48:132-139; No. 2, June, 1958; and Jenks, George F. and Knos, Duane. "The Use of Shading Patterns in Graded Series." *Annals of the Association of American Geographers* 5':316-334; No. 3, September, 1961.

[25] See references noted in 19 above.

[26] Tippett, J. T. and others. *Optional and Electro-Optical Information Processing.* Cambridge, Mass.: M.I.T. Press, 1965.

PART TWO

Teaching and Learning: Applications to Geography

Chapter 9

The Cognitive and Affective Learning of Children

Rosemarie McCartin

Despite years of speculation, and hundreds of laboratory investigations, no logically commanding and intuitively attractive answers concerning children's thinking exist.[1] The research literature offers neither a consistent nor a complete picture, and even Bruner, a prime contributor in the thought processes of children, admitted to exploring cognitive development as a new interest as late as 1965.[2]

The complexity of the child's conceptual structure will be understood only after much more research,[3] but the importance of children's thinking processes as forming a basis for modifications in teaching and curricular changes makes it imperative that we use all available information and get on with the task.

A recent recommendation of the Commission on Social Science commends, "The efforts of scholars studying how children develop over time an understanding of basic social science concepts [suggesting] special attention be given to the implications of this research for redesigning the elementary and secondary school social science curriculum."[4] Specifically, it was suggested that a task force be established to explore more fully the implications of research on basic learning processes for school curricula.[5]

Although a great deal has been said of the relationship between the affective and cognitive processes and how they produce concomitant learning in children, again speculation abounds and empirical data lags. However, lack of definitive answers need not discourage the use of the information which is available in order to understand better the child's learning processes. Enough data exist concerning the human thought processes to permit a growing awareness of the multiplicity of variables human behavior contains, all of which require educational attention.[6]

The developing research and theory in cognition has reached a point where a natural link should be forged between it and related research in curricular development. In the evolution of any technology, steps are needed between the pure science stage and the ready application of what is known.[7] The tasks of implementation and application in this instance fall to the classroom teacher.

In the pages that follow, serious attention has been directed to the ways of children's learning, including both the cognitive and affective dimensions, hopefully providing some important leads which have direct relevance for teaching and curriculum building. The cognitive component of the thinking process is first reviewed, then the relationship between cognition and the affective domain is explored.

Cognitive Processes

Creative thinking lies atop the learning ladder. The processes which form the rungs leading to this epitome of learning include sensation, perception, cognition. memory, and problem solving.[8] Sensation refers to the first unlearned response to any stimulus which the organism (sense receptor) receives. The concrete aspects of an object are sensed as hard or soft, light or dark, circular or straight, loud or quiet. Once the child organizes the incoming stimulus into figure and ground, and then relates meaningfully this organized *percept* to one or more categories, we have *recognition* or a "cognition." [9]

Ausubel makes the distinction between perception and cognition by suggesting that perception involves immediate awareness, or some level of meaningfulness of the sensory stimuli, and cognition refers to such processes as relating the new materials to existing cognitive structures or categories, thus reconciling the resulting new information or meaning with prior experiences.[10] The two processes are actually telescoped into one in most aspects of children's learning.[11]

However, the problem of differentiating a concept (cognition) from a percept is important in some contexts and becomes an objective of teachers in organizing curricula.[12] Perception feeds into the brain the immediate sensory record of objects and events so given perceptions become prerequisite learnings for concept building. Cognition no longer involves a mental image of the object, but rather the way an individual finds to *organize* and categorize his percepts. There is a hierarchical and interdependent relationship noted in moving from sensation to perception to cognition.[13]

Concept learning has been defined as some amount of meaning, more or less organized in the mind as a result of sensory perception of external objects or events, and the cognitive interpretation of the perceived data.[14] Although there is considerable debate about the definition of a concept, there is little question that concepts are the fundamental instruments of thought.

The child deals with his world by categorizing or grouping objects or events on the basis of perceived common characteristics. The young child perceives a particular group of objects, persons, events, or relationships and examines, though not usually intentionally, each member of the group for common attributes or features. Consider the problem a child faces in gaining the concept "dogness." Of the many objects around him some appear to have life, four legs, a tail, a certain torso configuration, and a bark. Some objects are short, some tall, some brown or spotted; some have long hair and some short. As a child discovers the *essential* likeness of the collected dogs, he selects those common characteristics, namely life, four legs, a tail, a body, and a bark, and categorizes or classifies the objects on the basis of these attributes. Once the concept "dogness" has been learned, the test is if the child is able to place a new kind of dog in the classification. The name dog may be assigned at this time, although it is not an essential part of the categorization and classification process.

Werner relates the story of 18-month-old Gunther Stern who could recognize objects having similar characteristics found in a garden.[15] As many children do, Gunther coined his word "psee" (plant) to label leaves, trees, flowers, and fruits growing in a garden.

So it is entirely possible that a child acquires particular concepts meaningfully without learning for some time what names to apply. Because he does not know what particular word to use, it cannot b-

assumed that a child does not know the corresponding concept meaning.[16] A three-year-old child sees at a glance what belongs together as she groups objects correctly in clearing the table. She stacks plates according to "size" though she has no label for the common property. The converse is true in that the child may be able to verbalize, or give the concept name, without an adequate understanding of the concept meaning.

When verbal input is substituted for sensory input and experience, concept learning can be impeded.[17] The dominant mode of conveying information in the classroom is verbal, with the teacher supplying information and the pupil receiving it. Woodruff observes tnat many studies and programmed lessons which propose to contain conceptual material actually fail since they require a verbal (factual or memory response) and not a comprehension response from the child.[18]

Failure to discriminate *conceptual knowledge* from *verbal knowledge* has led some teachers to reject as learning, concepts that cannot be verbalized, and to accept verbalization for concept learning. "If you know it, you can say it." Rote memorization, rather than concept learning, may result when words or symbolic material are stressed before the learner has a perceptual (experiential) basis for making an interpretation, when a concept is presented by a teacher in the absence of concrete examples and necessary prior experiences.

Concept utilization, a type of generalization and a test of concept mastery, occurs when the child uses known concepts in acquiring new knowledge, as when the teacher probes to see if the meaning is clear and asks the pupil to "find another." [19]

CONCEPTS CULTURALLY INDUCED:

Concepts do not develop in isolation. Perceptions, other than those which are possibly innate, are learned within a cultural context. Grouping on the basis of perceptual configuration is grouping determined by a togetherness and a likeness in the object seen. Certain figures are perceived as belonging together usually on the basis of common properties such as form or color.[20]

The Bakaïrí Indians in Brazil use the expression *tu ku éng* to designate the colors emerald green, cinnabar red, and ultramarine. This array of colors so different in quality is explained by the fact that *tu ku éng* is the name of the parrot which bears all three colors.[21]

The same culturally induced grouping process is in evidence in the young child. A three-year-old child sees a painted landscape with a boat in it, and says: "It's summer now!", even though it is a winter scene which is represented. The boat is related to summer in the child-like experience and that relationship determines the meaning of the entire picture.[22]

Critical Periods and Age Factors

Investigations of optimal ages and of critical periods for learning specific behaviors, coupled with teachers' concerns to sequence the curricular content in accord with children's maturation or learning levels, has led to a number of studies which attempt to ascertain, by observational and laboratory methods, the optimal age at which children are able to handle different aspects of their environment.

Piaget's[23] contributions to the thought processes of children have given impetus to great numbers of these studies. In general, investigations have been directed to verifying the developmental periods. The first period, termed the sensory-motor, covers the first two years. The child acquires sensory inputs and explores his environment by seeing, listening, touching, and tasting. He is accumulating notions of space, time, matter, and causality, and develops the notion of permanence of an object.

Ages two to six or seven are considered to be the years of the pre-operational stage. Early percepts and concepts are concrete, unstable, and irreversible. Later the child becomes capable of intuitive thought. He still does not appreciate the principle of conservation of space, length of surface, etc. During the concrete operational stage, which fills the years between seven and eleven, the child performs such operations as combining, associating, identifying, and reversing, but thinking remains tied to a concrete level for the most part.

Around eleven or twelve, the child becomes increasingly capable of logical thought. With cultural modification, Piaget's theory can be used to ascertain a child's cognitive stage and as a guide for curriculum building and teaching practices.

Age determinants reported are always approximate, since the acquisition of skills is a gradual process influenced by experience and other maturational factors.[24] Citing a given age for attainment of specific learnings may be dangerous because there is the temptation to overlook

the broad range of abilities found in children of any age and to expect, for example, that all seven-year-olds have attained the level of Piaget's concrete operation stage or, conversely, that no eight-year-old is still operating at a preoperational stage. In addition, Bruner [25] warns that we may be controlling behavior by imposing irreversible limits upon the child with many of our practices in education in which teacher expectancy of certain levels of behavior makes it difficult for the child to perform the unexpected.

If the qualifications cited are kept in mind, the evidence on age ranges of concept learning can contribute to an understanding of children's thought processes and to the systematic planning of curricular content.

Vernon [26] cites two characteristics of learning in early childhood: first, its vagueness and diffuseness, a lack in accurate observation of detail and selection of what to us seem to be significant aspects of the situation; and second, the child's inability to make inferences from his immediate sensory perceptions about the nature of objects and of the environment because he lacks knowledge to guide him. For example, the five-year-old can be misled by perceptions as when the child sees an equal amount of water poured into a tall-narrow beaker and a shallow-broad container and declares that there is more water in the tall beaker.

As seen today, cognitive learning begins in early infancy and the young child's capacity for learning is much greater than previously recognized.[27] Certain primitive forms of generalization appear at an early age.[28] For example, the child knows "this book" has a relationship beyond just what he sees before him because he has encountered different books in other situations and may encounter again this something which constitutes being "book." The child at this level does not necessarily have a common name, "book," to apply, so he often invents words. Two boys, ages four and six, were playing with blocks and they created terminology so that the younger could communicate with the older. For elongated blocks they used the terms "big 'thin window', little big 'thin window', big 'sharp window'," and for tall forms the reference was to "big peppermint and little peppermint"! [29]

In the preschool and primary grades, the child is limited in his learning to those concrete objects, events, and relationships which he can perceive. Children of kindergarten age can be given instruction and

appropriate experiences, thus learning to "conserve" number and amount. Perceptual deception is less frequent in children who have been trained to perceive accurately.[30]

A conclusion of King,[31] in studying concepts of length, weight, time, direction, and volume in investigating children from ages five to twelve, was that the relationship between volume and weight was not understood by children of these ages, but time and distance were understood and the estimations improved with age. Portugaly[32] developed and implemented a program to teach kindergarten pupils about the earth as a globe. It was concluded that the pupils developed a basic understanding of the topic, and that greater cognitive emphasis was practicable for kindergarten pupils than was formerly thought possible.

Luria,[33] in a study of Russian children, comments that it is interesting to find a decisive turning point in all our experiments between ages four and five when something very important happens to the human being. Also, there is some significant alteration in the mental functioning of the child during the age range from five to seven. Evidence from several independent contemporary inquiries into the child's learning and cognitive processes indicates that "whatever each system considers to be the essence of symbolic or abstract thought processes emerges in the child from five to seven."[34]

Piaget[35] holds a position that the operations which change with age are logical structures that are neither dependent on nor derivative from language. Kagan,[36] along with other American theorists, asserts that language is at the heart of reasoning.

When studying category usage in normal children, Birch and Bortner[37] found that children in the age range from three to ten show a shift in the ways in which they classify objects. Younger children classify by form and shape, while older children classify objects by function. Subjects trained on the shift from no conservation to conservation of substance performed better when the teacher presented two competing concepts which forced the child to reflect and think prior to verbalizing.[38]

Towler[39] found, contrary to Piaget's stages, that some very young children do have gross expectations concerning the relations between object appearances and their position in space.

Based on a study of 12,000 children from grades one through eight, Easton and Hess[40] looked at the concepts, attitudes, and values

held about the political world. They noted that the child's political world begins to take shape even prior to school entrance. By the time the child has completed the elementary grades his political orientation is set and tends to change little during the high school years. In effect, then, the years from three to thirteen appear to be the formative years for political orientation.

In a game of "twenty questions" played with boys ages six through eleven, investigators noted that the way of searching for answers changes in a rather regular way with growth: "The child goes from a kind of associative guessing at six, to a weighing of likelihoods at eight, to constraint seeking, or the attempt to eliminate half of the alternatives with each question, at eleven." To phrase it another way, growth moved with age from the "pure guess to the probable guess to the constrained guess." [41]

In studying children who are approaching the fourth of Piaget's stages, that of formal operations, Sigel,[42] reporting the work of Flavell, summarizes eleven categories in which he presents the integration of cognitive abilities with social concepts at ages ten and eleven. The age determinants are approximate, but the summary of cognitive prerequisites as related to social science concepts gives concrete and workable rudiments for the teacher and developer of curricula.

Admittedly there exists a lack of research in concept formation in areas other than mathematics and science. It remains then for teachers of geography and other social sciences to ascertain: (1) if there is a best time for the introduction of specific geographic and social science concepts; (2) if an optimal sequence exists in teaching these concepts; and (3) if in the replication of studies completed five to fifteen years ago results remain the same.

Because of its importance as an instructional goal in the schools, and to broaden the spatial base established in the following chapter, the development of a sense of time and chronology is used as an exemplar to illustrate the importance of concept development as a prerequisite and concomitant learning for understanding social studies. Social issues and events linked chronologically are seen as functionally related, and thus they become more meaningful when time concepts are well developed.[43] The selection of a few relevant time concepts to be stressed in the social studies might include: the dimensions of time and related vocabulary of definite and indefinite time expressions; familiarization with time concepts frequently encountered in reading

and listening; the relationship of dates to personal experience for use as points of orientation, and the placing of related events in chronological order.[44]

In general, the development of time begins with the child's comprehending the time word and responding with appropriate behavior. He then uses the word, and later uses time concepts correctly in answering questions. Some examples of the rather systematic and consistent patterns of growth are evident in the four-year-old who discriminates between morning and afternoon, and knows the time of his next birthday. Accomplishments of the five-year-old include how old he will be next, bedtime, and the days of the week. At six, suppertime, time to get up, schooltime, and afternoon constitute part of his temporal equipment. Age seven marks attainment of a readiness to employ such time concepts as months and seasons, while the day of the month and the concept of year are attained by age eight.[45]

One study of clock time indicated that the developmental sequence for children ages four to six began with the child telling the time of his activities in a regular schedule, followed by telling hours, then half, and finally quarter-hours by the clock. Setting the hands of the clock at specific times and explaining the operation of the two hands of the clock are later achievements.[46]

McAulay found, contrary to expectation, that the seven-year-old lacks understanding of time when related to his immediate family and community, but has a fair grasp of other aspects of time relationships.[47]

Time and space related to geographic time zones implies knowledge of such topics as distance, direction, orientation, and chronology. An experimental group, ages nine to eleven, was taught material designed to build an understanding of geographic time zones. The control group received no instruction except that in the regular program. The experimental classes profited considerably from instruction about geographic time zones. Davis concluded that time and space concepts may be introduced as early as grade four, an earlier age than was generally believed to be efficient.[48] However, some caution is indicated since by age eleven only two-thirds of the pupils understood indefinite words such as recent, eternal, and B.C. according to Friedman.[49]

While participating in the Consortium on the Social Sciences, Flavell selected the approximate ages of ten to eleven years to illustrate the integration of cognitive abilities with social science concepts. "The concept of time as a fixed rate, a measurable medium in which events

take place, is a prerequisite for the ability to comprehend historical time lines and to appreciate that historical events occur simultaneously or successively." [50]

Piaget noted that prior to conceptualizing time concretely and directly, the child orders before and after, termed *succession*, and develops a sense of duration which requires an estimate of the length of time. It is Piaget's contention that temporal relations be based upon experience with objects, space, and causality.[51]

An experiment similar to Piaget's yielded results based on one hundred subjects ages five to nine years. A steady increase in perception of simultaneity with age was noted, the concept of time improved under training conditions, and with increase of age came an increase of the understanding of the order of events.[52] In general, Piaget's results were substantiated.

Individual differences are present at all age levels and all intelligence ranges in children's use of and comprehension of time.[53] Children's acquisition of conventional time concepts and time relations is a slow process, beginning before school age and reaching an important stage at eleven or twelve when a rapid period of growth in time knowledge is experienced.[54]

Important implications for the teaching of the social studies emerge from these investigations which demonstrate the need to use concrete explanations related to children's experiences in teaching concepts until about age eleven.

Socioeconomic Status and Cognitive Learning

Plasticity of intelligence, or the ability to accept new ways of learning, appears to decrease as age increases.[55] The avenues of exploration for children of low socioeconomic status may be limited by lack of a stimulating home environment and of less well developed habits of hearing, seeing, and thinking.[56]

As the youth of poverty is reinforced for channeling his attention and energy toward mechanical abilities or other non-verbal tasks, he becomes less responsive to cues in his home and school environment which would require him to develop verbal and symbolic abilities. In essence, his energy is no longer free to be committed to learning verbal and conceptual skills so he remains slower and less competent in the transition from concrete to abstract modes of thinking. The cumulative nature of these developmental deficits, coupled with decreasing attention to verbal sym-

bols, lower the possibility of completely reversing environmentally induced retardation.[57] Early intervention, however, during the most plastic periods, could prevent cumulative deficits and provide appropriate models for building habits of hearing, seeing, and thinking. The mastery of lower level tasks in the hierarchy of learning would provide readiness for learning at higher levels, thus lessening the weighty task of schools which is to "make achievements independent of background and to overcome the differences in starting point of children from different social groups." [58]

Most definitions of the disadvantaged child include belonging to a family of low income, and possibly of recent immigrant or minority racial status. Though no hard and fast relationship exists between low economic status and a condition of disadvantage, the culture of poverty has characteristics which warrant teacher attention, if only to alert him to the differences in experiences which do exist.

The various consequences of severe malnutrition upon cognitive development are as yet not fully established.[59] However, the most probable account suggests that smallness of stature and poor intersensory development are due to malnutrition and are evidenced in such behavior as low energy level and an early exit from school life.[60]

The family environment, rather than malnutrition, provides the more glaring basis for poor school performance due to parental modeling of non-intellectual habits and the reinforcing of maladaptive social responses.[61] Among other home conditions, the child of a poverty culture may have a mother who models a harsh, punitive, and suppressive form of control.[62] As a consequence, the child manifests a negative attitude toward teachers and settings where any control is exerted. Thus some lower-class children tend to respond toward authority figures with either a show of compliance masking hostility and resentment, or with an overt disdain of a teacher-initiated task or project. The willingness to learn in school is often a way of expressing identification with the family ideal and, conversely, the decision to fail in school tasks may reflect the unwillingness of the child to aspire to a level of learning neither desired nor modeled by parents.[63]

The linguistic liabilities of children of parents of low socioeconomic status may include limited vocabularies, poor articulation, and faulty grammar. The recognition of fewer objects, and knowledge of fewer and different interest categories than middle class children manifest, adds to the school handicap of the child of poverty.[64] The modeling of

habits incompatible with school achievement is most clearly observable in the child who has no experience in delaying gratification of impulses. The inability to set goals with gratification gained in the future splinters learning into small segments for which linkage is improbable.[65] For example, mothers of lower socioeconomic class children tend to act without time for reflection or planning. This provides modeling behavior which lacks linking and meaning since any given act is unrelated to events preceding or following it. Such a model produces a child who is neither reflective in his behavior nor sees how ideas and events are related to one another.[66] As noted, this impulsivity or immediate reactivity is manifested by children and may reflect the style of decision making modeled by mothers.[67]

Kagan [68] describes those children as fast evaluators who make frequent errors in problems with high response uncertainty and whose evaluations are often incorrect. Cognitive histories of such children include lack of opportunity for activities required for locomotor and manipulative developments, punishment in response to their questions seeking relationship of objects and ideas, and paucity of suitable play things and appropriate models for imitation.[69] Low incentive to achieve, and little parental encouragement in tasks required by formal schooling, added to other factors in the home environment, militate against success on school-related cognitive tasks. Just as an enriched environment allows the child to go on developing, so one devoid of appropriate stimulation and encouragement sets the stage for later failure.

Counteracting Cultural Deficiency

It is imperative that the school provide an atmosphere which is conducive to learning for each child. Bruner,[70] in positing the idea of critical periods for cognitive development in the child, warns that early sensory and intellectual deprivation may prevent the kind of intellectual and emotional unfolding that nourishes early learning and makes later learning possible. The child does not inevitably move from a lower to a higher phase of cognitive development. He must be provided with the appropriate conditions for learning. These include:

1. stimulus situations which are relatively free from stress and which allow detachment of the concept from affective contents (A hole is *not* only a pit in which to fall.) and situations which will allow for a detachment of concepts from modes of action (A hole *is* to dig, but it is also a hole!),

2. play situations by means of which a child learns to place limits on the anticipated consequences of activities, and
3. freedom from overly strong incentives which narrow or block learning.

A setting rich in objects, pictures, and appropriate adult models, coupled with encouragement for exploratory and questioning behavior, could provide the varied experience upon which later verbal skills are built. Contact of preschoolers with models of good speech patterns, and a setting where questions can be asked, answered, and relationships established between objects and ideas, could remove most of the linguistic handicaps before the child enters school. Thus, in addition to preschool activities, Ausubel suggests that:

> . . . much time be spent in reading and talking to children, in furnishing an acceptable model of speech, in supplying corrective feedback with respect to grammar and pronunciation, in developing listening, memory, and attentivity skills, and in providing appropriate reading readiness, reading and writing instruction.[71]

Teacher acceptance of the culturally different child's less complete educational opportunities, and teacher willingness to provide more concrete props and experiences, could facilitate the youth's developmental shift from dependence on concrete modes to more abstract levels of thinking. The introduction of more creative ways of teaching, which would assist the culturally different child in his approach to learning, is long overdue.

Problem Solving

Problem solving is a subtle form of thinking, one difficult to put to an empirical test. The term "directed thinking" covers the processes of thinking whose function it is to convey solutions to problems.[72] Skinner refers to problem solving behavior as the process of finding the response which alters the situation and makes the solution more probable.[73] The distinction between difficulties, puzzles, and problems is that to solve a *problem* or make a discovery is to impose a puzzle form on a difficulty that converts it into a problem that can be solved. In effect it is to recast a difficulty into problem form.[74] In fact, Liverant sees all behavior as leading to problem solving and facetiously remarks, "Even scratching one's epidermis may be viewed as solving the problem of itching."[75]

A problem solving environment is created when a situation is unfamiliar and the individual's concepts do not provide him with a line

of action. He must find the known response which best approximates the demands of the situation. This process requires the ability to generalize from a known response (concept) and to transfer this response, or pattern of response, to a new situation.[76] In fact, Inhelder sees the separation of concept learning and problem solving as artificial, since each learning situation presents a problem of a sort, whether this be finding the way home, buttoning a new coat, or seeking the pattern of a new guitar strum.[77] In the process of arriving at a solution a relationship between certain relevant concepts is stated and a principle, rule, or generalization is formed. This generalization may later be employed in arriving at a solution to a problem.

A well-substantiated conclusion indicates that students do not know how to go about the process of problem solving.[78] Thus, in addition to having content (concepts) in subject matter, students must be taught problem solving behaviors.

Systematic instruction in solving problems has proved to be more effective than the provision of numerous examples of problems for children to solve.[79] The individual needs instructions which function to define the problem, provide understanding of the goal, establish a set, and introduce direction. Problem solving takes place through the use of rules or principles. A rule specifies a relation between concepts, and a higher order rule is defined as a relationship between previously learned rules. Prerequisite concepts and rules must be taught to the learner for him to be able to solve problems.

One suggested method of problem solving training follows these five phases:

1. The orientation consists of: developing a set or attitude to recognize problematic situations and to inhibit the tendency to respond impulsively.
2. Consists of training in: defining the problem in clear and specific terms.
3. Asking the question: "What can a person possibly do in this situation?" leads to the productive generation of alternative solutions. The student thinks of ways of combining parts of prior learnings in new ways.
4. Leads to the selecting of the alternatives which appears to have the best chance of solving the problem and which leads to the most positive consequences for the person.

5. The solution or selected behavior, is putting to the test. It is verified either in real life, in a role-playing situation, or in cognitive rehearsal and, where more practical, by testing the solution against that of one's peer group.[80]

When the problem solver employs an inductive learning method in which he is left to discover the rule or procedure, we use the term "discovery method." Bruner sees discovery as the act of obtaining knowledge for oneself by the use of one's own mind. He asserts that, "Discovery, like surprise, favors the well prepared mind." [81] Discovery requires the rearranging or transforming of known evidence so that one is able to reassemble this evidence to lead to new insights. Learning by discovery, then, refers to those teaching situations in which the solution to a problem is attained with little or no help from teachers. This experience supposedly leads students to a generalized ability to arrive at solutions. The ability to generate and evaluate hypotheses is linked to the child's capacity to tolerate uncertainty, which increases his ability to recognize problems, to use available information, and to deal openly with complex issues.[82]

A suggested approach to arriving at solutions, one of unguided discovery, is taught to the child as a technique in learning the strategies and tactics of scientific inquiry. Ultimately, then, it is a problem solving technique employing discovery learning, although not so stated by Suchman.[83]

Each inquiry session is about an hour in length and the three phases are the presentation of the problem, a practice session comprised of student-to-teacher questions about the presentation, and a teacher critique of the strategy and tactics of the group. Instruction in problem solving techniques needs to be supplemented by practice in the use of these techniques. It is in "the effort of discovery that one learns the working heuristic of discovery and the more one has practiced, the more likely is one to generalize what one has learned into a style of problem solving or *inquiry* that serves for any kind of task one may encounter."

Although problem solving is improved by techniques coupled with opportunity for practice, the effectiveness of the process is even more dependent upon the *nature* of the problem and the child's prior experiences.[84] Thorndike [85] suggested a division between practical problems, involving the need to accomplish a task, and intellectual problems, involving the need to understand. The task of the school is to help

children apply solutions resulting in understanding to the achievement of solutions to practical problems.

Watching a small child attack a difficult problem indicates the importance of instructions in the problem solving process. Attention to directions and information coming from others is confirmed as the child relays these instructions, usually overtly, to himself. At later ages the individual instructs himself through covert language and defines his strategy in that way.[86]

The ability to use words appears to be an important factor in the speed of concept acquisition, and requiring the child to verbalize may facilitate concept learning, thus problem solving.[87]

In responding to the question of whether the teacher should give the child examples and allow him to infer rules (discovery learning), or present the rule and encourage the child to seek relevant examples (expository learning), Kagan responds with: "the method of discovery is most appropriate for highly motivated older children who might have high dependency conflict and who are inclined to use a reflective strategy. This method is least appropriate for younger children, especially those below the age of nine, who do not have high motivation to master intellectual tasks and who tend to be impulsive."[88] Friedlander[89] concurs, reflecting on Piaget's cognitive stages and recognizing that below the ages of 11 or 12 the inferential method which employs syllogistic reasoning is not usually appropriate or attractive.

A child may not solve a problem for either of two reasons: the level of skill required, e.g., memory, judgment, reasoning, is not within his repertoire, or the right combination of expectancy and reward values is not operative.[90] A function of the teacher is to provide for the development of these prerequisite skills in a classroom which is conducive to their use.

Effective problem solving is not limited to solutions of conventional problems, but extends to problems demanding creative solutions.[91] Crabtree[92] structured two situations which would impose a classroom organization conducive to A, emergent or divergent thinking, and B, convergent thought. She found second-grade children utilized the thinking style corresponding to the imposed organizational structure; that is, divergent responses were made by children when the teacher set situations which encouraged these creative attempts, and conversely, more convergent, pat answers were given by children in the teacher-directed class.

Kersh[93] presents evidence that added interest accrues as a result of learning by discovery. However, results fail to support the notion that added meaning will enhance retention. The greater amount of time spent in discovery learning led Ausubel[94] to question the discovery method as a feasible technique for all students, especially those who may learn more quickly and as well by another procedure. Discovery alone is incomplete, and for retention to occur a synthesis and consolidation of knowledge should be programmed into discovery learning.[95] The most defensible program of problem solving experience includes a preliminary and minimum amount of appropriate didactic exposition.[96]

In retrospect, then, the cognitive processes begin with the simplest activity of the child, and lead to more complex forms as sensations are joined in a meaningful way to form a percept. As the child accumulates these sensations and perceptions he categorizes his inputs by responding differentially to each. By a process not well understood, the child sorts the essential characteristics from the accidental or non-essential characteristics and forms classes or concepts of objects, persons, or events. These concepts form the rudimentary unit out of which thought processes grow. When one concept or class is related to another, thinking occurs. Concepts are a function of the age of the child and of his peculiar constellation of cultural experiences. It has been suggested that every new concept presents a problem solving task. At any rate, much thinking in school settings is directed toward problem solving and may occur under numerous forms. A frequently employed and oft lauded approach has been the act or method of discovery. The teacher participation in the act of discovery may range from much direction in the case of exposition to extremely little in the inquiry model.

No ivory tower sterile environment shelters the thinking of the child. The cognitive processes emerge from a child who has attitudes, values, beliefs, and well-established coping patterns. A persual of one dimension of the affective domain and its interaction with the cognitive may indicate some ways to modify instruction in order to manipulate the school environment so that optimal learning is possible.

Affective Factors

In addition to cognitive growth in children, pupils change in other ways. Attitudes are learned, values internalized, feelings explored, and a flexible or rigid set toward perceiving one's environment established. All of these are important aspects of school learning. The affective or

motivational variables screen all sensations and perceptions which occur in the school environment and to some extent determine what is learned in the cognitive domain. What is being suggested here is that less distinction is found between the cognitive factors and the neocognitive or affective factors as each is studied more intensely.

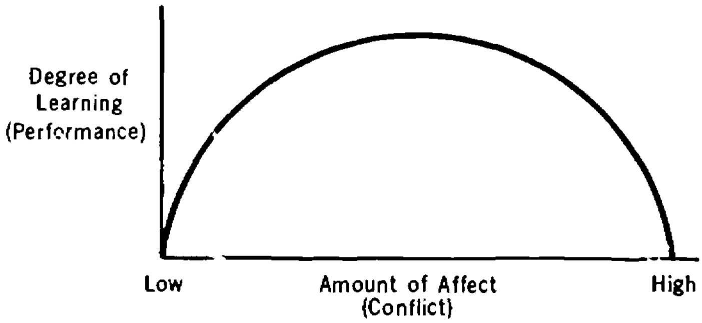
For the sake of more careful scrutiny, it is permissible to tease apart the cognitive and affective aspects of learning while keeping soundly in mind the interrelation of these components.[97] The terms neocognitive, noncognitive,[98] and nonintellective[99] have been used to refer to the determinants of behavior incorporating emotional, motivational, and temperamental states.[100] Attention to the *affective* domain, a term used to cover these somewhat less rational of our cognitive processes, brings to focus a whole array of variables which come into play in the thought process. Although the exact operation of these variables is not well understood, their inclusion in a study of children's thinking is warranted. Liverant[101] signals an apparent contradiction in the common case of a child who functions well in school but behaves stupidly with his peers, or the child who does admirably on an intelligence test and abominably in school. Only within the framework which considers all of the variables necessary to study behavior can we begin to gain an adequate understanding of the child-as-a-learner.

The younger the child is, or the lower the intelligence level, the more closely fused are the affective and cognitive systems. "Things do not stand out there, discrete and fixed in meaning with respect to the cognitive subject."[102] In the course of development the child gradually separates some feeling, perception, and activity while other aspects of feeling, wishing, and desiring remain closely tied through adult life.

Both the direction of the affect, whether positive or negative, with reference to an object, person, or event, and the strength of the affect, determine to an extent the cognitive structure and whether new information will be processed or blocked.[103] The influences of the affective state on thinking may be viewed as those which facilitate and assist the process and those which inhibit learning or distort it.

One way of conceptualizing the interaction of the affective and cognitive components is to view each of the several affective variables along a continuum moving from low through optimal to high strength. Cognitive learning, as performance, could be juxtaposed so that we have a curvilinear relationship that holds for some of the interactions. As conflict increases from low to optimal, so does the performance rate (Figure 1).

FIGURE 1



Beyond a given range conceptual conflict becomes too high in strength and performance decreases. Whether or not learning will occur and, if so, how effective it will be depends to a great extent then upon the learner's tolerance for conflict.[104]

The study of motivation has moved from an emphasis on instincts, through homeostatic theories and general drive states to a recognition of a whole array of motives now referred to as *competence* [105] or autonomy variables.[106]

It is a well-accepted fact that concepts and principles are generated more easily and with less error when the situation and the task are relevant and in accord with the age and development of the child. Other interpersonal factors, such as curiosity, exploratory behavior, novelty, attention, expectancy, reflectivity, innovative behavior, and competence, direct and sustain the behavior of the person performing a task.

Those self-regulating behaviors which tend to facilitate effective thinking develop spontaneously before age three and in an appropriate environment tend to be self-maintaining. A child demonstrates curiosity, the tendency to explore, manipulate, investigate, and discover in relation to novel stimuli when he:

1. Reacts positively to new, strange, incongruous, or mysterious elements in the environment by moving toward them, by exploring them, or by manipulating them;
2. Exhibits a need or a desire to know about himself and/or his environment;
3. Scans his surroundings seeking new experiences; and

4. Persists in examining and exploring stimuli in order to know more about them.[107]

Curiosity increases sensory input since the curious person seeks opportunities for stimulus novelty which lead to an active relationship with the environment. Current research indicates that curiosity can be induced and can increase the amount of cognitive input by varying the discrepancy between an expected and actual stimulus situation. Berlyne [108] postulates two types of curiosity: (1) *perceptual curiosity*, which is generated by novel stimuli which are reinforcing to the child; and (2) *epistemic curiosity*, which is elicited when a question arises that demands an answer, is satisfied when that answer is given, and is induced by conceptual conflict.

Some evidence indicates that curiosity is related to age, to ability, and to retention, since younger children tend to be more curious than college students,[109] higher ability children tend to be more curious than those of lower ability,[110] and children rated high on curiosity retain more information than those rated low on curiosity.

As early as 1959, Frenkel-Brunswik [111] noted a close link between emotional functioning and cognitive behavior in her studies on children and prejudice. Children who were prejudiced had the least tolerance for ambiguity, they resorted to black-and-white solutions, and arrived at premature closure to problems often at the neglect of reality. This stance of prejudice was clearly related to the inability to keep an open mind to new experiences, to sustain cognitive inconsistencies, and so to arrive at higher levels of thinking.

Always a topic of major interest to teachers, recent studies in educating children from disadvantaged areas have indicated an even more pervasive arena for the application of knowledge about motivation. Thus, a current theory relating cognition and motivation suggests that some children see adults as powerful and competent and so gain academically as they mimic or model mastery of academic skills in order to become similar to the adult and, in this way, share in his competence. This phenomenon operates to the detriment of those children who do not perceive parents as persons who value intellectual mastery as a means to power and competence. The child's motivation to maximize similarity to an adult model militates against school achievement-behaviors.[112]

Bruner,[113] in an observation, found children from poor families with high need for money overestimated the size of coins more often than did

children from high socioeconomic families who had more familiarity with and less need for money. Similar studies using candy and/or poker chips indicated the same relationship in which the objects were overestimated when closely associated with rewards.[114]

A strong relationship between motivation and perception emerged in a study of young children and their perception of mythical creatures. Children ages 5 and 7 drew pictures of Santa each week for a month before Christmas and again after Christmas. As Christmas drew near their drawings became larger and larger, Santa's costume became more elaborate, and he was drawn nearer the children's home. Solley [115] suggests that with increased motivation there was a corresponding increase in perceived form. After Christmas, as motivation presumably diminished, Santa was perceived as smaller, plainer, and far less significant. Perception (what was seen), a cognitive component, was governed to a great extent by motivation (what was important), the affect component.

Several studies report the effect of distorted cognitive learning as a consequence of excessive competitiveness, desire for power over others, assumption of a passive attitude toward teachers, anxiety over dependence, and the expectancy of success or failure.

In his work with children, Bruner [116] found good evidence that too strong an incentive for learning narrows the perceptual field. Under pressure the child blocks and becomes "functionally stupid." His behavior resembles an infant's to the extent that the principle of his cognitive organization becomes *complexive*, in which action, affect, and thought are fused, rather than *conceptual*. For instance, the child who is excessively fearful interprets all new data in terms of "things that hurt me," so much so that a spade becomes something-to-hit-with and a blanket a thing-to-hide-in. Restricted perception becomes an impediment to the development of higher levels of cognition and bars the child from effectively learning school-like tasks which in turn are so necessary for developing higher level problem solving.

Kagan has this to say of expectancy:

> Children quickly develop different expectations of success or failure in intellectual tasks. Unfortunately, the most frequent and prepotent reaction to an expectancy of failure is decreased involvement in the task and subsequent withdrawal. Educators have been guilty of minimizing the critical role which a child's expectancy of failure plays in shaping his behavior in a school situation. The child's motives are contingent on expectation of success or failure, and motives are sloughed or adopted with zeal depending

on the degree to which the child believes he can attain the goals that gratify the motive. Growth of specific motives and persistence at task mastery hang delicately on the balance between hope and fear.[117]

A moderate amount of tension improves the chances of attaining a goal. In extreme amounts, however, tension becomes disruptive and incapacitates the learner. Ascertaining the range and kind of tension necessary for creating an optimal learning environment is demanding to say the least. The teacher needs to be aware of the close relationship between the child's tolerance for stress, anxiety level, modes of meeting frustration, attitudes, and prejudices on the one hand, and his way of perceiving his physical and social environment on the other.

Despite evidence supporting the importance of these affective dimensions, teachers seem to feel more comfortable in stating their goals in cognitive rather than affective terms, and this preference may be manifest, too, in teaching for cognitive to the exclusion of affective goals and in so doing actually defeats the attainment of improvement in the thinking processes.[118] The teacher's awareness of the affective interaction is thus as important when his curricular goal is directed toward the cognitive as when he sets out to assist the pupil to attain social competence and personal adjustment.[119]

While development of higher level mental abilities is important, it is well to recall that there is no one best way of developing cognitive processes or of teaching all content. A linear approach to a problem may be preferable to the intuitive type process for some children and for some types of content. A parent's approval of his child's creative solutions in home and play situations may dispose a child to function well in school when the discovery method of solving a problem is used. The anxious child, however, may move cautiously from step to step in a linear manner, since for him it is not safe to risk the leap involved in intuiting.

Indeed, learning styles appear to be closely related to such personality variables as level of aspiration, degree of anxiety, amount of aggression, and feelings toward authority figures. The term "cognitive style" refers to the predispositions of an individual to attend to his environment, and to organize perceived elements in ways unique to him. Variations in cognitive styles exist all the way from complete withdrawal and no learning, through exploration, to thoroughgoing involvement with novel objects.[120]

Simple observations of children yield measurable differences in individual reaction and speed of reactions to stimulus events. The response difference might be reflections of true physiological differences, with some nervous systems being more sensitive, while other environmental differences may be attributed to learned behavior, and always there exists an overlay of learned behavior on a given physical organism.[121] At any rate, the different modes of intellectual responding to similar learning situations cannot be ignored.

Divergent styles of communication emerge during preschool years and provide the cognitive equipment and mode of operating for the school age child. Suppose a child is playing noisily in the kitchen when the phone rings.

> In one home the mother says, 'Be quiet!" In the other, the mother asks, "Would you keep quiet while I answer the phone?" In one instance, the child is asked for a simple mental response. He is asked to attend to an uncomplicated message and to make a conditioned response (to comply); he is not called upon to reflect or make mental discriminations. In the other example, the child is required to follow two or three ideas; he is asked to relate his behavior to a time dimension; he must think of this behavior in relation to its effect upon another person; he must perform a complicated task in following the communication of his mother, in that his relationship to her is mediated in part through concepts and shared ideas; and his mind is stimulated or exercised (in an elementary fashion) by a more elaborate and complex verbal communication initiated by the mother.
>
> As objects of these two divergent styles of communication, repeated in various ways, in similar situations and circumstances during the preschool years, these two imaginary children would be expected to develop significantly different verbal facility and cognitive equipment by the time they entered the public school system.[122]

In their studies of differences in the observed mental abilities of 6- and 7-year-olds, Stodolsky and Lesser [123] found effects of social class and ethnic-group influence on the developmental *patterns* of young children's thinking. Cognitive styles based on different patterns of verbal, reasoning, number, and space concept abilities emerged as a function of membership in their Chinese, Jewish, Negro, or Puerto Rican groups.

Kagan, in studying the basic cognitive structure of children ages 5 to 10, found some to be fast evaluators of a hypothesis and termed them "impulsive." [124] These children made quick decisions with frequent errors. Other children who brooded over answers were termed "reflec-

tive." They had a tendency to consider alternative solution possibilities. The tendency to reflection or impulsivity was related to cognitive tasks such as learning to read and to solve inductive reasoning problems. The reflective child is less likely to make errors of commission on learning tasks than is the impulsive child.

Development of an autonomous and actively exploring person, of one who has the cognitive ability to shift from impulsive to reflective thinking, from field dependence to field independence as the problem solving task demands, requires a freedom from constraint. The autonomous cognitive style posited by Banta [125] maximizes the need for cognitive shift and minimizes the possibility of rigidity in problem solving behavior.

One example of a child absorbed in the environment, self-assured, and ready to explore in autonomous ways, was summarized by Murphy: "Here is a little boy who moved into the situation warmly and spontaneously, quickly orienting himself by his alert . . . observation, and supplementing his own grasp by asking questions to clarify things further." [126]

Some children approach problems "analytically" by grouping stimuli according to their similarities, so that when shown a card with human figures they sort into "people with hats" and "people without hats." On the other hand, a child with a nonanalytic or relational cognitive style might view the same set of figures with the organizer being "people I like" and "people I don't like." Analytic thinkers are more field independent and separate relevant from irrelevant cues.[127]

Researchers continue to look for the interactions between instruction by teachers and ability patterns of the learner in that an instructional strategy capitalizes on the strengths and minimizes the weaknesses of the child's pattern of abilities.[128] A matching of child and curriculum should result in better learning, e.g., to learn space-oriented geographical concepts the child needs a specifiable minimal skill in space conceptualization. Means of determining match and avoiding mismatch remain to be developed.

Kagan [129] instituted a brief training procedure which emphasized inhibition of impulsive answers in first-grade children. The study demonstrated that impulsive children can be taught to modify their "cognitive tempo" to some extent and for a short duration.

The task of matching child and curriculum, learner and learning, cognitive style and methodology, remains a complex and as yet poorly

understood process. The idea of ability to shift from one style to another as demanded by the situation has been considered under the rubric of coping styles in that several styles may come into play in the problem solving act. For instance, ". . . if a general set toward a tolerance for ambiguity is not balanced by an opposing disposition toward cognitive closure, then the individual may not, in an effective manner, take the decisive steps needed for achieving the actual solution. . . ." [130]

Cognitive Dissonance and Learning

From the work of Piaget [131] on the concept of *disequilibrium*, of Rosenberg [132] on *intolerance* for *inconsistency*, Bruner and Postman [133] on *defensive perceptions*, and Festinger [134] on *cognitive dissonance*, there is ample evidence that the individual has a built-in principle of congruence — the tendency to arrange the world of objects, people, and ideas into harmonious relations with each other.[135] This striving for congruence may lead the child to ignore new experiences, rather than to change his own system to fit the new evidence. Since perceptual openness to new data is essential for concept development, those conditions which facilitate openness to reality and, conversely, those which lead to early closure or neglect of reality, should be of great concern to social studies teachers.

In order to develop higher level cognitions, the human organism must move from a very primitive level of conceptualization to successively higher levels. To develop, the organism needs to combine the strong principle of congruence with an ability to recognize and deal with ambiguity [136] and to put up with some "cognitive strain." [137]

Ausubel,[138] in summarizing studies on attitudinal bias, suggests that individuals who are negatively biased toward an argument cannot incorporate new material in their existing cognitive structure, since that new material competes with existing meanings, is ambiguous, and as such is subject to rapid forgetting. Positive attitudinal bias, however, operates in an opposite manner, allowing the child to incorporate and extend his cognitive structures.

From the studies on sympathy some important implications for social studies are drawn.[139] Barring important individual differences in sensitivity to particular affectively involved behavior of others, there appear to be relevant variables leading to a sense of alliance with others who are affectively involved. It appears that the ability to understand situations and people lies in what kind of models have been provided

children as examples of how to behave, and how the child's affective involvement has been rewarded in the past. In fact, Flavell[140] posits the cognitive acquisition of role-playing, the shifting of perspective to the other person's point of view, as a prerequisite for important social studies concepts such as acceptance of a respect for others' positions which are held in good faith. Unless parents and teachers provide positive reward for children's affective involvement, and supply models so that role-taking skills can be learned, the consequence will be an absence of those abilities for understanding much of everyday human behavior.

Concerning the amount of dissonance which is conducive to learning, important variables such as home background, including ethnicity and socioeconomic level, have been considered. The amount of tolerance for ambiguity and, hence, for processing large amounts of information, appear to be limited in lower socioeconomic children. This finding, though real, has been attributed to rigidity and to the need to keep certain aspects out of awareness,[141] and to low motivation and to lack of impulse control.[142]

Subjects exhibiting tolerance for instability have been described as those who can take their experiences at face value and have relatively little need to mold them in terms of expected reality.[143] They are open to new information. Intolerant children are described as those who resist perceptual or cognitive experiences in which ideas or sense data are in opposition to conventional reality. These tend to screen out that part of reality which would threaten or disturb their equilibrium — which would make them change and, hence, arrive at higher stages of cognitive development.

Indeed, if doubt is the beginning of all knowledge, and some children cannot afford the luxury of doubting, then there is a challenge ahead for teachers to make the way safe for all children to doubt and to risk, to be uncertain enough to be open to the new, and so to grow.

The way in which one approaches a learning task is termed his cognitive style, and refers to the predisposition of an individual to ignore or to attend to particular aspects of his environment and to organize perceived elements in ways unique to him. Tests which yield profiles of children's abilities, which provide data for charting such factors as spatial relations, perceptual-motor skills, numerical reasoning, and divergent and convergent production, are replacing the outmoded concept of capacity expressed by an I.Q. score. As our knowledge of different styles of learning grows, it may well provide a sound basis of

grouping for instruction. At any rate, it is necessary to ask in what ways do the patterns of abilities that students bring to the learning situation affect the nature of the teaching process? Or, as Bloom has phrased it, "Can the learning process be different for the verbally able, the numerically able and spatially able?" [144]

Since material organized in terms of one's cognitive style has a better chance of retention and retrieval, greater attention probably will be given in the future to determining individual differences in terms of motivation, cultural backgrounds, maturity level; in a word, to the constellation of abilities which we term style-of-learning or cognitive style.

Summary and Conclusions

The curriculum builder and the classroom teacher of the future will focus on relatively few goals, all of which center around or build upon better understanding of the cognitive processes of sensation, perception, concept formation, and thinking as a means to problem solving, and the relationship of these processes to the affective dimensions of emotions, attitudes, and motives. Laudable are the gains being made to understand the factors which underlie cognitive styles of thinking, and to provide optimal learning conditions which make school tasks relevant for a young person at a particular phase in his development. The student, now more a program planner and less a recipient, becomes the generator of principles and rules for finding solutions, while he continues to respect some clear-cut teacher aims, directions, and procedures which reduce confusion, circular discussions, and wasteful dissipation of energy. Expository and discovery methods play complementary roles as dictated by teacher sensitivity to curricular content and to individual thinking styles.

Meaningfulness and relevance govern selection of content from the disciplines to personalize the learning focus for this youth in this situation. A renewal of the emphasis on understanding symbolization versus verbalization should redirect the objectives in teaching and evaluating from what students know to what they can generate, to how well they can leap from learning to thinking to acting.

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Chapter 10

Children's Spatial Visualization

John Eliot

Spatial visualization is one of several spatial abilities. Most of what we know about spatial abilities has been learned from those responsible for defining intelligence and for predicting academic success. For this reason, it is difficult to define a particular spatial ability without first taking into account changing conceptions of intelligence, and the evolution of intelligence tests.

Most of the early mental tests were constructed in order to predict which students would succeed in school. Although Binet's pioneering efforts included both visual and verbal tasks, other early tests soon became predominantly verbal because it was thought that successful scholarship was closely related to an ability to read and write. Although "performance tests," such as the Mechanical Assembly Test, were administered during the First World War, the assumption was commonplace through the 1920's that "intelligence" was best measured by verbal means. Not until 1931, when Stephensen statistically demonstrated the existence of a group factor of visual ability distinct from verbal ability, was serious attention paid to the identification of various visual abilities.

Contrary to commonplace assumptions, theorists concerned with the definition of intelligence were much interested in visual abilities long before 1931.[1] Indeed, statistical efforts to specify spatial abilities from

among visual abilities were well under way by the late 1920's. Spearman, for example, presented statistical evidence in his *Abilities of Man* [2] for and against the existence of a group factor involving spatial relations. Shortly thereafter, Truman Kelley reported in his *Crossroads in the Minds of Man* [3] that there appeared to be a statistical factor involving the "sensing and retention of visual forms" which he distinguished from a factor which he described as the "manipulation of spatial relations." Similarly, El Koussy published the results of extensive studies of spatial relations conducted with children in 1935. In 1938, Thurstone included a spatial factor in his analysis of primary mental abilities, a factor which he characterized as a "facility with spatial and visual imagery." [4] Later, in 1941, Thurstone commented upon the difficulties involved in trying to distinguish spatial abilities from other visual abilities. He wrote:

> The spatial factor is found in tests which require the subject to manipulate an object imaginatively in two or three dimensions. It is quite distinct from perceptual processes which require only the perception of detail in a flat surface, and which do not require the imaginal movement of an object in two or three dimensions.[5]

The works of Spearman, Kelley, El Koussy, and Thurstone are among the important milestones in the effort to distinguish spatial abilities from visual abilities.

Further specification of spatial abilities was stimulated by military demands during the Second World War. The Army Air Force, for example, conducted a large-scale program to develop classification tests to screen personnel. Several spatial factors were isolated in the statistical studies carried out by Guilford and Lacey [6] as part of this program. A remarkable feature of this research was the difficulty encountered by those in the program who tried to clarify the distinctions between different spatial factors. As Spearman and Jones observed in another context, ". . . herewith we come upon what constitutes perhaps the most serious disturbance in factor-analysis. This is the fact that one and the same cognitive task can often be done in two or more different ways." [7]

In 1951, J. W. French reviewed both the early and the military literature on spatial and visual factors and concluded that there was sufficient statistical evidence to support the existence of three spatial factors: spatial, orientation, and visualization. He described the spatial factor as "an ability to perceive spatial patterns accurately and to com-

pare them with one another." He described the orientation factor as one requiring a person to remain unconfused by the varying orientations in which a spatial pattern may be presented. The third factor, visualization, was characterized as "the ability to manipulate objects in imagination."

Since French's review, there have been additional efforts directed toward clarifying the characteristics of these spatial factors. For example, Michael, Guilford, Fruchter, and Zimmerman reexamined the literature in 1957 and concluded that French's spatial and orientation factors could be regarded as one composite factor distinct from a spatial visualization factor. The latter they described as requiring the individual to "rotate, turn, twist, or invert one or more objects or parts of a configuration . . . and to recognize the new position or location or changed appearance of the objects that have been moved or modified within a more or less complex configuration." [8]

Two comments should be made about this brief history and definition. First, spatial visualization has been a difficult factor to identify; second, it has been identified comparatively recently in the evolution of intelligence tests. Before turning to some further developments since 1960, the implications of these two observations deserve amplification.

The difficulties encountered by Spearman, Thurstone, French and others in statistically isolating a spatial visualization factor underscore the fact that visualization is a complex composite of both visual and imaginal behaviors. This writer believes that the act of visualization, which probably requires the rapid integration of a number of subordinate behaviors, merits further consideration from a psychological point of view.

The act of visualization can be described as a cumulative summation of behaviors in terms of a perceptual-imaginal continuum: perceiving, recognizing, distinguishing, and relating. Beginning with the perceptual end of this continuum, the act of visualization requires a person *to perceive* the distinguishing attributes of a number of objects and their relationships one to another. Next, the act of visualization requires an ability *to recognize* a standard configuration among competing configurations. A person must remember the distinctive features of the standard configuration in the face of distracting information. Moving toward the imaginal end of the continuum, the act of visualization next requires an ability *to distinguish* a transformation or displacement of the *same* configuration from a different orientation. Finally, the act of

visualization requires a person *to relate* the relationships of a transformed configuration to those of the standard configuration. This fourth behavior is considered the most abstractive of the four behaviors because it requires imaginative manipulation of objects in space. It can also be regarded as a form of reasoning because it results in some kind of judgment about the position, location, or changed appearance of objects.

This preliminary analysis, besides underscoring the complexity of the act of visualization, may also help to explain some of the difficulties which people have with visualization tasks. A lack of competency with any of the four behaviors on this continuum, for example, could easily impair a person's ability to master a visualization task. Similarly, a lack of competency could also account for differences in performance on visualization tasks among people at the same stage of development or among people of different ages.

As most geographers know, a majority of American psychologists have long been preoccupied with learning theory and with language as the basis of thought. Geographers and educators, consequently, have received few clues as to how to regard spatial visualization. The repeated efforts to summarize the literature on children's spatial conceptualization,[9] and the repeated attempts by educators to conduct such research,[10] are testimony to an awareness that "something is going on that we don't know how to manage." Only in the last fifteen years has there been an effort by American psychologists to define and to interpret that "something."

Efforts to define spatial reasoning, however, must be seen as part of a large-scale expansion of interests throughout contemporary psychology during the 1960's.[11] Thanks to the interests of Jerome Bruner, J. Mc. V. Hunt, John Flavell, and others. the theory and works of Jean Piaget, in particular, have opened up new horizons for research in cognitive development. Of special interest to this chapter, of course, are Piaget's studies of the construction or representation of space by children.

Piaget, when he described the child's construction of space in 1956, argued that a child evolved from a perceptually-dominated space to the achievement of a conceptualized space. In elaborating upon his theory of intelligence, he distinguished between a static, perceptual space and a transformable or conceptual space — the latter being achieved when the child discovers that he has a point of view. As he argued:

To discover one's own point of view is to relate it to other viewpoints, to distinguish it from and to coordinate it with them. Now perception is quite unsuited to this task, for to become conscious of one's own viewpoint is to

liberate oneself from it. To do this requires a system of true mental operations, that is, operations which are reversible and which are capable of being linked together.[12]

According to Piaget, five- and six-year-old children have difficulties with spatial representation because they lack the cognitive organization which will permit them to do more than restructure their own point of view. Piaget found that children of this age regard groups of objects as if the group itself was one static mass. These younger children persist in "centering" upon the relationship between themselves and the entire mass of objects, rather than upon the relationships between themselves and each of the separate objects of the group. Their representation, therefore, remains incomplete and fragmentary because they assume that if they "depict one relationship correctly, then all other relationships will be depicted correctly as a matter of course."

Eight- or nine-year-old children, by contrast, have achieved a cognitive organization or system of mental operations which permits them to maintain the relative position of parts of a figure, of figures relative to one another, or the whole display relative to different points of view. Piaget contends that the discovery of perspective or different viewpoints comes about when a child no longer regards an object as an entity in isolation, or through his becoming aware of the relations which link objects to other viewpoints or orientations.

This brief summary of Piaget's developmental account of a child's conceptualization of space should suffice for our purposes of definition. It should be apparent that his definition of perspective contains many of the same behavioral characteristics which Michael *et al.* used to distinguish a factor of spatial visualization from other spatial factors. Indeed, the act of visualization can be said to require the ability to perceive and to imagine a spatial arrangement of objects from different points of view for both the Genevan and the American psychologists.

In this effort to define visualization, the writer has described both the gradual emergence of a spatial visualization factor and Piaget's developmental account of spatial conceptualization. Implicit in the effort is the argument that, at the very least, visualization could benefit from further research in one of three ways: from studies of visualization as a spatial factor, from studies of the act of visualization in terms of its subordinate behaviors, or from additional studies of children's achievement of spatial representation in keeping with Piaget's theory. In the discussion of research which follows, the writer will suggest additional approaches.

Before reviewing any research, it should be made clear at the outset the writer's criteria for including certain kinds of studies and ignoring others. The writer also wants to specify a particular visualization task to serve as a common reference and as a focus for organizing this review.

With respect to criteria, the writer must confess that his choice of research areas and specific studies is based largely upon intuition. In the absence of an explicit description or model of visualization, it has been decided to highlight a few areas of research which appear, for both logical and intuitive reasons, to hold promise or to deserve further encouragement and support. This review of research, in other words, will not be an exhaustive one. Indeed, considering the fragmentary and diverse nature of the available literature, this section spends more time pointing to areas of promising research than reviewing particular studies in depth.

With respect to specifying a particular visualization task, the writer decided to organize his review in terms of Piaget's three-mountain demonstration for two reasons. First, it is his impression that most of the literature on children's spatial visualization can be tied, in one way or another, to Piaget's task or theory.[13] Second, Piaget's task appears logically as part of his developmental theory of intelligence. As we have already seen, his account of spatial representation has prompted many to focus on the child's initial reliance upon perceptual cues, his use of imagery, and the combination of these two in a form of spatial reasoning. Piaget, in other words, has provided educators with several behavioral cues with which to bridge the distance between intellectual growth and curriculum development.

To demonstrate children's achievement of perspective or visualization, Piaget confronted 100 children of 4-11 years of age with a model landscape of three pasteboard mountains, and used three methods to assess their ability to visualize or represent this landscape from different viewpoints. One method was to show each child a series of ten pictures of the landscape, asking each child to select the picture which matched the view of a doll placed along one of the sides of the model landscape. Another method involved asking each child to select one picture and then to indicate where the doll must have been located in order to take the picture. Finally, Piaget presented each child with three cardboard model mountains and asked him to reconstruct their relationships with respect to a view of the model landscape in a given picture.

Since Piaget described this three-mountain task in 1956, there have been numerous studies which have sought to test Piaget's assumptions about spatial representation.[14] Generally speaking, these studies have supported Piaget's contention that children experience a sequential development of concepts of space, and that the ability to conceptualize space is a relatively late developmental product. It remains unclear, outside the context of Piaget's theory, what the three-mountain task actually measures. For example, we are unsure what behaviors converge at the moment when visualization or spatial representation occurs. Moreover, we have yet to devise ways of knowing how perceptual factors and operational processes interact when a child is given the task of imaginatively transforming a spatial pattern into another visual arrangement. For these reasons it may be well to keep in mind the fact that the behaviors required by Piaget's three-mountain task may not necessarily be *all* the behaviors required for the act of visualizing spatial arrangements in a different context.

Despite these reservations about the three-mountain task, the following review of research is organized in terms of three kinds of experiences which the writer suspects converge at the moment of visualization: (1) the composite of abilities and experiences which a person brings to the visualization task; (2) the shaping of these abilities and experiences by display or contextual variables; and (3) the expression of this interaction between abilities and contextual factors in some symbolic form. Rather than discuss these three kinds of experiences in terms of Piaget's three methods, we shall focus, for the most part, on the method requiring children to compare successively a series of pictures of the landscape model with the actual model itself, and then to specify where the camera must have been located when each of the pictures was taken.

Even this limitation of focus to one task, however, has only the rough effect of limiting the number of variables within each of the three kinds of experience. A child still brings to the visualization task a "set," a manner of deploying and maintaining attention, a means of transporting information to and from memory, and highly individual procedures for coding and processing visual information. Similarly, the contextual or display variables still include the number of elements which make up the task, the apparent organization of these elements, the discriminability of these elements, and the number of observations and responses required of a person. Finally, our symbolic experience includes a variety of means we use to designate objects, scale, or spatial

relations according to the conventions peculiar to maps and similar two-dimensional representations.

Given the length limitations of this chapter, this review is restricted to specific areas within each of these three kinds of experience. For example, we shall discuss some perceptual studies, some theoretical considerations about imagery, some studies of physical variables, and some cultural studies under the heading "Individual Abilities and Experiences." Under "Contextual Variables," there is discussed some research on the effects of different object arrangements (landscape models), photographic variables, and instruction upon children's performance of the visualization task. Finally, under the "Symbolic Variables" heading, we discuss two research efforts which hold particular promise with respect to spatial reasoning.

Individual Abilities and Experiences

In our preoccupation with developing a logically coherent curriculum, many of us tend to pay more attention to the tasks which we pose children than to the differences in the abilities and experiences which the children bring to the tasks. Considering the difficulties attending the definition of spatial visualization, however, this has not been the case. More attention has been paid to abilities and experiences required for successful performance on the visualization task than to the ways in which this reasoning behavior might enhance the curriculum or be incorporated into instructional strategies. In this first section of the review, we discuss four groups of variables (perceptual, imaginal, physical, and cultural), and comment on a few areas of research within each group.

PERCEPTUAL VARIABLES

A systematic examination of the literature on perceptual development reveals that presently it contains a large number of "status" studies (assessing one visual dimension across ages), a growing number of "preference" studies, and a comparatively few studies of visual training within an age group.[15] From this literature, however, it is possible to make some general statements about differences between adult and child perceptions. Gibson and Olum, for example, have provided us with just such a summary or baseline of characteristics. In general, they state that a young child's perception is: (1) highly sensitive to feelings; (2) easily stuck or fixated; (3) closely related to actions; (4) dif-

fusely organized; and (5) closely tied to the child's own viewpoint. Elaborating upon these characteristics, Werner noted that "a young child's perception is organized around a minimal number of cues." [16]

These characteristics of children's perceptions may explain, in part, the difficulty children have with such complex perceptual tasks as spatial visualization. Without reviewing the developmental literature further, it seems clear to this writer that there are two kinds of research activity which are particularly relevant to the study of spatial visualization: studies of cross-modal learning, and studies of visual search and recognition. Presumably, research on cross-modal learning may eventually tell us something about the ways in which people integrate different kinds of information across senses; research about visual search and recognition may indicate the ways in which children select and process different kinds of visual information.

The notion of cross-modality, or intersensory learning, is actually a very old one in philosophy and psychology. Underlying cross-modality research is the assumption that some kinds of sensory experience depend upon others for their meaning (vision allegedly gains meaning from touch, for example), and that the senses, originally separate and specific, become progressively integrated with increasing age. Although much has been learned about this progressive integration in the past decade,[17] we still know comparatively little about age changes in perceptual activity, or about the kinds of exploration which children use when making intersensory judgments of comparisons.

Cross-modality research is particularly relevant with respect to Piaget's theory of intelligence and his visualization task. Piaget contends that children's initial "knowledge" of objects and their relationships is achieved through their acting upon those objects. With further growth, physical action is complemented by imaginal action. Images, for Piaget, are deferred action which have been internalized. Since his visualization task requires both perceptual and imaginal behavior, we need to know more about the interaction between physical actions and imagery at the moment of visualization. Moreover, we need to know more about the ways in which different cross-modal actions affect imaginal manipulation.

Studies of visual search and recognition are also important to visualization for what they can tell us about how children select and process visual information. On one hand, there is a growing number of studies of form perception [18] which indicate that young children generally are

confused by figures with intersecting lines, with forms which contain disguised or embedded figures, or with forms that share boundaries. For some reason, perhaps schooling, these confusions tend to disappear with increasing age.

On the other hand, there have been some Russian and American studies of eye movement activity in the identification of objects or forms.[19] Bruner and his associates, for example, filmed the eye movements of children and adults as they examined pictures presented in differing degrees of focus. Generally speaking, they observed that younger children used an almost random mode of search for significant detail, restricting themselves to a very small part of the visual field and returning again and again to the same kinds of detail. Often, when attempting to recognize objects in pictures in different degrees of focus, the child recognized not the real identity of the object but his own previously wrong identification, and this served, as before, to block correct recognition.

With older children, more objects or features are reported, but with little mind as to their relationship, or how they might be combined as a basis for further discovery. With still further growth, Bruner noted that properties of the whole picture became increasingly important, serving to shape hypotheses about identity and relationships and to correct error. Older children begin attending to empty space as well as filled space; they begin to shift their preoccupation from features and objects to that of the context which defines relationships.[20]

In addition to providing further information about the perceptual development of children, these findings suggest research concerns with respect to Piaget's visualization task. For example, we need to know more about the conditions which affect children's search patterns and recognition of relationships in superimposed displays. Moreover, we need to know more about the possibility of "training" children's search patterns to achieve a more effective processing of visual information about complex displays.

Imaginal Variables

One of the most interesting developments in contemporary psychology in the past decade has been the change in attitude toward imagery and the role of imagery in thought. As Piavio has observed, the negative attitude that Watson fostered with regard to imagery has softened, and the concept of imagery has received considerable attention from theo-

rists of diverse interests.[21] Piaget, in a recent essay on imagery, suggests that this revival of interest stems from at least three sources: psychophysiological studies and psychopathological observations which have revealed some of the conditions governing the production of imaged representations; theoretical considerations which have led a number of theorists to argue that images need no longer be interpreted as extensions of perception but can be regarded as a symbolic system in their own right; and finally, studies in child psychology which have stressed the role of imagery as mediation between actions and thought.[22]

For more than fifty years, the majority of American psychologists have concentrated their efforts on defining thought in terms of language or verbal processes. Piavio, in a recent essay, points out that implicit verbal processes are no less inferential than are images: "One can respond verbally to pictures as well as to words, and so, by analogy, one's verbal response could just as logically be mediated by a 'mental picture' as by 'mental words.' Both are inferential."[23] Piavio goes on to suggest that images can be regarded as symbolic processes which are linked developmentally to associative experiences involving concrete objects and events. Indeed, he argues that verbal and visual processes can function as alternative coding systems or modes of representation. He explains that:

> These may be relatively directly aroused in the sense that a concrete object or event evokes a perceptual trace, and a word, an implicit verbal response. Or, they may be associatively aroused in the sense that an object elicits its verbal label, or memory images of objects of the same class; and a word, if it is concrete, arouses an object image.[24]

The two coding systems differ, however, with respect to memory functions. Visual memory codes appear organized to represent the environment spatially, whereas verbal memory codes appear organized so that at any point in time items of information may be retrieved in a fixed order. As Hebb points out, differences in the possession of imagery may not reside in the mechanisms of thinking but rather in the retrievability of the image.[25]

The role of imagery in visualization is by definition obvious but, by empirical analysis obscure. The child, to perform the visualization task successfully, must hold an image of the landscape in mind while he looks at transformed relationships depicted in pictures. At the present time, we are only beginning to learn what conditions facilitate image building or image maintenance in children.[26] The writer believes, how-

ever, that the resurgence of interest in imagery will generate an impressive increase in research activity. If this is the case, then we may know considerably more about imagery and its part in visualization before another decade is over.

PHYSICAL VARIABLES

Most of us take for granted that sex, IQ, motor coordination, hand/eye dominance, and other physical variables influence the way in which children perform on mental tasks. However, there seems to be little in the literature which bears specifically on the relationship between these variables and the performance of children on Piaget's visualization task.

Take, for example, sex differences. Although many observers have stated that boys outperform girls on spatial tasks,[27] it is difficult to support this conclusion in terms of studies of the visualization task. Indeed, in many studies there is no mention of sex differences in performance, although it is clear from sample descriptions that the investigators have thoughtfully included roughly the same number of boys as girls.[28]

The relationship between standardized IQ scores and children's scores on the visualization task is somewhat less equivocal. In general, children who perform well on the spatial tasks of standardized IQ tests also perform well on the visualization task.[29] However, there appears to be little data on the relationship between specific spatial tasks and the visualization task itself. Although such tests as Thurstone's Space Test, the Kuhlman-Finch Space Test, the Minnesota Paper Form Board and the Flags Test allegedly measure visualization, the writer has not seen a systematic attempt to establish their relationship to Piaget's visualization task. There is some evidence that the Draw-A-Man Test and the Beria Gestalt Test correlate with children's visualization scores, but these correlations are not high.[30]

Within Piaget's context, it is interesting to note that mentally retarded children apparently follow the same developmental sequence in the achievement of spatial perspective, although their rate is much delayed.[31]

The relationship between hand and eye dominance, and success with various visual tasks, has fascinated many for several decades.[32] Children in the first grades of school are often extremely adaptable about the hand or eye they choose to use for visual and motor tasks. With respect to Piaget's visualization task, many observers have noted that children will hold a photograph along one side of the landscape model before

making a judgment about the camera's location. If the child happens to be right-handed but prefers to "sight" with his left eye, it is possible that it will take him longer to unscramble relationships than a child who is clearly right-handed and right-eyed. The work of Zigmond,[33] Frostig,[34] Myklebust and Johnson,[35] and Harris[36] either may help clarify such confusions, or at least help us to specify some needed distinctions between neurological immaturity and different kinds of learning disability.

Finally, there are a number of other relationships between physical variables and the visualization task which deserve further study. For example, younger children frequently resort to an almost random judgment pattern after the first four or five pictures. Other children, by contrast, demonstrate the most remarkable persistence with respect to paying attention to detail over the whole series of pictures. Given such differences, it would be interesting to ascertain whether children with great persistence also display Kuhlman's "high imagery,"[37] and whether this relationship changes with increasing age. Similarly, it would be interesting to determine the relationship between persistence and children's scores on tests of intuition,[38] or children's ratings on Kagan's "reflective-impulsive" continuum of cognitive style.[39]

Cultural Variables

In this last of the four groupings under "individual abilities and experiences," we refer to the growing literature on cognitive behavior across cultures, and mention two studies of differences within our own culture.

It seems highly plausible to argue that because different cultures support some behavior patterns and punish others, children from these cultures will bring to the visualization task different patternings of abilities and experiences. This argument, however, is based on the assumption that there are universal characteristics to cognitive development, and that it is these universals which are shaped by different cultures. It could well be that there are a great many kinds of cognitive development possible, and that we have been trying to account for intellectual growth from too narrow a viewpoint. Greenfield makes this point in another way. She observes that:

> The study of intellectual development has been confined almost entirely to members of our own western societies. Our richest picture of cognitive development, that drawn by Jean Piaget, is based entirely on experiments

in which age alone is varied. In his view, cognitive maturation is made to appear like a biologically determined and universal sequence. While Piaget admits that environmental influences play a role, the admission is *pro forma* and inventive experiments remain confined to American and European children, usually middle class at that.[40]

Where Piaget's work has been extended to non-Western societies, the emphasis has been largely upon conservation tasks, and upon age differences in the development of "foreign" children.[41] In the last five years, however, the meager literature on cross-cultural studies of perception has been enriched by a few studies which have sought to establish response differences between children from diverse cultures to a number of non-verbal tasks.[42] Unfortunately, where these tasks have been Piagetian ones, they rarely have entailed spatial visualization.

Within Western society, the cross-cultural picture is not much clearer. There are efforts in the literature which have sought to establish differences between the perceptual development of children of remote (Eskimo) as against children of a highly suburban (Cambridge, Mass.) environment. There have also been a few studies which have sought to compare the perceptions of children with and without the benefits of formal schooling. Maccoby and Modiano, for example, summarized such differences between rural and urban Mexican children by saying that:

> . . . there is indeed a patterning of growth going on in the child between eight and twelve with respect to his approach or resistance to equivalence judgments, his preference for attributes, and the manner of specialization in the use of his mind. The perceptual, concrete, difference-sensitive village child is by age twelve in sharp contrast to the more abstract functional, similarity-sensitive cosmopolitan child of the same age.[43]

Of greater relevance to our understanding of visualization, perhaps, is the work of Pinard who has studied 700 French-Canadians between the ages of two and twelve. He reportedly has carefully cross-matched his sample for sex, socioeconomic level of the parents, and achievement in school. His battery of tests includes spatial tasks requiring visualization in keeping with Piaget's theory. His results may be published during 1970.

Within our own country, there has been a rapid increase of research with respect to the mental abilities of children from different social class and cultural groups. In part, this research, stimulated by concern for the "underprivileged" child, has benefited from three decades of efforts to develop "culture-fair" tests of ability and achievement. To cite one

example of this research, Lesser [44] studied the patterns of mental abilities of children in the first and third grades from different ethnic groups and social class backgrounds. He found, among other things, that ethnic group affiliation strongly affects the patterning or organization of mental abilities of children. Once the specific patterning of an ethnic group emerges, social class variation does not alter this basic organization. Moreover, Lesser found some interesting variations in the overall mental performance of children from four ethnic groups. Chinese children ranked first, Jews ranked second, Puerto Ricans third, and Negroes fourth. These rankings, while interesting in themselves, may be especially provoking to those who feel strongly about Jensen's conclusions concerning IQ and scholastic achievement.[45]

To summarize the first section of this review, it seems clear that a person brings to the visualization task a host of different abilities and background experiences. It also should be clear that we need to know much more about the cumulative influence of these abilities and experiences upon tasks requiring spatial reasoning. Presumably, the more we can learn about particular abilities and cultural influences, the more we can do about them.

The identification of abilities and experiences, however, is only one part of a much larger and more complicated research problem. We also need to know more about the ways in which these abilities and experiences interact with particular stimuli or combinations of stimuli. Specifically, if Piaget is correct that "just as thought organizes itself by adapting to objects, so the presence of objects forces thought to organize itself." then we need to know more about the ways in which different presentations of objects or object patterns affect children's spatial visualization.

Contextual Variables

It is the writer's impression that the literature about spatial perception contains an almost overwhelming number of studies of two-dimensional discriminations. This emphasis may well be explained by the psychologist's desire for adequate experimental control and by the many difficulties he encounters when trying to control the variables of a three-dimensional display. One long-term consequence of this emphasis, however, is that comparatively little is known about the effects of three-dimensional or superimposed stimuli upon children's thought patterns.

In this second section of the review, we bring together some research about three kinds of display or contextual variables (landscape, photographic, and instructional) which are particularly relevant to the visualization task. The discussion of these three kinds of contextual variables will also include comment about needed research.

Landscape Variables

In most studies employing the visualization task, children are encouraged to inspect the landscape model closely before being presented pictures and asked to make judgments about camera locations. Interestingly enough, there appears to be remarkably little uniformity in the construction of the landscape models which children inspect. In some studies, the baseboard of the model is square or rectangular, the "mountains" vary greatly in size and shape, and the landscape appears very "naturalistic" or without artificial cues (toy animals, houses, etc.). In other studies, the baseboard of the model is circular, the "mountains" are approximately the same size or are represented by geometrical shapes, and the landscape appears "simplified" or enhanced by obvious cues. Clearly, these differences in landscape construction may account for variability in the responses of children of the same age, as well as for differences in the performance of children of dissimilar ages.

After watching several hundred children attempt the visualization task with a "naturalistic," rectangular landscape model, the writer is convinced that the size, shape, number, and organization of the "mountains" strongly affect the ways in which children respond to the task. In a sense, the behaviors required by the visualization task are the same as those required by the classical problem of figure-ground perception. As Witkin,[46] Bruner,[47] Gibson,[48] and others have observed, young children are apt to respond to the attributes or features of the "figure," while older children respond more to the less obtrusive "ground" or base patterning. The visual field in the visualization task, however, is not divided into two unequal parts as in most figure-ground tasks. To perform successfully on the visualization task, children must perceive and maintain the "figure" and "ground" or features and base patternings of both the model and each picture.

The visualization task, in other words, is more complicated than most figure-ground tasks because children must penetrate visually two sets of figural features in order to determine the critical spatial relationships from two sets of patternings or "ground." Older children may perform

better than younger children because they identify an object patterning in the picture, and then find a comparable patterning in the model by first registering but then ignoring a succession of "feature" levels. Younger children may be less successful because they do not choose a significant patterning, or because their visual penetration is distracted by such features as the sizes, shapes, or colors of "mountains" at a more surface level.

In addition to variations in the construction of landscape models, the writer has found great differences in the amount of movement permitted children during the visualization task. In some studies, the children are firmly seated at one side of the landscape, and are not permitted to move about the model once the pictures are presented. In other studies, children are permitted to move around the landscape model or, depending upon its construction, the model may be built to revolve freely. In any case, differences in the amount of movement can clearly result either in differences in the amount of information about the model which is available to children during the task, or in differences in the kinds of "feedback" about correct judgments which children make during the course of the task. The combined effects of information and feedback could easily be related either to young children's distractions by surface or figural features of the landscape, or to their repetition of wrong judgments despite new information about the model.[49] Perhaps Vurpillot is correct in concluding that young children stop processing visual information before they tax their processing capacity, and that older children perform better upon complex visual tasks because they have greater capacity for processing.[50]

In short, it seems plausible that the differences in landscape construction, and in the amount of movement permitted during the visualization task, are two kinds of display, or contextual variables, which deserve further study. In any case, they represent two obvious ways in which the "presence of objects" may well force children's thought to organize itself in different ways.

Photographic Variables

The use of photographs in the visualization task introduces an imposing number of contextual variables which can affect children's processing of visual information. Presently, however, we possess remarkably little data about the effects which distance, altitude, light and shadow, color, or central focusing of pictures have upon children's

performance of the visualization task. These "mechanical" variables merit attention inasmuch as several investigators have noted that, despite efforts to control camera distance, altitude, and central focusing, each picture in their task series has served as an independent test from a statistical viewpoint. In fact, a number of investigators have noted that, despite the logical expectation that certain pictures would be "easier" than others, no such sub-groupings or sub-tests emerged. Although this lack of inter-picture relationship may be a consequence of the complexity of the visualization task, the writer suspects that it also reflects great variability in the pictures themselves.

Rather than discuss these "mechanical" variables further, however, it appears preferable to consider some problems posed by pictures as being a separate class of representation.

Although many adults take for granted that "a picture is worth a thousand words," it has not been demonstrated that two-dimensional pictures convey the same information as three-dimensional displays. The intelligent viewing of a picture requires knowledge of pictorial conventions on the part of the viewer, conventions which enable us to re-present objects distinct from and independent of their actual physical referents. It is possible that young children must learn habits of selective attention to certain kinds of visual information and, in the absence of some characteristic information about solid objects in the pictures, it is possible that they must learn a special attitude toward pictures as well. Differences in knowledge of pictorial conventions, in other words, might well affect the ways in which children view pictures or compare pictures with the landscape model in the visualization task.

The existence of pictorial conventions has been demonstrated in a number of ways. Hudson, for example, studied the role of education as it influenced the spatial judgment of Bantus and other Africans, both black and white and of differing ages. He presented pictures and outline drawings to his subjects, keeping constant relative size differences, superposition, and perspective. When a subject reported that the antelope was closer to the hunter than the elephant, he recorded this response as three-dimensional.

Although none of his subjects had difficulty identifying the pictured objects, Hudson noticed some striking differences among the responses recorded as three-dimensional. School-going subjects, for example, reported depth more frequently than illiterates or subjects living in remote places. Hudson concluded that judging depth in pictures requires

both habits of attending to pictorial information and a learned attitude about pictures.

With respect to spatial visualization, Deregowski presented Bantus with a landscape model, and three pictures of that model taken from different viewpoints. He concluded that Piaget's developmental account was inadequate, and that the Bantus' difficulties with this visualization task were primarily due to their unfamiliarity with pictorial materials.[51]

Closer to home, Sigel and his associates have studied classification problems with five- and six-year-old children from lower- and middle-class environments. In one study, he presented each child with two sorting tasks involving three-dimensional, life-sized objects (a pipe, pencil, etc.), and two-dimensional pictures of the same objects. Lower-class children differed from middle-class children with their grouping by pictures, but not by the objects themselves.[52] More recently, Shantz has tried to overcome this response difficulty by presenting lower-class children with models exactly like the standard but at different orientations. Finally, in the writer's own research, he has observed that many young, middle-class children do not appear to know what they are supposed to be looking for in the pictures of the landscape model which he presented them. Given the fact that all pictures were taken from the same altitude and from the same distance from the landscape model, the writer observed that most of these children did not know that mountains which are the largest in the pictures are also apt to be those closest to the camera when the pictures are taken. Even when this relationship was pointed out, the children's judgments about picture location did not become more accurate. Interestingly enough, most of these children claimed that their parents both owned and used cameras at home.

These few observations about photographic variables are intended to underscore our limited knowledge about the nature of pictorial conventions, and about children's responses to pictures. With respect to the visualization task in particular, we need to clarify the ways in which pictures affect children's reasoning about spatial relationships.

Instructional Variables

The growing body of literature about "task" or "response" variables suggests that it would be foolish to underestimate the ways in which the presence of an adult, the language used in the instructions, or the manner in which we present the visualization task might affect children's organization of thought or the strategies they might use in spatial reason-

ing. Certainly, the investigator's concern for accuracy in recording children's responses is an attitude quickly sensed by most children. Similarly, the language of multi-staged task instructions can often preoccupy children with a fear that they "might miss the next step," a preoccupation which may seriously interfere with their processing of visual information.

Rather than attempt to review a large number of such instructional variables, this discussion is limited to some particular problems which stem from the language used in the instructions, and to some effects which schooling appears to have upon children's responses to instructions.

As Epstein once observed, in well-designed developmental studies of perception, the task instructions ought *to be* the same and *mean* the same to all children, regardless of age.[53] Those of us who have worked with young children know that this is a difficult criterion to meet. Particularly with respect to the visualization task, instructions which ask children to "find the place on the landscape which has the same view as the picture" may sound simple enough, but may mean different things to children of different ages. For example, Vurpillot has observed that young children's crit for judging whether two views are the "same" are based upon one or two details only; older children's criteria are quite different.[54] Therefore, while the above instructions may seem the same to the adult, they actually may mean different things to children of different ages.

There are, unfortunately, no magical formulas for generating instructions for children which contain language that both means the same thing and is stated in the same way. An alternative, of course, is to devise methods of presenting task instructions in non-verbal forms. Corsini, for example, has studied the effect of verbal and non-verbal instructions on the retention capacity of kindergarten children who were presented a task requiring the manipulation of familiar objects. In general, he found that when non-verbal cues were presented simultaneously with verbal instruction, retention was significantly greater than with verbal instruction alone. Whether these non-verbal cues would interfere with an older child's spatial judgment remains to be seen.[55]

A different but related problem with task instruction has to do with the effects of schooling upon children's responses to instruction. In this writer's own research, he was once surprised to find that, contrary to Piaget's account, many of his pre-school children were outperforming

school-aged children on the visualization task. This discrepancy was puzzling until he watched a friend test children from both groups. The pre-school children were literally following the eye movements of the "instructor," while the older children were responding to the language of the "instructions." This difference in response to instruction raises some interesting questions about the validity of pre-school children's responses to many of Piaget's tasks.

To summarize this second section of this review, it should be evident that, in addition to differences in abilities and experiences, we must take into account a large number of contextual variables when considering any form of reasoning behavior. It should also be apparent that only a small number of display or contextual variables have been mentioned in this review, and that before we can make some substantial gains in our knowledge about visualization, we need to know a great deal more about the landscape models we construct, the photographs we present, and the instructions we give.

Symbolic Variables

One further kind of experience, present when visualization occurs, remains to be considered. Here we refer to the interaction between abilities and contextual variables, and the child's expression of this interaction in some symbolic form. As indicated earlier, one of the most interesting developments in psychology in the past decade has been the change in attitude toward imagery and its role in thought. As Piaget has observed, a number of theorists have recently argued that images need no longer be interpreted as extensions of perception but can be regarded as a symbolic system in their own right. In the remainder of this review, we will comment upon this argument and indicate two ways that it might have meaning with respect to Piaget's visualization task.

As Kessen has noted, the heavy outpouring of new data about human behavior in the past decade has overtaxed the simple models we have to account for it. This is particularly true with respect to data about cognitive or higher mental processes. The pressure of data has forced many psychologists to redefine phenomena, and to search for new models or metaphors of the mind.[56]

Some psychologists have found value in regarding the computer as a profitable metaphor of mind. From their work, we can extract a basic distinction between coding systems and the programs which make use of the systems. In terms of geography, the parallel distinction is between

knowing the symbolic conventions peculiar to mapping, and possessing the visualization ability needed for making maps. As most of us know, it is quite possible for children to learn to read and to interpret the symbolic conventions of maps without ever learning how to make maps. Computer scientists, in other words, have helped many to recognize the fact that knowledge of symbolic convention does not necessarily entail the ability to reason in terms of those conventions.

From a somewhat different vantage point, psychologists interested in information processing have helped us to divorce the concept of "symbol" from its traditional verbal connotation. A symbol can be regarded as being any kind of coded information. Similarly, the term "language" can refer to any number of symbolic systems. Myklebust and associates, for example, have been interested in the different kinds of coding which occur in the two hemispheres of the brain. Such non-verbal "languages" as mathematics, music, spatial relations, etc., appear to be related to the predominantly non-verbal or right hemisphere, for example. "Language," in other words, refers to the conventions which govern a coding system.

Thus, it is now possible for such researchers as Piavio, Hebb, and Piaget to argue that visual and verbal processes may serve as alternative coding systems or modes of representation. Contrary to Bruner, visualization may not require the translation of imagery into some verbal formula "to shield the child from the distracting appearance of the perceptual array." [57] Indeed, the spatial reasoning demanded by the visualization task may be impeded by cross-coding when verbal instructions are presented to younger children. Similarly, when young children are confronted by a task requiring imaginal symbolic manipulation, they may be confused by the combination of perceptual organization of the display and the logic which is so closely associated with the structure of language.

Of course, it is one thing to argue that a symbol may be a reduced and coded image. It is quite another and more difficult task to specify the conventions and constraints of an imaginal symbolic system. In terms of how such a system might affect the visualization task, however, two research efforts are worth mentioning. In both cases, these efforts take their cue from verbal reasoning or linguistic work.

Huttenlocher studied the ways in which people represent to themselves the premises of a three term syllogism. (If John is taller than Phil, and Tom is shorter than Phil, then the tallest of these three is

John.) She found further evidence that people create imaginary spatial arrays in a manner analogous to the way they would build actual spatial arrays with real objects. Moreover, she found that people attributed mistakes in reasoning to difficulties in constructing accurate arrays, not to difficulties in obtaining answers from them.[58]

The visualization task can also be regarded as requiring a three-term form of syllogistic reasoning. The first premise could be the spatial relations held constant from display to image; the second premise could be the spatial relations held constant from photograph to image; and the conclusion might be the "reading off" of superimposed images in the form of a judgment. In any case, Huttenlocher's work provides an interesting starting point for speculation about the kind of reasoning required by the visualization task and its mode of expression.

Another research effort worth noting entails the various attempts at writing the syntax for three-dimensional arrays, and for all their possible transformations. The "syntax" in this case refers to the basic, underlying rules which govern our perception of spatial relationships between objects. Using a tachistoscope and very short exposures, for example, it is possible to present a series of "sliced" or "parsed" segments of a three-dimensional display and, having previously calculated the memory load required by each segment, to observe the ways in which a person integrates the array and then makes judgments about different viewpoints of the display. It is possible, in other words, to write the perceptual "grammars" of people in much the same way that linguists write the verbal grammars which people use in speaking. Moreover, it is also possible to compare the rule sequence used by "able" visualizers with that used by "poor" visualizers. Presumably, if we know where a child is using an inappropriate rule, we may be able to intervene and to teach him a more efficient sequence.

To summarize this final section of this review, it should be apparent that the expanding research in computer science and psycholinguistics has provided us with a number of interesting ways to view the structure and expression of children's spatial reasoning. The purpose of this review has been to bring together fragmentary and often diverse kinds of research which has bearing on children's spatial visualization. Although only a few variables were touched on with respect to the abilities and experiences which a person brings to a visualization task, their interaction with contextual variables, and their expression in some symbolic form, it should be clear from this review that enough research has

already been done to serve as a springboard for further study of visualization as a form of spatial reasoning. Such study has direct relevance to geographers, geographic educators, and psychologists alike.

Relevance

To the geographer, the study of spatial visualization has implications which pervade the whole discipline. Although geography itself has been described in terms of interest in land-man interactions, earth science, or regional characteristics, geographers continue to express these interests through the medium of maps and similar graphic displays. Throughout history geographers have used maps to orient themselves and to record variations in physical or cultural behavior. Maps, as the representation of spatial arrangements of objects or events, are the common medium of geography; indeed, the geographer's concern with spatial relationships and spatial reasoning should be of concern to all who study geography.

To the geographic educator, the relevance of research about spatial visualization is somewhat more obvious. As the writer understands the situation, the social studies curriculum has largely confined the study of spatial relations to geography, and the study of maps to skill learning. Under this scheme, map skills have come to mean the ability to manipulate the symbols peculiar to maps (to the exclusion of map making), and have been further diminished in importance by being relegated to a skill group which includes the reading and interpreting of charts and graphs. A critical weakness of most map skill programs is the presupposition that knowledge of symbolic conventions necessarily entails the ability to visualize the spatial arrangement of the objects represented.

Further study of spatial visualization could well affect the strategies we use to teach geography to children. The purpose of such research would *not* be to make all children practicing geographers, but rather to teach them to observe their immediate world more intelligently. Such an emphasis would be in keeping with a tradition which is already part of the curricular history of geography.

At the turn of the century, the geography curriculum for the schools was strongly influenced by the German preoccupation with "home" geography and its emphasis upon field experience. Richard Dodge's *Journal of School Geography* helped to convey this preoccupation to this country, a focus of interest which was later shared by Edith Parker and, more recently, Neville V. Scarfe. While the emphasis on field

experience has waned, interest in visual training has persisted. One recent expression of this interest is evinced in the work by Blaut and associates with aerial photographs and mapping.

Another expression of this curriculum tradition might be the inclusion of visualization tasks. The writer is convinced that the teaching of geography would benefit if children were provided fewer games requiring skill in symbolic manipulation and more tasks requiring spatial reasoning.

To the psychologist, the study of spatial visualization offers some unique opportunities to explore a form of perceptual-imaginal reasoning. As Piaget observed, spatial visualization requires the ability to perceive and to imagine an arrangement of objects from different viewpoints. To achieve this ability, the child must become conscious of his own viewpoint and to liberate himself from it. In the opinion of the author, this achievement is more than a developmental landmark; it distinguishes man from all other animals on the phylogenetic scale.

> Man has gone on to his own greater freedom — and bewilderment — by learning to conceptualize about concepts, to think about his thoughts. Man is distinguished from the ape not by his ability to reason, at which the ape is often no slouch, but by his meta-reason or his capacity to think about his own thought.[59]

Visualization, in short, is a form of thinking about thought which deserves encouragement and support from all concerned with the nature of thought and its stimulation.

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Chapter 11

Developing and Using Behavioral Objectives in Geography

Ambrose A. Clegg, Jr.

One of the newer trends in the teaching of geography is the effort to specify instructional goals in clear, precise terms. It is based on the assumption that the clearer and more precise are a teacher's objectives, the more effective will be the instruction and the more likely that student learning will occur. This approach seeks to specify objectives in terms of the student's performance or behavior that are readily observable and measurable, and that can be easily evaluated by a criterion measure of acceptable performance. Thus the name, behavioral (or performance) objectives.

In the past one could pick up almost any curriculum guide or teachers' manual and find instructional objectives written in familiar terms:

- to know the major rivers, capital cities, and chief products.
- to understand the growth of large cities.
- to appreciate the importance of transportation routes to the settlement of the West.

Although such terms as *to know*, *to understand*, or *to appreciate* were commonly used, they provided little help to the teacher as to what learning activities were actually intended, or how one was to know if or when the goal had been satisfactorily accomplished. Because

the terms were so ambiguous, they meant many different things to different teachers. Evaluation on the basis of some common criterion was virtually impossible. In contrast to the vagueness of this older style, the behavioral objective employs a precise formula for writing instructional objectives. Each must contain the following elements:

1. The *person* who is to perform the particular learning behavior (e.g., the student, the learner, the class, a small group, a committee).
2. The *specific behavior* required to demonstrate accomplishment of the objective (e.g., to write, to name, to construct, to locate).
3. The *learning outcome* or product by which the accomplishment of the objective can be evaluated (e.g., a statement of fact or a generalization, a contour map, a simple grid system).
4. The *conditions* under which the behavior is to be performed (e.g., with the aid of an atlas, using data from the 1970 census).
5. The *criterion* or standard used to evaluate the accomplishment of the performance (e.g., correct to the nearest mile, four out of five correct).

Using this format, a behavioral objective in geography might thus be stated:

> Given data from the 1960 and 1970 censuses, the students will be able to construct a bar graph showing the change in population for the following cities: New York, Chicago, Detroit, Cleveland, St. Louis, and Seattle. Data will be correct to the nearest ten thousand.

From this brief explanation, and the above example, one can see more easily the basic purposes for writing instructional objectives in behavioral terms. Exact specifications help to delimit the scope of available content and require that curriculum designers and teachers make explicit decisions about what to include and what to exclude. Such explicitness also makes the learning process and its outcomes open to inquiry so that both objectives and methods can be modified if outcomes are not achieved. But perhaps of greatest value is that the statement of the objective contains the elements needed for evaluation of the learning outcomes in the initial definition of the task. Content, materials, learning process, outcome, and assessment are all linked together in a single statement designed in advance of the instruction. Instead of being a casual afterthought, evaluation measures for determining the accomplishment of the objective are as equally important as the selection of content and materials.

As novel as all of this may seem, the concept of writing instructional objectives in behavioral terms is really not new at all. Behavior descriptions were carefully developed by the evaluation staff of the Eight Year Study.[1] Kearney's[2] study on *Elementary School Objectives* and French's[3] *Behavioral Goals of General Education in High School* both worked out comprehensive sets of social, intellectual, physical, and emotional goals stated in behavioral or performance terms. Bloom[4] and Krathwohl[5] have developed taxonomies, or systems, for classifying educational objectives for the cognitive and affective domains which identified specific skills and processes of learning and related each to observable measures of behavior. Stemming from quite a different tradition, the principles involved in the writing of materials for programmed instruction required the very clear specification of the desired student response and the appropriate stimuli (frames) needed to produce that behavior.[6] However, if any single factor could be cited as perhaps the most influential in the trend toward writing objectives in behavioral terms, it would probably be the publication of Mager's[7] little volume, *Preparing Instructional Objectives.* Popham[8] later amplified Mager's work with a filmstrip and audio-tape package. Both of these have since been widely used in pre-service and in-service teacher training programs. The development of behavioral objectives, including a number of controversial issues surrounding their use, is discussed at length in the report of a symposium sponsored by the American Educational Research Association.[9]

Developing Behavioral Objectives in Geography

The technique of writing behavioral objectives is at best only a technique. It is a *means* to a more precise method of stating instructional objectives; it is not an *end* in itself. A number of appropriate ends or goals of geographic education have already been suggested in the preceding chapters. Briefly stated, these take the form of:

1. *Content (or product) objectives* which involve the development of important facts, concepts, and generalizations selected from various aspects of the discipline of geography.
2. *Learning process objectives* which include a wide range of cognitive and affective activities such as comparing, contrasting, predicting, forming hypotheses, valuing, and decision making. Also included are particular geographic skills such as interpreting map symbols, locating a place by its grid coordinates, estimating dis-

tance using a scale of miles, or using longitude and time zones to determine local time.

It is the job of the classroom teacher, or the curriculum designer, to select those that are most appropriate for the broad-range educational goals, and to arrange them in an appropriate sequence from K-12. For the purposes of this chapter we shall assume that the reader has already chosen a number of content and learning process objectives. Our task now is to state them in language that is clear and precise and that will communicate to all concerned the intended outcome of the objective.

BASIC CHARACTERISTICS:

Several basic characteristics are essential to writing instructional objectives in behavioral terms: (a) the objective describes an intended outcome; (b) it is stated in behavioral or performance terms using a strong action verb; (c) necessary materials or conditions are specified; and (d) a criterion of acceptable performance is stated. Each of these basic characteristics is discussed below.

(a) *The intended outcome* is the result of the teacher's instruction. It is not a description or summary of content to be learned. The teacher must continually ask himself, "What do I want the students to be able to do in some observable way?" To help identify outcomes we use the introductory stem: *"As a result of this lesson the student will be able to. . . ."* Now the teacher selects both a geographic content objective and a learning process objective, and combines them so as to state the teacher's intended outcome. For example: "As a result of this lesson, the students will be able to use the latitude and longitude coordinates given in an atlas and locate correctly the following cities on a slate globe: London, New York, Tokyo." Note that the intended outcome in this example is the ability to locate the cities correctly by interpreting and applying the coordinate system. It is a combination of both a content and a process objective. It is also a relatively simple example that can be handled by children in upper elementary school grades who have had previous concrete experiences with locating places on a grid coordinate system. As noted above, there is a wide range of content and process objectives that involve complex and sophisticated learning operations. Some of these are listed below.

(b) *Stating an objective in behavioral or performance terms* means that the objective must tell what the student is *doing* when he is demonstrating his achievement of the objective. This action must be readily

observable and easily recognized by another teacher, student, or some other competent outside observer. To accomplish this, a precise *action* verb is used in the infinitive form to state what the student will be able to do. Such verbs as *to write, to measure, to draw,* or *to interpret* symbols convey the intended meaning of a terminal behavior far better than such ambiguous but commonly used verbs as *to know, to understand,* or *to appreciate*. There must be no confusion or uncertainty among observers, including the teacher himself, about the objective's intended outcome. The chief purpose of having an observable outcome is to make sure that the objective has been accomplished and student performance can be adequately assessed and evaluated.

It should be noted that many philosophic and psychological arguments have been raised about the matter of requiring an overt, observable performance as the evidence that learning has taken place.[10] It can be argued that complex and powerful mental operations may occur while a person shows no outward sign of change. Nevertheless, the point of view presented here is that we can *infer* that some kind of learning has occurred from the evidence of a student's ability to perform some certain action which (presumably) he could not do before. We assume that this observed behavior is the result of a learning process.[11]

Listed in Figure I are a number of strong action verbs classified as cognitive or affective processes or as geographic skills. These are only samples and many others can be gleaned from the chapters in Part I dealing with these topics.

FIGURE I: A Sample of Strong Action Verbs

Cognitive Processes	*Affective Processes*	*Geographic Skills*
to recall	to prefer	to construct (a model)
to recite	to choose	to draw (a map)
to describe	to believe in	to interpret (symbols)
to identify	to react positively or negatively toward	to locate (countries)
to compare		to identify (time zones)
to contrast	to respond to	to measure (distances)
to evaluate	to judge as good or bad	to determine slope
to solve		(from a contour map)
to apply	to approve	to translate (color codes)
to observe	to comply with	to show distortions of various projections
to analyze	to acclaim to react with pleasure	

Having identified a strong action verb and an appropriate geographic content objective, it now becomes a simple matter of combining them to form the basic outline of a behavioral objective: the introductory stem, the verb, and the resultant product. A sample listing is presented in Figure 2.

(c) *Specifying the conditions under which the terminal behavior will occur* is the next, and perhaps easiest step in writing the instructional objective. It identifies the curriculum materials to be used, the limits that might be placed on the task, or the basic data to be used in the development of some higher order process.

In the area of geography a variety of curriculum materials can be specified. These might include an atlas, gazeteer, encyclopedia, or

FIGURE 2: Combining an Action Verb and Geographic Content

Stem: As a result of this lesson (or unit of study) the students will be able to:

Action Verb	*Plus*	*Geographic Content or Product Objective*
to recall	.....	the names of the continents
to compare	.....	population distributions
to develop the concept	.....	population density
to apply	.....	the principles of a grid coordinate system to a hypothetical country
to estimate	.....	distances via great circle routes
to point out	.....	areas of greatest distortion on a Mercator projection
to explain why	.....	windward slopes receive greater precipitation than leeward slopes
to judge as good (or bad) *or* to make an ethical judgment about	.....	a system of land tenure
to react with sympathy	.....	to evidence of hunger or poverty
to be moved to action	.....	to improve environmental quality
to prefer (or choose)	.....	a flood control project over preservation of a district as a wilderness area or wild life preserve (or vice versa)
to develop the generalization	.....	that man's use of the land in a given region is a function of the attitudes, objectives, and technical skills of the population

census data reported in an almanac. Other kinds of tools or materials might be a slate globe, a relief map, a magnetic compass, or perhaps an inexpensive Instamatic camera for making 35 mm. colored slides while on a site visit or a field trip. With primary grade children, large rolls of wrapping paper and vivid tempera paints are ideal for helping them to make simple maps of their neighborhood or town. Older students can learn to work with marking pens on transparencies for an overhead projector. More advanced students can make transparencies with several overlays. The following is an example of a behavioral objective in which specified curriculum materials are called for:

> The student is able to prepare a map of the population density of the Seattle area based on the 1970 census data, using tempera paints to identify different levels of density.

Another way of specifying the material or conditions under which the behavior is to be performed is to provide a list of "givens" which the student must use in some special way. Most often this is a means of providing (or assuming) a basic input of data, as the basis for undertaking some more complex or higher order task. For example:

- given the following climatic conditions. . . .
- given a list of mineral resources. . . .
- given data on cost per acre and yield per acre. . . .

For example: Given data on the rainfall in Singapore, the student will be able to determine the months in which the wet monsoon occurs.

or:

The students will make comparisons and contrasts and develop a generalization in their own language which approximates the following: "Man's use of the land is determined by its physical features as perceived by man as a function of his attitudes, objectives, and technical skills." To form this generalization, students will use the comparative data previously recorded on a chart developed by the class on the cultures, natural resources, and the physical conditions of the land taking four sample countries in Latin America.

Note that in this second example the terminal behavior is the development of a generalization. The intermediate task of making comparisons and contrasts is also specified to provide a further guide as to the processes to be used in arriving at the generalization. The *type* of data to be used is specified, but the teacher or student is referred to some

previously developed chart or compilation for the exact details.[12] Generally, the list of "givens" is short and is stated first as in the earlier examples. Where the conditions are more detailed, however, the objective is written in two sentences to avoid awkward phrasing or a long Ciceronian sentence that would put the operational verb at the very end.

Another variant is to make only a brief reference to the material to be used, focusing the major attention of the objective upon a new, higher order process. For example:

> Using data similar to that gathered above, students will test out the validity of the above generalization by applying it to another country in Latin America (or to a country in some other part of the world).

Occasionally a teacher might want to limit the types of data or the materials to be used. This is helpful to focus attention on a specific skill when it is first being learned, or as a means of demonstrating proficiency in its use. Some examples include:

The student is able to:

- present an oral report aided only by 3 x 5 notecards.
- locate and draw the continents in their approximate location (or label the major oceans) without the use of an atlas or globe.
- using only a contour map, estimate the maximum height of the Pyrenees mountain range.

(d) *Criterion of Acceptable Performance.* In order to be complete the behavioral objective must state a criterion measure for evaluating the student's performance. This is usually thought of as:

> At what level did he perform the task?
> How well did he perform?

The criterion measure is a precisely stated, readily observable measure. It is often stated in terms of some minimum level of acceptable performance. This can take the form of the number of correct responses, e.g., four out of five. A time limit could be specified, e.g., the task is to be completed within 30 minutes, or within two class periods. Or to borrow the criterion measure often used in programmed instruction: 90 percent of the students will score 90 percent or better on the final test. (This criterion measure is often difficult to attain especially with newly developed materials being used for the first time; 80/80 might be a more reasonable goal.) Finally, the degree of accuracy could be prescribed: e.g., correct to the nearest whole number, or to the nearest degree of longitude.

Criterion measures can also be specified for process goals, though typically we are less accustomed to doing so. When students group observations or events in the process of conceptualizing, the criterion is that all items do, in fact, possess the same attribute at least in some degree. Similarly, the naming or labelling of the category requires only that the concept word or phrase be sufficiently abstract or general to include all the items in the group and their common properties. To be sure, one cannot be rigid in evaluating the performance on either of these processes. Students will often develop groupings that are not mutually exclusive, and some items could appropriately fit in more than one category depending upon the attributes involved and how the student has defined the common properties. Students can also conceptualize the same data quite differently, depending upon the perceptions one has in viewing the data. For example, the development of natural resources in Africa or Asia by Western nations has been referred to variously as economic expansion or as imperialism, the latter carrying strongly affective overtones. Similarly, conflicting conceptualizations are evident when data on wages or farm crop income is labelled as "minimum subsistence level" by a government bureaucrat but "poverty level" by a concerned welfare worker. In all of these cases, the teacher should encourage such divergent responses but insist upon "logical sufficiency" as the essential criterion for the validity of the different grouping or the concept name. In the same way, the criterion for the generalizations that students develop is that the inferences and generalizations are warranted logically by the data presented.

Each of the above examples has illustrated some minimum level of mastery. Given the need to individualize instruction and to provide higher levels of accomplishment for various students, several other approaches to setting criterion measures are possible. The simplest approach is to increase the quantities in the examples specified above: nine out of ten responses correct, 100 percent accuracy, or the same task completed in a shorter time. Such measures test for greater retention, accuracy, or speed of learning, but the learning task remains essentially the same. There is no qualitative increase in the intellectual level of learning (the process goal), nor in the geographic product or content goal.

Qualitative increases in the level of learning may be accomplished by specifying more complex, sophisticated, and higher order processes of cognitive or affective learnings. The nature of these processes, and

the teaching strategies for obtaining them, are discussed more fully in other chapters of this book. An excellent guide for writing instructional objectives at higher levels that is keyed directly to the levels of the cognitive and affective taxonomies was developed by Metfessel and others.[18]

Another approach to setting different levels of performance is to require a more creative approach to the task. For example, the criterion measure may be to present two or more *different* approaches or solutions to the same problem, rather than to seek a single, convergent solution. Using some of the higher level thinking processes, students may be asked to provide two or more alternate solutions in a decision-making situation, each of which might be equally feasible or would solve the problem, although one might be more preferable than another.

A note of caution should be entered here. In specifying different levels of performance, the teacher should be sure that the terminal behavior remains the same. Oftentimes when we expect students to "perform at a higher level," or to "be creative," we really are expecting them to perform different and usually more complex tasks — though we never say so explicitly. Consider the following example:

> Students will be able to interpret the data from a bar graph correct to the nearest hundred people per square mile. To obtain a higher grade, students will be able to project an estimate of the population density for the same area by 1980 using data from the 1950, 1960, and 1970 censuses.

It should be evident that though these tasks may be closely related, they really require quite different skills and abilities. The first calls for interpretation of data; the second calls for a prediction or extrapolation made from a series of other known data points. In the final analysis, the student is really performing two different tasks that should probably be left separate.

The problem of setting different levels of performance for task is almost invariably linked with the problem of establishing a norm-referenced evaluation system. The criterion-referenced evaluation associated with behavioral objectives is usually a "go/no go" system. The performance is either attained or it is not within the limits of the accuracy prescribed. The norm-referenced evaluation measure, however, asks how well a particular student performed in relation to all others in his class or group. This is usually in the form of a numerical rank order in the class, a percentile ranking on a standardized test, or more often some form of an A,B,C,D scale. Letter grading systems frequently

carry with them, at least implicitly, a number of assumptions of the normal curve related to the distribution of these grades. Specifically, the number of A grades is sharply limited compared to the number of C grades that can be given. Thus, the assessment of student performance and the school grading policies often operate from different bases. Confusing, too, is the fact that the criteria for letter grades are seldom stated explicitly. They tend to be private criteria, based on the teacher's intuitive judgment of what constitutes a desired degree or level of excellence. In contrast, behavioral objectives attempt to specify readily observable examples of the desired performance using publicly stated criterion measures. Thus, the dilemma of trying to mix criterion and norm-referenced systems of evaluation. The most practical alternative is to simply list the objectives in brief check-list form (Figures 3 and 4). An "x" or check-mark in the box in the student's column indicates that he has achieved the particular objective. The check-list also gives a good record of performance on a variety of different level objectives and is an informa ive device for reporting a student's progress to his parents. A master list compiled by the teacher provides similar data about all individuals in the group, thus offering evaluative data for determining whether curriculum objectives have been accomplished or not.

FIGURE 3: Individual Progress Repo.

As a result of this unit of work on ______ (topic) ______,

______________________ is able to:
(student's name)

		Comments
1. Recall the names of the seven continents.	x	
2. Compare the population distribution patterns of New York, Chicago, and Seattle.	x	
3. Develop the concept "population density."		
Apply the principles of a grid coordinate system to a hypothetical country.	x	See attached map completed in class

FIGURE 4: Class Progress Report

As a result of this unit of work on ______(topic)______, the students are able to:	Chris	John	Mark	Robert	Connie	Matt	Stuart	Carolyn
1. Name 7 continents.	x	x	x	x	x	x	x	x
2. Compare population distribution	x		x		x		x	x
3. "Population Density"	x	x				x		x
4. Apply principles of Grid Coordinate system	x	x	x			x	x	

Summary

This chapter has discussed the development and use of behavioral objectives as one of the newer trends in the teaching of geography. It emphasized that the instructional objective was stated in terms of the student's performance or behavior, that it was readily observable and measurable, and that it could be evaluated by a criterion measure of performance. A format was given for writing behavioral objectives which included the following elements: (1) the persons involved, (2) the specific behavior, (3) the learning outcome, (4) the conditions under which the behavior is to be performed, and (5) the criterion or standard of acceptable performance. Examples and techniques for writing each were given. Many illustrations were also provided giving samples of learning processes and geographic content objectives. Relationships to different levels of cognitive and affective learnings were also pointed out. Finally, criterion measures of acceptable performance were discussed including possible ways of specifying higher levels of accomplishment. Sample charts for recording and assessing student performance were also presented. These were found to be useful for reporting an individual student's progress to parents, and for providing evaluative data on the entire class to determine whether curriculum objectives had been accomplished or not.

FOOTNOTES

[1] Tyler, Ralph W. *Basic Principles of Curriculum and Instruction.* Chicago: University of Chicago Press, 1951.

[2] Kearney, Noland C. *Elementary School Objectives.* New York: Russell Sage Foundation, 1953.

[3] French, Will and Associates. *Behavioral Goals of General Education in High School.* New York: Russell Sage Foundation, 1957.

[4] Bloom, Benjamin S., editor. *Taxonomy of Educational Objectives: Handbook I — Cognitive Domain.* New York: David McKay, 1956.

[5] Krathwohl, D. R., Bloom, B. S., and Masia, R. B. *Taxonomy of Educational Objectives: Handbook II — Affective Domain.* New York: David McKay, 1964.

[6] Gagné, Robert M. "The Analysis of Instructional Objectives for the Design of Instruction." *Teaching Machines and Programmed Learning, II,* Glazer, R., editor. Washington, D.C.: National Education Association, 1965.

[7] Mager, Robert F. *Preparing Instructional Objectives.* Palo Alto: Fearon, 1962.

[8] Popham, W. James. *Systematic Instructional Decision-Making.* Los Angeles: Vimcet Associates, 1965.

[9] Popham, W. James and others. *Instructional Objectives.* American Educational Research Association Monograph Series on Curriculum Evaluation, No. 3. Chicago: Rand McNally, 1969.

[10] See, for example, Eisner, Elliot W. and others. "Educational Objectives: Help or Hindrance?" *School Review* 75:250-282; No. 3, 1967. Also, Jackson, P. W. and Belford, E. "Educational Objectives and the Joys of Teaching." *School Review* 73:267-291; No. 3, Autumn, 1965. Many of these arguments are debated in Popham, *Instructional Objectives.*

[11] Gagné, Robert M. "Educational Objectives and Human Performance." *Learning and the Educational Process.* Krumboltz, J. D., editor. Chicago: Rand McNally, 1965, pp. 1-24.

[12] The concept of a "data retrieval chart," associated with the Taba strategies for developing generalizations, is an excellent means of organizing and displaying data from several samples or areas of study. See Chapter 12 for a more detailed discussion of this technique.

[13] Metfessel, Newton S., Michael, W. B., and Kirsner, D. A. "Instrumentation of Bloom's and Krathwohl's Taxonomies for the Writing of Educational Objectives." *Psychology in the Schools* 6:227-231; No. 3. July, 1969. For a similar classification scheme adapted to writing classroom questions see Manson, G. A. and Clegg, A. A., Jr. "Classroom Questions: Keys to Children's Thinking?" *Peabody Journal of Education* 47:302-307; No. 5, March, 1970.

Chapter 12

Building and Using Inquiry Models in the Teaching of Geography

James L. Hills

The traditional picture of the teaching process has the teacher transmitting knowledge and skills to students. Such a teacher selects the content and delivers it to the students by having them read, listen to, or examine materials he has selected. He asks questions which test their recall of the factual data. Sometimes he has students perform selected activities, often followed by more fact-oriented questions. In short, he dispenses information, a process to which students must submit without choice. All of us have known teachers who bear a striking resemblance to this description. Our own children bring home ample evidence that such teachers still exist, if they are not, in fact, still a majority of the profession. Our children — their pupils — resent the stifling effect such teaching has on learning.

Recently other approaches have received much attention under the rubrics of the *inquiry* approach and the *discovery* method. Jarolimek and Walsh highlight the difference between the "old" and "new" methods:

> Two significant learning acts occur in applying an investigation-oriented proach: (1) the individual engages in some kind of inquiry or ideational-formational searching process focused on a question to be answered or problem to be solved; and (2) the pupil makes a discovery, perceives a

causal relationship, states a generalization, or predicts an outcome growing out of the inquiry process.[1]

The inquiry approach requires the teacher to move from the role of dispensing the data to helping the student find the data for himself. He encourages the student to do his own thinking and to arrive at his own conclusions. This teacher seeks to foster student independence rather than maintaining student dependence. He guides the student in using the tools and developing the skills necessary for the investigation at hand.

Geographic tools used will include maps, globes, and models; charts, diagrams, and tables; pictures, films, and transparencies; as well as written observations. Cognitive skills will include observing, identifying categories, defining, comparing and contrasting, generalizing, predicting, verifying predictions, the construction of models, hypothesis making, hypothesis testing, and decision making. There are affective processes involved whenever the student moves in his thinking from a consideration of what he observes to what *ought* to be — as in the consideration of environmental changes such as pollution, redirection of water resources, *etc.* They are not, however, within the scope of this chapter.

The benefits ascribed to the inquiry approach are laudable. Jarolimek and Walsh [2] identify greater retention of knowledge and greater transfer of learning as prime benefits. Bruner [3] would add an increase in intellectual potency, a shift from extrinsic to intrinsic rewards, and an increased comprehension of the heuristics of discovery.

From the many inquiry models, two well-known ones are presented here. *The Inquiry Development Program* developed by Suchman [4] is distinguished by its open-ended quality, dominated by student questions rather than teacher questions. The teacher acts as a part of the "responsive environment" in this model, answering student questions with a "Yes" or "No" except where the question deals with the verification of a student's theory. When these questions occur, the teacher invites the student to test his theory by the further use of questions which can be answered with "Yes" or "No" answers from the teacher. The Suchman type of inquiry session often opens with a film, or teacher demonstration, designed to produce a discrepant event which will contradict student expectations. Although the *Inquiry Development Program* materials provide the teacher with the questions which can be posed to suggest ways of organizing the data about a problem, or to focus attention on certain events, "the bulk of the inquiry session is

devoted to data-gathering questions raised by the students and answered by the teacher."[5] Suchman holds the opinion that:

> . . . emphasis on discovery in learning has precisely the effect upon the learner of leading him to be a constructionist, to organize what he is encountering in a manner not only designed to discover reality and relatedness, but also to avoid the kind of information drift that fails to keep account of the uses to which information might have to be put.[6]

Another well-known approach to inquiry has been developed by Taba.[7] In contrast to the Suchman model, where the student asks the questions and the teacher controls the data sources, in the Taba model the teacher and pupil roles are reversed: the teacher asks the questions and the students control the data. Both inquiry models are highly effective and can be adapted to the teaching of geography.

Many readers will be acquainted with Taba's three cognitive tasks: *Concept Development, Interpretation of Data*, and *Application of Principles*. They are grand strategies of inquiry in that they each package together several of the discrete cognitive processes treated later in this chapter. The "list, group, and label" activities of her *Cognitive Task I* include observing, identifying categories, and defining. The processes of comparing, contrasting, and generalizing are included in *Cognitive Task II. Cognitive Task III* incorporates the predicting and verifying of predictions described on subsequent pages of this chapter. To the informed reader there are obvious geographic implications to Taba's cognitive map of the third-graders class discussion of the question: What would happen to the way of life in the desert if sufficient water became available?[8]

Because time limitations do not permit teachers the exclusive use of free-wheeling student questioning, many teachers will choose to structure inquiry activities — to provide more direction and more guidance than is found in the Suchman model. This can be done by structuring the environment, assisting students in formulating productive questions, and employing teacher questions to: (1) serve as models of questioning; (2) focus and refocus attention on the task at hand; (3) introduce discrepant data as a technique of preventing premature closure or over-generalization; and (4) raise the level of the cognitive processes employed — that is to say, the level of inquiry.

Levels of Inquiry

Several investigators have identified levels in the cognitive processes. While Taba labeled her levels *cognitive tasks*, Gagné[9] prefers to call

his levels "learned intellectual capabilities." The writer has undertaken the synthesis depicted in Figure 1. Each of these levels can be arranged in a hierarchy so that it is subsumed under the next higher level. They can be dealt with individually or in clusters, depending on the strategy of the teacher and the objective of the learning experience.

Assumptions about the materials presented. The writer makes three assumptions in presenting the materials to follow. First, any teacher who undertakes to use the ideas which follow must give serious attention to the sequencing of materials and activities to assure cumulative learning. When the focus is placed on student inquiry, whatever the model, the sequence of learning activities in which the cognitive processes are introduced is crucial. Each level of the processes is dependent on an adequate development of its prerequisite cognitive processes. In turn, each becomes the foundation upon which the next higher level must be built. No such incremental development can be assured when the sequence is interrupted by skipping about in a helter-skelter fashion. A student cannot generalize unless he has first learned to compare and contrast; he cannot compare and contrast unless he has developed the definitions for the categories he needs, *etc*.

The different levels of cognitive processes require their own forms of content organization. Developing or identifying categories in a discovery approach demands that the student organize a number of specific discrete details into concepts such as *natural resources, topography,*

FIGURE 1.
Hierarchy of Inquiry Processes
(after Gagné)

Making Decisions
Testing Hypotheses
Formulating Hypotheses
Developing Models
Verifying Predictions
Predicting
Generalizing
Comparing and Contrasting
Defining
Identifying Categories
Observing

N.B. Each level subsumes all levels below it and is subsumed under each level above it in the hierarchy of cognitive processes depicted on the chart.

climate, and *life style.* On the other hand, developing geographic generalizations requires the student to be able to describe similarities or differences for several places according to identical concept categories — such as the *natural resources, topography, climate,* and *life style* just mentioned — before he can "sum up" the relationships into a generalization. And, because the *student* is locating the information and doing the thinking, the teacher must provide the necessary resource materials in the appropriate sequence if incremental learning is to take place.

The second assumption is that teachers will want to make their own adaptations of the ideas and materials presented here. The writer has attempted to present illustrations in sufficient variety and at reasonable levels of student ability. Since most of the cognitive skills listed above (Figure 1) can be developed at most grade levels, and since many of the materials can be used, with adjustments in pacing, at a number of grade levels where students have widely differing competencies, it is incumbent upon the teacher to exercise careful judgment in making the necessary adaptations.

A third assumption is that a description of the terminal behavior expected on the part of the students — behavioral objectives, according to Mager [10] — is a most suitable device for clarifying the intent of the instruction.

1. OBSERVING

The old axiom tells us to "start where the pupils are." An inductive approach assures us of likely success when we ask students what they see in a picture. If we have overestimated their sophistication, it soon becomes evident. If we have underestimated, we can make the necessary adjustments immediately. The activity, thus, has a "self-correcting" feature built into it.

BEHAVIORAL OBJECTIVE. Given a picture or map, the students can identify the features they observe by pointing to them as they name them. The teacher must select a picture which has content in keeping with his content objectives: generalizations, concepts, and underlying facts. Then, he must evolve a question sequence directed toward his content objective. For less sophisticated students this sequence will lead to their identifying specific elements — concrete concepts such as people, things, activities, *etc.* More sophisticated students, however, may identify abstract concepts or clusters of elements such as *central*

business district, industrial center, heavy industry, and *communications center.*

A picture of an early river port (or of a colonial harvest, an early assembly line, a caravan, or an urban scene) could take an open-ended question such as "What do you see in this picture?" This question implies that students will point to features (concrete concepts) as they name them. Should this question be one which the students can already handle with alacrity and accuracy, a higher level form of the question can be substituted: "What can you tell me about the city from this picture?" Here the students may offer some interpretation of their observations. The result may include some more abstract concepts — *river site, frontier settlement, hinterland,* or *river port.* The focus of the question is important to consider, for when only a few members of the class handle the abstract concepts with ease, the teacher must move downward in the focus of his question to a more specific focus (lower cognitive level). For a record of what students have observed, and for use in the next step, the teacher should keep a list of student responses.

A map can provide a similar experience in observation. Assuming that students have seen a picture of the layout of the city (akin to an aerial photograph), they may be asked to identify what they observe on the map: "What can you tell me about the city from this map?" For students beginning to read maps, the teacher would arrange for the "early river port" picture experience, for example, to be followed with a map depicting the same scene. The students would be applying their same identification skills to the new media form as they, in effect, matched map items with pictorial items. Students who have had sufficient experience to understand clearly the representational nature of maps may be able to omit the picture reading counterpart. In other words, pictures and maps can be used independently or together, depending on availability and on a deliberate exercise of teacher judgment.

2. IDENTIFYING CATEGORIES

Teachers will want to proceed to inquiry at a higher cognitive level by using the list of pupil responses to the open-ended question used previously, e.g., "What can you tell me about the city from this map?" As part of his preparation for this activity, the teacher is well-advised to undertake the listing, grouping, and labeling steps on his own, in order to estimate a desirable number of responses to be sought and listed.

BEHAVIORAL OBJECTIVE. Given their own listing of 18 to 35 items identified from the picture (or map), the students can group together similar items and label the categories they have created. After listing the pupil responses, the teacher will ask the students which items belong together and he will group them according to students' suggestions. Then he will ask the students for labels for each group. In the process he will recognize that (1) some items may be placed in more than one group; (2) some groups may be subsumed under other groups; and (3) students may reorganize groups as they proceed with the task. The classifications become higher order concepts which have been developed out of this experience. The teacher may wish to substitute accepted geographic terminology for these labels as soon as this can be done without confusing the pupils.

Because carefully selected materials properly sequenced in appropriate activities produce cumulative learnings, the teacher may choose to use several pictures and maps. If a single picture or map adequate to his objectives is not available, the pooled listings from several examples will make possible the classifications desired.

3. DEFINING

As the classifications are undertaken, there is a problem of defining what the labels mean. Here the student is faced with the task of formulating a definition which can be used to determine whether or not an item is a member of the category. Given a map experience, when is a settled area a city and when is it not a city? Given our river port picture and a presumed category such as "harbor area," what is included in the harbor area and what is not included? Assuming one had a category of *central business district*, how would he locate it? Where does it end? Granted that one may start with what can be called working definitions, these definitions will be refined by the testing of their adequacy — their ability to accommodate or exclude new items. The definitions are modified until they can include all new instances encountered and exclude all non-examples. Thus, the improved definitions clarify and refine the concepts used as labels for the categories.

BEHAVIORAL OBJECTIVE. Given the categories which have evolved from the listing, grouping, and labeling experiences, students can formulate a definition for each category which permits the inclusion of the items that are instances and rejects items which are not instances. The teacher who sets *defining* as the terminal objective for a series of

learning experiences must check to see that the prerequisite experiences and materials have been provided.

At this point the interlocking nature of the preceding intellectual operations should be evident to the reader. While each of the cognitive processes can be used and treated as a separate operation, there is a considerable advantage to treating them as a package operating as a subsystem of the larger system of cognitive skills. Taba has identified this particular group of cognitive skills — listing, grouping, and labeling — as a single cognitive task, described extensively in other publications.[11] Defining is included as a dimension of the labeling process in her Cognitive Task I.

4. Comparing and Contrasting

Although a form of comparing and contrasting, on a lower cognitive level, was included in the *Identifying Categories* process, now the teacher is concerned with having students make comparisons of some different content examples which allow them to discover obvious similarities and differences. This calls for a high level of contrast where the focus is on *differences*. The possibilities are manifold: here *versus* there, before *versus* after, hot regions *versus* cold regions, wet places *versus* dry places, high places *versus* low places, industrial regions *versus* agricultural regions, urban settings *versus* rural settings, desert areas *versus* forested areas *versus* plains, *ad infinitum*. Properly handled, the exercise prepares pupils to move on to the next higher level of cognitive processes — generalizing.

BEHAVIORAL OBJECTIVE. Given (the development of) a set of criteria adequate to the purpose, students will describe similarities and differences between two (or more) examples. Given a series of maps of Amsterdam or San Francisco[12] made at selected intervals of time, the students could describe the likenesses and differences they observed between the maps depicting any two specified periods. In such an exercise, the focus would be on *change* and on *continuity*. The criteria, which might either come from the teacher or be elicited from the students, could include the following: size (area covered), shape, density of population (dwellings), variety of transportation facilities, extent of harbor area, and patterns of land use (industrial development, residential development, etc.). Whatever they include, the same treatment (criteria) must be used for each map used for this purpose. Other comparisons of maps are possible, such as in the development of a region over a period of time.

Two or more pictures can be used similarly for comparing and contrasting. A picture of heavily-robed Bedouins outside their goat-hair tent, their animals widely separated as they graze the scattered tufts of short, dry grass, can be compared to a picture of Ceylonese farmers in their short and light-weight garments, barefoot and up to their calves in water as they transplant rice from the seed bed to the planting bed in front of the terraces holding a heavy growth of tropical vegetation.[15] Were the objective to illustrate the influence of the natural environment on the ways people live, the criteria for comparison and contrast could be put into a series of questions: What is the terrain like? What kind of plant life do you observe? What kind of animal life do you see? How are the people dressed? What kind of work are they doing? What are their homes like?

Students unaccustomed to picture reading and interpretation will profit from having the teacher demonstrate the technique by taking the class through the process one question at a time. First, they take one picture, then the other. Students who are accustomed to the procedure can undertake the process with considerable independence.

If the data gathered from either picture reading or map interpretation are to be used in higher cognitive processes, the recording of the information on charts allows storage of the information in a form facilitating data retrieval as needed. Such a chart format is provided below (Figure 2) for the pictures just described. The questions are collapsed to categories to allow more space for the information which is to be recorded. Now they describe the similarities and differences they observe, category by category.

While we have achieved our immediate behavioral objective at this point, we are also ready for the next higher cognitive process — for the

FIGURE 2.
Example of a Data Retrieval Chart

	Near Basra, Iraq	Near Colombo, Ceylon
Terrain		
Plant life		
Animal life		
Clothing		
Work		
Homes		

students are ready to generalize about the relationship between the environment of "Near Basra" and its influence on the way people live and make a living there. They are ready to generalize about "Near Colombo" in the same way. And then they are ready to build on those specific generalizations in order to generalize at a higher level. Although they have looked at only two instances, they can make tentative generalizations about the relationship between the environment and the ways people live and make a living: "The natural environment in which a people live influences the way they live and make a living as they do." [14] But more about this in the next section on Generalizing.

Maps and pictures are not the only geographic tools which lend themselves to the process of comparing and contrasting, or describing likenesses and differences. In addition to the student-constructed data retrieval charts, such as the one shown in Figure 2, there are many tables, charts, and graphs presented in texts, census reports, yearbooks, and encyclopedias.

Any graph or table has within it data organized for comparative purposes. There is a real danger that the level of abstraction presented by the data will be so far beyond pupil experience as to have little meaningful value, unless the teacher has taken specific steps to make it relevant to pupil experience. The booklets of the *Table and Graph Skills* series [15] provide a good example of the kind of sequence which can be of great help in making sense out of graphs and tables. For example, in one exercise [16] the students read a narrative selection which incorporates data on the hours of daylight on December 21 for six locales ranging from the southernmost part of South America to the far northern part of North America. After answering questions which identify the hours of daylight for specified points, the students are asked to categorize these places by arranging them in order — from longest to shortest days — recording the places in sequence on a chart provided, citing the hours of daylight for each place by recording it in a column adjacent to the place name. Next, they make comparisons between places. Finally, the students use the data to make a bar graph on the form provided, thereby illustrating the data recorded on the chart. A hemispheric map accompanies the lesson to assist in the identification of places and to facilitate the comparisons of the locations of the places. Although the data are provided which would allow the students to generalize about the relationship between the sun's position and the number of hours of daylight, the lesson neglects to carry the cognitive development that far.

Because the student often will encounter much of the data he needs sprinkled through tables far more complex than that described above, one valuable exercise for the student is the construction of his own graphs from the tabular data provided. Thus he has only to deal with those items of data that are relevant to the questions he has in mind. When the data are placed on a bar graph in ranked order, comparison is facilitated. The process of accommodation required of a student to convert data from one form to another heightens his understanding of the data, enhances his ability to interpret it, and enables him to understand better the significance of it in various forms. Much of the mystery has been eliminated as the student encounters new data in forms similar to those he has worked with in this fashion. In the final booklet of the *Table and Graph Skills* series is a checklist [17] which is designed to help students select a suitable graph form for converting raw data or tabular data to a graph of his own creation. In addition to providing a model for a multi-column table, eleven different kinds of graph forms are illustrated to help the student make his own. Lessons are included in the series for each of these. Teachers may wish to refer to the series and the teacher's guide for help in developing appropriate experiences for their own pupils.

5. GENERALIZING

The real pay-off from comparing and contrasting comes when the students are able to interpret the data to the point of formulating generalizations. This gives meaning and purpose to the careful work that has gone into teaching students how to read and interpret pictures, maps, tables, and graphs. It is the generalization that allows students to transfer their learning from one situation to another. It is the generalization that determines which content examples are necessary for the instructional program and which are superfluous.

While the traditional teacher presents generalizations to students to be memorized as "facts," the inquiry-oriented teacher depends on students to develop their own generalizations from their interpretation of the data. In an inquiry-oriented program, students are encouraged to discover relationships by comparing and contrasting data and then to state these relationships in the form of principles (generalizations). This forces them to go beyond the data itself.

BEHAVIORAL OBJECTIVE. Given similarly organized observations (representing two or more contrasting content samples, with the

data grouped according to identical categories) students will draw inferences and formulate generalizations of wide applicability.

The generalizations we desire — the highest form of content we deal with much of the time — become the criteria which determine the selection of content examples to be compared and contrasted. The generalization "The natural environment in which people live influences the way they live and make a living as they do" [18] made the pictures described in the previous section on *comparing and contrasting* (Near Basra and Near Colombo) good pictures and the question sequence a valid one.

However, in order to secure the *generalization* the question sequence represented by Figure 2 must be extended by the addition of three more questions: 1. "What can you say about the relationship between the natural environment and the way people live and make a living near Basra?; 2. What can you say about the relationship between the natural environment and the way people live and make a living near Colombo?; and, finally, 3. What can you say about the relationship between the natural environment in which people find themselves and the way they live and make a living?"

It is assumed that the teacher would take up the content samples (Near Basra, Near Colombo), each in turn, to elicit the "generalizations" about it. The data the students need is summarized in the chart. Technically, these are not generalizations, but *sub-generalizations*, according to Womack,[19] for they deal with a single sample only. They are statements, some of which will support a generalization, universal in application. The teacher records these sub-generalizations for the students to use in the next step.

The relationships "summed up" in the sub-generalizations based on each of the samples may now be compared. The teacher asks: "What can you say, based on both examples (content samples), about the relationship between the natural environment in which people find themselves and the way they make a living?" It is this third question which produces the *generalizations*. Rightly speaking, even though the teacher is confident of the universal application of the student statements of generalization, the students cannot be, until they have tested it — which will be treated more fully in the next section. If the teacher knows of exceptions, he can prevent premature closure by producing cognitive dissonance, introducing a discrepant event. He can ask: "What about such-and-such a situation? How does your generalization handle this apparent exception?"

Given this particular generalization, other content examples with high contrast could have been substituted to serve the same function. Another generalization would have required different content samples — and would have presented concepts which dictated the observing, classifying, and defining experiences described earlier. Given the generalization from the California Framework "People in different stages of civilization react differently to similar environments,"[20] the teacher must develop the concept clusters *stages of civilization* and *similar environments* which, in turn, require that the concepts of *civilization* and *environment* have been developed previously with the students. *Environment* demands a distinction between natural environment and man-made, or man-altered, environment.

In developing a segment of the curriculum (or the whole curriculum, for that matter) which will include the generalization — arrived at inductively — the effective teacher is committed to beginning with the generalization and planning backward (downward on our hierarchy) to insure that the prerequisite experiences are included for each prior cognitive level. Then, the sequence is reversed for the pupil so that he proceeds from the simple to the more complex in what Taba called "bite-size" increments.

Concepts or generalizations are not developed once and for all time in a single learning activity. What is laid out in a linear sequence of development as a strategy for developing an understanding of the interrelatedness of different cognitive levels should not obscure the fact that learning is also spiral in nature. At strategic points, the teacher will plan reinforcing re-engagements with concepts introduced — germinated, as it were — at an earlier point. This is done to expand these concepts, to add new dimensions afforded by more recent learnings that were not available to be drawn on at an earlier point.

The use of maps affords another example. Maps deserve attention as a special form of data retrieval chart in which the contrasting samples are represented by the symbols of the map key. A population map of the United States makes it possible for students to contrast the density of population in various states or parts of the country. A number of generalizations can be reached from such a single purpose map: "The eastern half of the United States is more densely populated than the western half." "Demographic distribution is more irregular in the western portion." "The very heavily settled parts tend to be concentrated in the Northeast." Although these "generalizations" are too specific and too discrete to qualify as such using Womack's criteria,[21] they

qualify in the writer's opinion as the product of the generalizing process following *comparing and contrasting* as an intellectual operation.

When the teacher seeks to elicit such generalizations by asking the students, "What can you tell me about the United States from this map?", the students are required to identify the symbols, identify the categories and classification system they represent, observe the definitions used for establishing the parameters of the categories, compare and contrast the places/regions indicated by the symbols, and generalize regarding the relationships they observe. When such a question results in low-level or inadequate responses on the part of the students, such responses indicate to the teacher that he needs to proceed through some, or even all, of these lower level cognitive operations with the students if they are to achieve the capacity for making adequate generalizations. A question sequence, such as the following may be in order:

1. What can you tell me from the map legend?
   a. What symbols do you see? (Identification)
   b. What does each symbol represent? (Classification)
   c. What meaning is attached to each symbol? (Definition)
2. Where can you find examples on the map of . . . (each symbol taken in turn)?
3. Where do the examples of . . . (a specific symbol) tend to concentrate? or, What is the areal distribution of . . . (the specific symbol)?
4. What patterns of distribution do you observe? (Higher Level Identification)
5. What relationships do you observe between these patterns? (Comparing and Contrasting)
6. What is the meaning of these relationships? How can you sum up these relationships in a sentence or two? (Generalizing)

The number of generalizations available is vastly increased as other maps are compared with the population map. When the population map is used along with a rainfall map, generalizations can be made about the relationship between rainfall and population. Given the addition of a map of land use, generalizations now become available between population and land use as well as rainfall and land use. The addition of a topographical map allows new generalizations between topography and rainfall, topography and population, and topography and land use. The preparation of transparencies using the same map for a "base map" allows these generalizations via overlays despite the absence of such maps in the students' texts. Indeed, such transparencies can be prepared by any students old enough to discover the relationships involved — a valid map-making experience which has a functional value to the

whole class and even to subsequent classes taught by teachers who wish to use them. Further, accuracy as required by overlays will motivate a level of careful preparation often missing in the usual "coloring-in" assignments made by traditional teachers. Some school districts have made sets of transparencies for inductive teaching which include maps of vegetation, railroads, manufacturing, mineral deposits, political boundaries, *etc.*, employing a common base transparency. Of course, it is assumed that a parallel treatment of nations, or continents, or states is equally appropriate through the use of similar maps for each.

Charts are a necessary adjunct to the generalizing process. Properly designed and used, they maintain the focus necessary for clear-cut comparisons. Given the need to generalize regarding cultural change over a period of time, the chart below will serve to illustrate the process.

FIGURE 3.

Percentage of Households Owning Electric Appliances in Japan[a]
(From Hall[22])

	1958		1960		1961	
	Urban	Rural	Urban	Rural	Urban	Rural
Television	16	3	55	11	72	29
Refrigerator	6	[b]	16	1	27	3
Washing machine	29	5	45	9	55	15
Rice cooker	16	4	38	9	45	14

[a]According to Kokumin Seikatsu Hakusho ("Survey of People's Living"), edited by the Economic Planning Agency. Figures are based on questionnaire surveys carried out biannually in urban and rural areas.
[b]No figure given.

Textual sources do not always provide the data so organized. If the data must be drawn from case studies or expository treatments, a question sequence must be provided by the teacher (or elicited from students who have had previous experience with the procedure) to guide the quest for relevant data. The question sequence leads to the construction of the necessary data retrieval chart. Given an expository treatment of the development of cottage industries at the village level as a means of bolstering the economy of India, and given a similar treatment regarding town-centered alternatives, the teacher could ask questions such as the following. From them a data retrieval chart could be developed.

1. What is the employment potential?
2. What amount of energy is available?
3. What demands will be made on the transportation system?
4. What housing is available and at what cost?
5. What population dislocation will result?
6. What stimulus to increased production is anticipated?

Many teachers will find that the Contra Costa Social Studies units,[23] recently revised to include grades seven and eight, are an excellent source of models illustrating this process applied to a variety of grade levels and content areas.

While comparing and contrasting and generalizing have been presented as discrete cognitive processes, it is clear that the quality of the generalizing depends on the quality of the interpretation made of data. Taba grouped these two operations together in a powerful inquiry strategy she identified as Cognitive Task II.[24] The task culminates in a class discussion which permits students to undertake the formulation of generalizations as a group activity. This has the twin virtues of encouraging students to listen to each other (providing that the teacher is not one who "parrots" the students' comments) and to ride piggyback on each other's thinking — a tactic which tends to produce generalizations on a higher level, of a greater universality, and with a greater clarity of understanding than those coming from any single individual.

6. PREDICTING

Once students have developed generalizations, they have reached a significant point in the development of their powers of observation. True as this is, they have only created a tool which releases them to begin to do consciously what scholars do constantly as they encounter the vast quantities of new data about the world around them — they apply these generalizations to familiar elements in novel settings and to novel elements in familiar settings. Having identified causal relationships in their generalizations, they transfer the principles they have learned to new content. Taba considered this transfer to be adequate justification for the additional time an inductive approach requires to develop cognitive skills. Such experiences in depth come at the cost of foregoing the more superficial treatment demanded by trying to "cover" a vast amount of information. The effort to cover everything, as though it were all equally important and equally relevant to the

student, has been the curse of the school program for many years. It still is a strongly entrenched notion with which every good teacher has to do battle.

BEHAVIORAL OBJECTIVE. Given the generalizations the pupils have formulated previously, students can predict the relationships which will be found in a novel setting, or at a future point in time, or at a point in the past which the students have not previously considered.

If the students have examined the effect of Chinook (Foehn) winds on the weather patterns of the Rocky Mountain region of the United States, contrasting what happens on the eastern slopes with what happens on the western slopes of the Rockies in terms of the temperature and moisture content, they may have generalized that the Chinook winds often affect the climates where they occur, making it warmer and drier at those points than at neighboring places. They can predict the location of places with similar climates in the region east of the Canadian Rockies.

If students have generalized the effect of ocean currents on air masses, and have identified the nature of the Japanese current and its effect on air masses off the west coast of North America, they can predict the effect of the Humboldt (Peruvian) current on the air masses off the west coast of South America.

If students compare the landform features of western South America and North America from 30° to 45° latitude, using their knowledge (generalizations) of ocean currents and Foehn winds in the Northern Hemisphere, they can predict the reasons for the existence of the Atacama Desert in South America — a phenomenon it is presumed that they have not previously studied.

Not all predictions are so involved. It is much easier to generalize the trend of data on a graph and predict data for subsequent time intervals. Familiarity with causal relationships between selected political, social, and/or economic indicators and standards of living in modernizing societies allows students to use trends to predict both future developments and changes in living standards and societal values.

7. Verifying Predictions

No teacher is satisfied with all of the predictions students usually make. Being allowed to predict, let alone being actively encouraged to predict, is such a novel experience for most students that they can get carried away with it. Part of the challenge is due to student im-

maturity — the fact that the students are growing and developing and experimenting with new ideas and new skills. Another explanation may come from the tendency many teachers have to reject any student contribution which is not immediately supported by factual data from a text or similar source. In a similar way, being encouraged to generalize may produce the over-generalizations mentioned earlier. If uncorrected, such generalizations can foster unwarranted predictions. Hence, the verification process is a necessary means for building in safeguards against incredible predictions.

BEHAVIORAL OBJECTIVE. Given the predictions they have made, the students will justify their predictions by logical (If — then) thinking or by locating data (maps, graphs, tables, case studies, or expository treatment) which will support or refute the predictions.

One place to turn in the verification process is internal. Because of the interlocking nature of the cognitive processes as depicted thus far, it is important to take the necessary steps to prevent over-generalization. A number of questions may be asked in order to accomplish correction, through reexamining the data from which the generalizations emerged: What knowledge (generalizations) serve as a basis for the prediction being considered? What data are available to support the generalization? Do any data refute the generalization or limit its universality? If so, what are the data? What are the sources of the data in support and in opposition? What is the authority of the source? If there are no specific data, what body of informed opinion exists in support of or antagonistic to the generalization? If a generalization is based on meager data, or if there is a body of information or informed opinion which seems to be of contrary nature, the generalization must be considered untenable at this point — and until new support becomes available.

Another direction which is open is to examine the information related to the novel setting from which the prediction was made. The test of the logical basis for the predictions can be used in the absence of hard data. For example, third-grade students made a number of predictions following the question: "What would happen to the way of life in the desert if sufficient water became available?",[25] cited earlier. Included among them was the following chain: trees → more lumber → more carpenters → build furniture and houses → develop cities. This chain ought be followed by such a test, probing the logic of the reason-

ing used by the students. The question could be asked whether, under the desert circumstances, trees might be much more desirable for other immediate functions (e.g., for shade and fruit or food) rather than lumber.

When facts are available to corroborate or refute the predictions, verification of the prediction is quick and conclusive. However, it takes many verifications of many predictions employing the generalization to establish the universal validity of that generalization. Hence, the distinction is made between verification of the prediction and verification of the underlying generalization on which the prediction is based.

Both types of verification experiences are invaluable to students: the factual base because of its practical, efficient, and conclusive nature as a check on predictions; the logical "If — then" test because many predictions must be made in the absence of readily available sources of external evaluation.

A strategy for putting the results of inquiry to further use, combining the operations of prediction and verification, has been formulated by Taba as Cognitive Task III.[26] Of special interest is the use she made of *cognitive maps*[27] as a means of recording the thrust of pupil prediction from group discussions. It is apparent that the same kind of mapping can be undertaken by the teacher in anticipation of such a discussion as a means of forecasting student predictions and preparing the necessary verification materials and procedures. When such data as are needed must come from the use of such materials as census reports, *The Shorter Oxford Economic Atlas of the World, The United Nations Statistical Yearbook, The Atlas of Economic Development, The Japan Statistical Yearbook, The Statesman's Yearbook,* etc., woe unto the teacher unfamiliar with the contents and the organization of these volumes who expects to use them "cold" with students, or expects librarians to instruct students in their independent use of such sources of information.

8. Developing Models

As students work with generalizations dealing with trade patterns, wherein nation *B* provides a market for nation *A*'s raw materials and depends, in turn, on nation *C* to be the market place for *B*'s finished products, the relationships can be reduced to a diagram or model of three-cornered trade. This requires the reciprocal relationships to be added to complete (close) the model. The familiar diagram of the

water-cycle is another example of a model. So are diagrams of the flow of ocean currents. In an inductive approach to instruction, the models or constructs are products of the pupils rather than products developed by scholars and presented to students. What the teacher seeks are models from which high level generalizations and principles can be derived. These models or constructs illustrate principles which have been tested and refined and verified sufficiently to have promise of being universal, or nearly so, in application.

BEHAVIORAL OBJECTIVE. Given generalizations developed earlier and modified sufficiently to survive the prediction and verification steps, students will develop models or diagrams depicting the dynamics of the relationships involved. This is a level of intellectual attainment largely absent from the classroom. No doubt this is in part due to the level of cognitive operation it represents. It seems safe to theorize that another reason lies in the fact that the teachers personally, for the most part, have neither experienced the creation of such models themselves nor observed the experience on the part of others. With sufficient and diverse models as they can gather together for examples, they are in a position to invite pupils to attempt to create such models.

One procedure worth exploring would be to present some models to students for their analysis (a deductive process) to get them to describe the dynamics involved. Then students can be encouraged to take the results of their comparisons (generalizations), predictions, and verifications and attempt to devise models representative of the dynamisms they identify. The "modulex map board" developed by the High School Geography Project[28] could be used for the deductive process initially and, later, for the inductive role. A sand table made out of an inexpensive plastic wading pool could serve the same purpose in many classrooms. Students are not expected to develop representations unique to the "history of mankind," but the models they develop ought to be appropriate to their point of development.

A reasonable first step might be the alteration or improvement of an existing model. Suppose, for example, students had been keeping daily weather records, taking their own readings from their own weather station and making daily forecasts. If they were given the following chart and given access to local weather records for an extended period of time, they might be asked: "What changes would you make in the following forecaster's chart to make it more accurate for your locale?"

FIGURE 4

Adapted from: Thompson, Philip D. *Weather*. Morristown, N.J.: Silver Burdett Company, 1965. p. 167.

A GUIDE FOR WEATHER FORECASTING

Direction of Wind	*Barometric Pressure*	*Expected Weather*
SW to NW	30.10 to 30.20 steady	Fair with little temperature change for one or two days
SW to NW	30.10 to 30.20 rising fast	Fair, followed by rain within two days
SW to NW	30.20 or above steady	Continued Fair, with little temperature change
SW to NW	30.20 or above, falling slowly	Slowly rising temperature: Fair for two days
S to SE	30.10 to 30.20, falling slowly	Rain within 24 hours
S to SE	30.10 to 30.20, falling fast	Wind rising in force: rain in 12 to 24 hours
SE to NE	30.10 to 30.20, falling slowly	Rain in 12 to 18 hours
SE to NE	30.10 to 30.20, falling fast	Rising wind: rain within 12 hours
E to NE	30.10 or above, falling slowly	In summer, light winds, rain not immediately likely: In winter, rain in 24 hours
E to NE	30.10 or above, falling fast	Rain probable in summer within 24 hours: In winter, rain or snow and windy
SE to NE	30.00 or below, falling slowly	Steady rain for one or two days
SE to NE	30.00 or below, falling fast	Rain and high wind, clearing within 36 hours
S to SW	30.00 or below, rising slowly	Clearing within a few hours, Fair for several days
S to E	29.80 or below, falling fast	Severe storm imminent: clearing within 24 hours: colder in winter
E to N	29.80 or below, falling fast	Severe northeast gale, heavy rain: in winter, heavy snow and cold wave
Going to W	29.80 or below, rising fast	Clearing and colder

Guidelines: Pressure and Wind

This chart summarizes decades of meteorological experience in the Northeast region. In this section, winds from the west almost always bring high-pressure readings and good weather, while those from an easterly direction generally mean a falling barometer and rain or snow. A wind that swings from easterly to westerly usually brings with it a swift and welcome change — from bad weather to good.

Or, given the following chart of social indicators and levels of modernization developed by Bob Henderson and Jerry Moore,[29] students might be asked to develop a similar chart using other indicators.

Much of the success with model-making in the classroom will depend on the strategies employed by the teacher. One inductive strategy available to the teacher who has a model available is to use the model as a basis for developing a question sequence. For example, each pamphlet in a series dealing with "Area Studies in Economic Progress"[30] contains the same diagram (model) for analyzing an economic system. If the teacher wants students to develop a diagram of their own (with, perhaps, some resemblance to this model), he could use a series of questions such as the following:

1. What are the major wants expressed by the nation and/or its leaders?
2. What natural resources, human resources, and capital are available for meeting these wants?
3. What choices must be made?
4. How are decisions made about
   - - - what is to be produced?
   - - - how much is to be produced?
   - - how resources will be allocated to production?
   - - - who will get what and how much?

Given the opportunity to employ this questioning strategy with several countries, and to generalize regarding the data acquired from their study, the students may be able to develop a diagram of their own to represent the functioning of the system. The objective is not to reproduce the diagram of the scholar-author by manipulating students in such a way that it is inescapable. The goal is to focus student attention on the inter-relationships among the significant factors in such a way as to facilitate their understanding of the dynamics involved. The production of a model requires an understanding of the patterns of interaction which is more than the accumulation of a series of generalizations. The questions help them discover the relationships basic to model building. From this kind of an intellectual experience a theory may emerge as a hypothesis about all economic systems — market, command, or mixed. Many scholars today consider the eco-system to be the basic unit for the study of any geographic region.

9. Formulating Hypotheses

A hypothesis is defined, for our purposes here, as a proposition expected to ha· · "generalizability going far beyond simple predictions

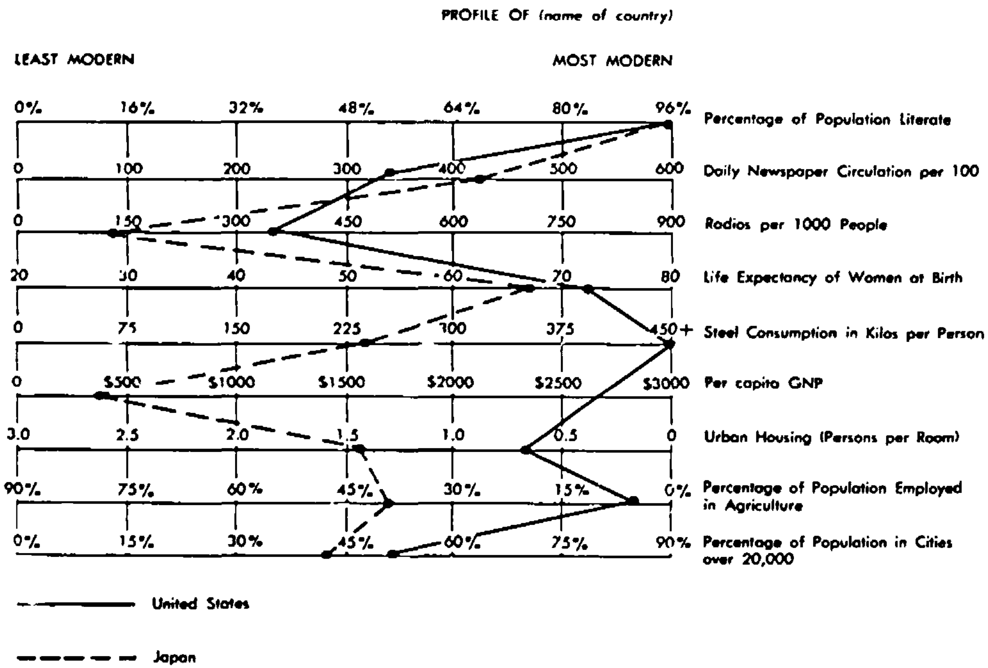


FIGURE 5

From: Henderson, Bob G. and Moore, Jerry R. "Modernization: A Conceptual Approach to Asian Studies," *Social Education* 32: 686-690; No. 7, November, 1968. p. 688.

based on likenesses and differences. They provide explanations of social phenomena."[31] They have a logical "If — then" quality about them — "If such-and-such is true, then so-and-so will follow." For example, "If a man has an above average income, then his consumption of the goods available will be above average and his contribution to environmental pollution will be greater than average."

While the end-product of the comparing and contrasting operation is a generalization or series of generalizations which lead to relatively simple predictions, the model-making described above expresses the relationships among a system of several generalizations. It is a way of demonstrating these relationships in a visual form. To verbalize the inter-relationships requires a higher order of generalization than is the usual result of the simple comparisons discussed in *Section 5* above.

Womack makes some distinctions regarding generalizations which help clarify the matter.[32] For example, there is the distinction between substantive generalizations and sub-generalizations:

> Substantive generalizations are rules or principles expressed in complete sentence form which have universal application. . . . The essence of it can be stated at different levels of complexity appropriate to different levels of maturity. . . .
>
> The sub-generalization differs from the substantive generalization in that it has limited application rather than universal application.

The sub-generalization is introduced by a qualifier, if Womack's examples are followed.

It is the universal type of substantive generalizations which is most apt to be involved in hypothesis-making as treated here. The hypothesis represents more complex principles than those of prediction. For example, the student can *predict* that the sun will rise tomorrow because it always has. The student is expressing a *hypothesis* when his notion that the sun will rise tomorrow is based on a theory of day and night which he has derived from his understanding of the rotation of the earth on its axis. He can demonstrate the hypothesis with a model — using a filmstrip projector as a light source and a globe or ball as the earth.

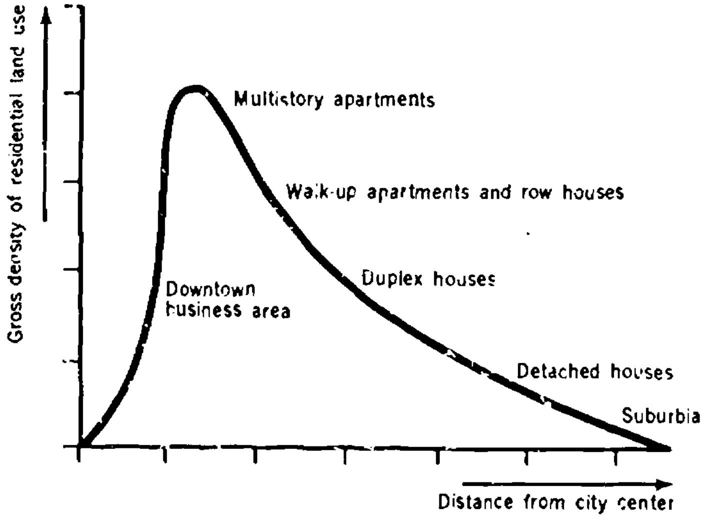
BEHAVIORAL OBJECTIVE. Given diagrams, models, or case studies depicting the inter-relationships between the dynamic factors involved in the model or system depicted, the student will formulate the relationships observed into statements of hypotheses. When students

have observed maps or aerial photographs of an urban area made at specified intervals, and have generalized about the changes they observe, such as that "population density tends to grade away toward the edges of the city . . . but often is more highly concentrated along major radial transportation routes than in sections that are less accessible,"[33] they are in a position to formulate hypotheses for use in anticipating changing land values and land uses in a city contemplating providing for a major change in its existing transportation system.

Students who have observed Murphy's "Schematic relationship of population density to distance from city center in relation to type of housing" (Figure 6) are in a position to attempt the construction of a similar representation for housing along major radial transportation routes as a step toward the formulation of a hypothesis regarding the relationship which is revealed. A similar adaptation could be made in

FIGURE 6

Schematic relationship of population density to distance from city center in relation to type of housing. (After Marion Clawson, R. Burnell Held, and Charles H. Stoddard, *Land for the Future*, Baltimore, 1960, fig. 6.); from Murphy, Raymond E. *The American City: An Urban Geography*. New York: McGraw-Hill, 1966. p. 159.



developing a hypothesis about zoning changes required by the development of a new major shopping center.

As we as a nation are becoming increasingly concerned about the quality of our environment, the application of this process in our classrooms becomes increasingly relevant and necessary. It offers a means of examining the probable impact of the introduction of any of a number of technological innovations ranging from the introduction of the Boeing 747 and, especially, the supersonic transport — SST, the consideration of different proposals for urban renewal and the mitigation of slum conditions, and the possible effect on existing harbors of the advent of Japan's new super-ships, to the consideration of the contribution of various industrial practices to environmental pollution. All of these problems are worthy of high classroom priority in our consideration of ways of managing our environmental resources for the benefit of all citizens, present and future.

10. Testing Hypotheses

When students develop the hypotheses necessary to solve current problems — if viable solutions were available, the problems would no longer be *problems* in the true sense of the word — they are apt to come up against counter-hypotheses which must also be considered. Testing such hypotheses presents many problems.

The testing process "is concerned with the applicability of a hypothesis to one or more specific situations." [34] Obviously, the hypothesis is corroborated whenever a situation demonstrates its application by providing supporting data. When data do not fully support the hypothesis, several options are open: gathering additional data, revision, rejection, or development of an alternative hypothesis.

BEHAVIORAL OBJECTIVE. Given the hypotheses formulated, students will demonstrate the universality of the hypotheses by testing each of them in a variety of settings. Given the hypothesis that "if an urbanized area is treated as a unit, the socioeconomic status of suburbia is higher than that of the central city," Leo Schnore studied 200 urbanized areas. He concluded that the hypothesis was more likely to hold for old settlements than for more recent ones. "In newer urban agglomerations, the central cities tended to rank higher in education, occupation, and income than their respective suburbs." [35] A number of explanations (alternate hypotheses) are suggested in Murphy's discussion of the study in *The American City: An Urban Geography*. It is the

writer's opinion that the organization and presentation of materials in this book exemplify what can be done to assist students and teachers.

Oftentimes the hypothesis testing just described is impossible due to lack of data. The step need not be omitted, however. Since relevant education is not limited to the school setting, it follows that experience in the classroom may open many problems for examination which will remain unsolved for the student long after his diploma has been received. At times the only classroom test feasible, as Gagné points out,[36] may be a description of how the hypothesis *could* be tested. Such a rational approach serves at least as a safeguard against becoming easy prey for the propagandists who seek to substitute emotional appeals for rational decision making.

11. MAKING DECISIONS

Decision making is the capstone of the cognitive processes making up the inquiry system described in this chapter. It is dependent upon adequate development of the underlying processes. In developing the prerequisite skills, the student has identified, classified, defined, compared and contrasted, generalized, made predictions, verified the predictions, developed models, formulated hypotheses based on the models, tested the hypotheses and alternative and counter-hypotheses, and now chooses a desirable course of action to be followed. This process results in the "learned intellectual capabilities" so necessary for responsible citizens in a democracy: it exposes as shoddy the notion that one person's opinion, informed or not, is as good as another's.

Given the need for 100 new major cities[37] to disperse the additional population predicted for the United States, where should the cities be located? Given the increasing demands for potable water in some regions, and the present abundance in others, should water be diverted according to demand? Should water diversion be curtailed to encourage population dispersal? Given the capacity to create a huge agricultural surplus, what should be done about the agricultural use of marginal lands? Give our capacity to cover prime agricultural land with concrete freeways, asphalt parking lots, new shopping centers, and individual dwellings, what restrictions should be placed on land use? The list of urgent social problems with geographic dimensions seems almost limitless.

BEHAVIORAL OBJECTIVE. Given a problem which requires a solution, and relevant hypotheses which the students have formulated

and tested, the students will describe the course of action which they deem preferable as a result of their study. Obviously the recommendation of a course of action involves values as a central concern and, therefore, is not a process resting solely in the cognitive domain. The process depicted here is rational in its focus rather than an unexamined by-product of dammed-up emotions. It is recognized that each cognitive process has its affective counterpart, although in the design of this chapter the affective processes were omitted.

The approach of this chapter has been to start with an inductive treatment of simple and basic cognitive processes and move upward in our examination of the cognitive hierarchy. Now we ought to begin in our *planning* curriculum with the decision-making processes at the top of the ladder and work downward. What crucial decisions face mankind — our world, our nation, our state, our community? We can select those most relevant around which to build a vehicle for providing sound geographic learnings. Then each step down the ladder (Figure 1) depicts the prerequisite skills which must be developed by appropriate learning activities. Thus, we know at each step what preparation students need to be ready for that stage in the processes described.

Granted that it is relevant to try to decide where 100 new cities should be located, we can proceed to identify some necessary learnings. Students will need to know something about the types of cities there are (e.g., transportation and break-of-bulk, central places, etc.). They need to know about the effect cities have on each other. Now we can begin to lay out an inductive sequence which will carry students up the ladder.

Having identified the requisite learnings, an overall inquiry strategy can be designed which is consistent with the content objectives identified in our pre-planning. For example, starting with a base map, an outline of an imaginary island having a coastal indentation, Jack Sheridan and Carl Schomburg of the University of Houston have worked with middle-grade students, introducing a number of hypothetical situations to develop such learnings. Given good fishing in the off-shore waters, fishermen hunt for a place to berth in order to avoid the long trip back to the mainland. Where would the most likely place be and why? The students discover this will be at the indentation (harbor), via a Suchman type of inquiry session.[38]

In carefully planned steps, other hypothetical situations can be introduced: the development of a temporary settlement, the need for

food as a permanent settlement develops, the development of an agricultural base, the emergence of a central place city in the agricultural sector, the need for transportation between the cities, and a comparison of the two cities, the discovery of minerals in the mountainous backbone of the island, the emergence of a mining town, the development of new patterns of inter-relationships between the three towns, etc. New generalizations are constantly made from new comparisons. Then it is an easy jump to examine real cities which, at one point or another in their development, represented these "pure" types. Eventually, through carefully developed incremental steps, a grand strategy has enabled students to develop conceptual models adequate to the formulation of the hypotheses necessary in arriving at decisions about where new cities should be located.

Summary

There is a hierarchy of learned intellectual capabilities, identified by Gagné, which should be developed by any geographic instruction undertaken in the '70's. These cognitive skills can be developed using either of two inquiry models. The Suchman model places the teacher in control of the data with the student asking the questions; the Taba model places the student in control of the data with the teacher asking the questions. The skillful teacher has the options of using one or the other model, or of rotating between them. It is assumed that the teacher will also rotate between the use of inductive and deductive strategies, although this chapter has dealt with the former.

Although the cognitive hierarchy has been treated step-by-step in the development of this chapter, at three points an alternative to the step-by-step approach for students has been offered in the form of one of Taba's three cognitive tasks. It is assumed that, with experience, teachers who aspire to be more than learning technicians will develop an intuition for flexible use of the ideas contained herein and will free themselves from the apparent rigidities which result from a slavish following of the linear organization selected for the purpose of clarity of exposition.

For each of the inductive strategies there is at least one deductive counterpart. The focus on inquiry has made it impractical to consider these counterparts here, but interested readers are referred to Marlin Tanck's chapter, "Teaching Concepts, Generalizations, and Constructs," in *Social Studies Curriculum Development: Prospects and Problems*,[39] and David Ausubel's "advance organizers."[40] For each of the cognitive

skills there is also an effective counterpart which has been omitted from the discussion here.

Finally, it is suggested that curriculum development in geography utilize the cognitive hierarchy in reverse. Beginning with decisions that need to be made in the '70's, provision can be made for students to have the learning experiences prerequisite to each level of the hierarchy. Once the planning has worked down the hierarchy ladder, the sequence of student learning activities which has been developed is inverted. They now provide an incremental sequence of learning activities where each step builds on the previous step and leads up to the next.

FOOTNOTES

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Chapter 13

Educational Simulations in School Geography

Angus M. Gunn

Educational simulations at times are games, not in the sense of Friday afternoon diversions such as toys or quizzes, but serious representations of social or physical systems. One writer has called them "operational games" to underline the fact that they are just as serious in their own way as the war games employed by military authorities.[1] As games, educational simulations have gripped the imaginations and energies of the educational community as few developments of modern times have done. The National Council for the Social Studies in a recent series of articles titled "Simulation: the Game Explosion" has pointed out that no other topic provides its journal with so many manuscripts.[2] The Foreign Policy Association, in *Simulation Games for Social Studies Classrooms*, goes further than most in claiming that "we are in the beginning stages of a movement not a technique."[3]

Games represent a particularly high point of interest but the phrase "educational simulations" means many more things than games. R. J. Chorley and P. Haggett have shown that simulations have long been a feature of geography.[4] R. G. Klietsch has described simulations more generally as "systems designed to replicate essential aspects of reality for the purpose of finding ways of managing, controlling, solving, and

ultimately agreeing on optimal solutions for problems."[5] "Educational simulations" simply means the harnessing of simulations for educational purposes — for organizing information, for posing problems, and for stimulating interest. The strong emphasis given here to simulation games is due to their ability to serve many educational purposes at once.

Game simulations in one form or another date back thousands of years, yet there is an amazingly small theoretical literature on them. This may be the result of a long-standing feeling that games are not essential ingredients for life. They have been variously described over the past century as "unnecessary activities," "non-productive activities," or "time wasting activities." Perhaps not until the time of John Dewey did they gain respectability in the education community.

> The core principles of the technique — e.g., the active and simultaneous participation of all students in an educational game, with the teacher in the role of aid rather than judge; the internal rather than external locus of rewards, and thus motivation, in a game; and the linking of the student to the outside world through the simulated environment . . . can all be traced to one or another of Dewey's works.[6]

Some have suggested that the game innovations of the 1960's represent a second and more accurate translation into classroom practice of Dewey's principles of progressive education.

In this chapter attention will be directed to research findings on educational simulations; to procedural devices for designing simulation games; to descriptions of particular geographic simulations — detailed accounts of a simulation game and an instructional simulation, and brief descriptions of others; and to a summary of advantages and disadvantages of educational simulations.

Research Findings*

Sarane Boocock has reported on the good effects of simulations on previously withdrawn, unresponsive, nonachieving troublemakers.[7] But the same data has revealed no significant correlation between learning in a game situation and performance in conventional settings. Cleo Cherryholmes has reported on the powerful motivational effects of

**The author is particularly indebted to Paul A. Twelker of Teaching Research, Monmouth, Oregon, for help in the preparation of this section and, to a lesser extent, of other sections.*

simulations.[8] Jerry Fletcher, while reporting on his attempts to define operationally many of the possible dependent variables used in research on learning, had this to say about prevailing conditions:

There are very few playable games on which research can be done; the games which do exist vary enormously in their basic features; and most simulation games are not designed according to any theory about the mechanism by which a player could learn from them.[9]

Fletcher's research findings point to large sex differences in the quality of play, boys far outperforming girls. Because of the inconclusive character of so much of the research work done to date, it might be better to summarize the present situation in terms of hypotheses rather than findings. Project Simile has done this for us.

HUNCHES ABOUT SIMULATIONS
Developed by HALL SPRAGUE and R. GARRY SHIRTS
of
Project SIMILE
Western Behavioral Sciences Institute
May, 1966

1. Maybe simulations are "motivators." Their main payoff may be that they generate enthusiasm for or commitment to: (a) learning in general, (b) social studies or some other subject area, (c) a specific discipline like history, (d) a specific course, or (e) a specific teacher.
2. Maybe a simulation experience leads students to more sophisticated and relevant inquiry. That is, perhaps the important thing is what happens after the simulation is over.
3. Maybe simulations give participants a more integrated view of some of the ways of men. Maybe they see the interconnectedness of political, social, inter-personal, cultural, economic, historical, etc., factors.
4. Maybe participants in simulations learn skills: decision-making, resource allocation, communication, persuasion, influence-resisting.
5. Maybe simulations affect attitudes: (a) maybe participants gain empathy for real-life decision-makers; (b) maybe they get a feeling that life is much more complicated than they ever imagined; (c) maybe they get a feeling that they can do something important about affecting their personal life or the nation or the world.
6. Maybe simulations provide participants with explicit, experiential, gut-level referents about ideas, concepts, and words used to describe human behavior.
7. Maybe participants in simulations learn the form and content of the model which lies behind the simulation.

8. Maybe the main importance of simulations is their effect on the social setting in which learning takes place. Maybe their physical format alone, which demands a significant departure from the usual setup of a classroom (chair shuffling, grouping, possibly room dividers, etc.), produces a more relaxed, natural exchange between teacher and students later on.
9. Maybe simulations lead to personal growth. The high degree of involvement may provide some of the outcomes hoped for from T-groups, sensitivity training, basic encounter groups, etc.

Simulation Game Design

In traditional social studies courses, decision-making opportunities that lead the student to an appreciation of his role in changing things rank high in the initial statements of objectives. But the translation of these objectives into appropriate learning experiences has rarely been evident. In simulation games design makes quite explicit the decisions to be made by each player, together with the concrete circumstances in which he will make his decision. This is good training for the citizen of tomorrow's world.

The first step in game design then is the identification of outcomes.[10] These outcomes are related to place, time, or function and so the identification of the bounds that mark the "where," "when," and "what" is the starting point in the process of analysis. The analysis begins by identifying the decision-making components such as government or individual citizens. Roles for players within each component are then spelled out. This includes the recognition for each role player of his goals, the way in which his decisions might affect the total outcome, the measure of success he can be expected to achieve, and the resources available to him. These items set the stage for significant decision-making, a stage that will represent a compromise between the reality being simulated and the degree of complexity permissible for the game.

The second step in design is the planning of the game in a step by step fashion. The relative importance of each role is stipulated. The possible interactions between players are tabulated, and these may be cooperative or competitive. The sequence of events is next determined either as a series of similar cycles or as a fixed number of moves. In this sequence the external factors must be taken into account. By external factors are meant those conditions such as weather, or behavior of people in other parts of the country, which are beyond the control of the players but affect the outcome. Often these external factors will be introduced by a throw of a die. As a final phase of game planning

the physical factors are selected — a board for each player, one large board for a whole game, or simply paper and pencils.

Several experimental playings of a game are necessary to get the "bugs" out of it. Idle time for players has to be eliminated. Calculations that "drag" in the course of the game have to be simplified or speeded up. Rules have to be tightened up so that they are not likely to be misunderstood. Tradeoffs may have to be made between conflicting factors.

Concentration on one topic may be desirable for better understanding, even at the expense of comprehensive coverage of the theme. Dramatic phases of play may be necessary for stimulating interest even at the expense of calm discussion of serious topics. Indeed, because of the wide range of abilities and ages for which most games seem to be suitable, it may be highly desirable to make the game playable at several levels of complexity. This can be done by introducing a series of complications that make the game increasingly realistic for more experienced or more mature students.

Geographic Simulations

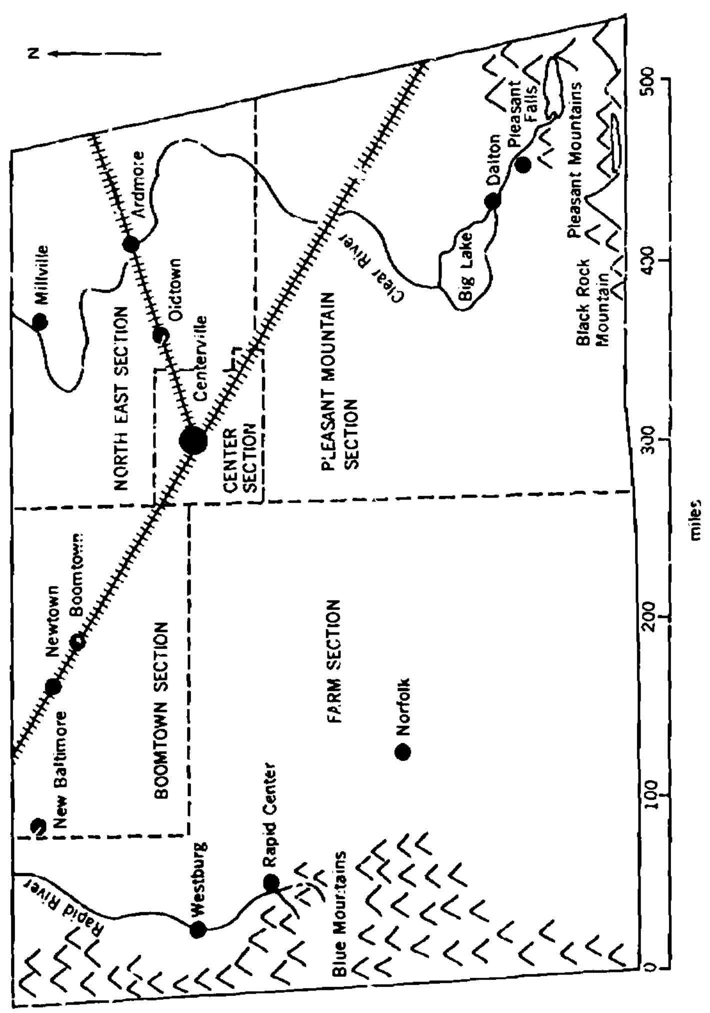
SECTION: A SIMULATION GAME [11]

The game of *Section* was designed to provide students with an understanding of the conflicts of interests among the sections of a political territory as they are expressed in the political process. Regional competition occurs at two levels. First, there is political competition within each section because it includes people and groups of different social and economic interests. Second, there is political competition among sections, each expressing certain dominant interests. Only the latter competition is directly represented in the political arena.

So that students actually experience the pressures of conflicting interests at both individual and sectional levels, the game requires that students deal with each other as citizens of a hypothetical state, Midland, USA. Midland is a simplified representation of any state, composed of a capital, Centerville, and four sections: an agricultural section (Farm); a growing manufacturing section (Boomtown); a declining manufacturing section (North East); and an underdeveloped rural section (Pleasant Mountains). Each sectional team desires state aid for several improvements. Each individual within the section wants those improvements that he thinks will bring him the greatest personal benefit.

FIGURE 1

Title: State of Midland



The information necessary for play is provided through a regional scenario *(The Midland Gazette)* and role profiles. In the scenario, social and economic characteristics of each section are described and the needs of each section are indicated either implicitly or explicitly. The role profiles give each student a unique personality and outline his individual interests.

To emphasize regional political competition, *Section* focuses on the period just prior to a session of the state legislature that will allocate funds for public projects in the state on the basis of sectional requests. In the first phase of the game, the members of each section prepare a proposal requesting state funds for desirable projects. Several steps occur during this phase. First, each section member and his representative meet to identify sectional needs. Then, players are given an opportunity to communicate with members from other sections in order to define mutually beneficial projects. Next, students return to their sectional teams to prepare proposals under the leadership of their representatives. These proposals are then presented to the State Executive Committee by the political representative. The representative, then, returns to his constituents to discuss the tentative budget plan. If this plan is acceptable to the constituents, the representative will try to have the budget approved. If it is unacceptable, the representative will try to have it redrafted. No predetermined outcome has been built into the game.

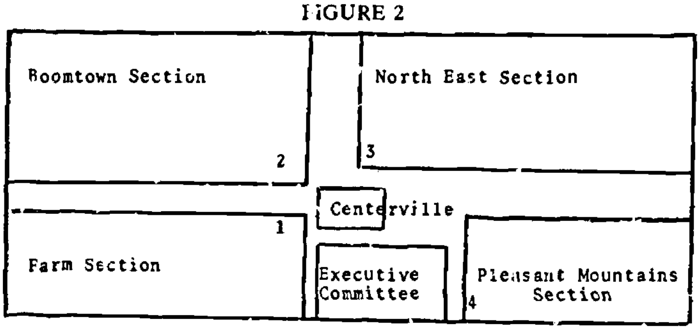
In the second phase, the political consequences of the game are assessed. Each citizen will indicate his satisfaction or dissatisfaction with the approved budget by voting on a scale of points from one to ten for his sectional representative. The representative with the highest number of points is the winning representative. Simultaneously, representatives will vote on whether or not the Executive Committee should continue in power. Finally, a calculation will determine the winning sectional team. Rules for scoring procedures are given under Scoring. The game will conclude with a class discussion of the concepts learned during the playing of the game.

Guidelines

The estimated teaching time is seven days.

The classroom is divided into six sections in accordance with the following description, and the players should be assigned to the appropriate part of the room.

FIGURE 2



Scenario Sample

THE MIDLAND GAZETTE

BUDGET FEVER?

Centerville, Midland

The streets of this two-hundred-year-old state capital are gay with flags, the hotels are packed, and the sort of excitement normally associated with election campaigns is in the air. The elections are still six months away, but the results of those elections and the political careers of the representatives may be determined by the legislative session that starts in five days. The crucial issue for this session will be the appropriation of a $25 million budget for the various needs of the different sections of the state.

Role Profile Sample

BOOMTOWN

ARTHUR DOLE

Unemployed Worker

You dropped out of high school in the 10th grade feeling that nothing you were learning had any relevance to your life. You are intelligent, but undereducated, and have become the spokesman for a fairly large group of unemployed workers. You have held down various jobs at various times, but lack the skills for the plum jobs in the paper mills or the synthetic fabrics industry. You envy and resent the highly paid employed workers. You have come to realize that training is necessary before you will ever get a highly paid job, and you and your group have got together to lobby your representative to get state funds for a vocational training college. The factories themselves find it cheaper to pay very high wages than to spend the time and money necessary for an effective training program. Most of your group and you, yourself, live in expensive substandard housing and your children go to inferior overcrowded schools. You want the state to help break the vicious circle, fund urban renewal and school building.

You should decide which of these things you want most, and then do your best to secure funds for some or all of these projects

The above is a small part of the total activity but it may be adequate to give a picture of the whole. In school trials with some twelve hundred ninth graders and six hundred tenth graders, interest in *Section* was extremely high. Both teachers and students rated this activity above eight other political geography activities that employed more traditional strategies. Furthermore, one-third of those involved in teaching all nine activities concluded that the objectives of the nine could be achieved through the *Game of Section* alone.

BLOCKADE-PASS ROUTE: AN INSTRUCTIONAL SIMULATION [12]

This simulation is part of a series of activities in which some of the factors influencing the spread of ideas are isolated and incorporated in student behaviors. The purpose of the series is to demonstrate the processes by which ideas and information are spread from one person to another or from one group to another.

The details of the student activities in *Blockade-Pass Route* are listed below together with student answers. The work is done on an individual basis either at home or in class and then discussed in class. The following extracts are typical of the suggestions provided for teachers for the conduct of this discussion session.

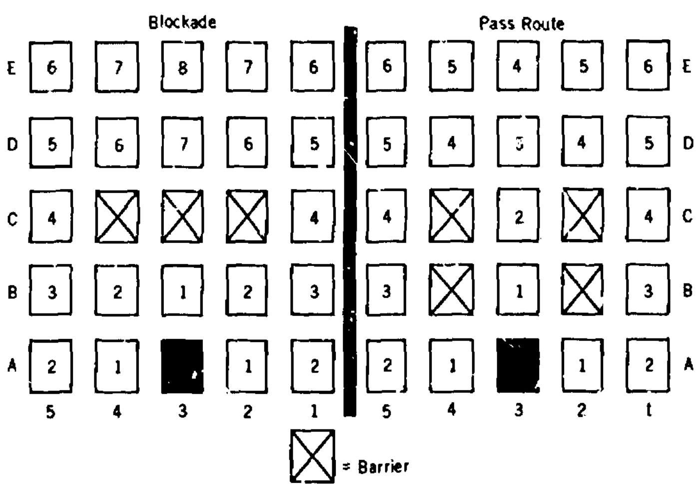
Discussion might commence with the question: Why did "Blockade" with only three boxes as a barrier impose a greater obstacle to the flow of an idea than "Pass Route" with four?

The simplest answer is that the direction of the barrier, and whether it is solid or has gaps in it, are as important as the size. A smaller barrier at right angles to the flow can alter or delay innovation waves more than a larger barrier that is parallel to the flow or has gaps in it. Thus, barriers are important in influencing the pattern and the rate of the spread or diffusion of ideas.

Can you give examples of real-life barriers to the spread of ideas and tell how they are comparable to the "Blockade" and "Pass Route" examples? Your class could come up with any number of examples. You should make a list of them on the chalk board as they are suggested. A few possibilities are:

1. Distance: As has already been pointed out, this can operate as a barrier.
2. Mountains: If a mountain range is very high and inhospitable, it might work like the "Blockade" example; if it is cut by some easy passes, it could operate as the "Pass Route" example.

Blockade-Pass Route
(Note: answers included here)



Purpose: This exercise lets you see how different barriers affect the flow of information in an area.

Instructions: 1. On each of the above maps, "Blockade" and "Pass Route," use box A-3 as your starting point. Decide which boxes A-3 can reach by the rules of the game, which are the same as those you have already used in class. You can move only one box at a time and at right angles. You must not move diagonally or skip. The idea cannot pass over or through any barrier marked with an (X).

2. Write the number 1 in all the boxes A-3 can reach under the rules; 2 in all the boxes the 1's can reach; and so on until all the blanks on both maps are filled except those containing an X. No numbers are permitted in the X boxes.

3. Draw a line that marks the front edge (boundary) of all your 1's; then a line marking the boundary of your 2's; and finally complete the map with similar lines for each number.

4. Write the highest number that appears on each map:

Blockade Pass Route

This will tell you how many series of passes were needed to spread the new information over the whole of each map.

5. Some boxes received the idea on a later pass than would have been the case without the barriers. Write the numbers of the boxes affected:

On Blockade On Pass Route

3. Deserts: Again, if the desert is a solid inhospitable area, it would be similar to "Blockade." If it were sprinkled with oases, then it would be similar to "Pass Route."
4. Forests: A tropical rain forest might present a "Blockade" type of barrier or, if cut by many navigable rivers, it might resemble "Pass Route."

Now point out to the class that they have been concentrating on physical barriers, but that there are other barriers to the spread of ideas which we might call "cultural" or "human." The effect of cultural barriers on the spread of ideas seems to be more complex than the operation of physical barriers, perhaps because human actions are as yet less well understood. Again here are some possibilities:

1. Language or cultural differences which make it difficult for the innovator to "put across" his idea or for the receiver to understand the new idea.
2. Political, social, and religious systems which strongly oppose the introduction of a new idea or new ideas in general, especially if they contradict elements which are essential to maintaining the system.
3. Lack of need or desire for the new idea. Ask the students how they think ear muffs and steam heat would "go over" in the tropics.
4. Difficulty in making the new idea fit into the receiver's culture.
5. Individual resistances to innovation.

How are these examples similar to "Blockade" and "Pass Route"?

As with the physical barrier examples, each of these can range from a condition of almost complete "Blockade" to a "Pass Route" type of situation.

The so-called Iron Curtain following World War II presented a "Blockade" type of barrier to the exchange of ideas between Eastern and Western Europe. More recently, however, opportunities for exchange (that is, diffusion in both directions) have expanded and we have a situation more akin to "Pass Route."

OTHER GEOGRAPHIC SIMULATIONS

The following brief descriptions are culled from a variety of sources. The burgeoning literature in the field of educational simulations demands daily attention if a sampling of this kind is to be made representative of the state-of-the-art. At the time of writing the author would recommend for beginners the Foreign Policy Association's *New Dimensions: Simulation Games for Social Studies Classrooms.* This book provides brief descriptions of twenty-five simulations. For more advanced study, the author would recommend *Instructional Simulation Systems* published by The Continuing Education Press. This book provides brief descriptions of over two hundred simulations and lists sources

for hundreds more. The latest edition of this book will also give information on availability of the simulations listed here:

1. *Eurocard*
   Preschool — 12th grade
   A four game kit which teaches speed recognition of the size, shape, and location of European countries, teaches players to use reference books (almanacs, atlases, textbooks) quickly and efficiently, and helps students to organize and summarize information clearly and succinctly.
2. *The Market Place*
   Game, Elementary
   Children learn how the Kikuyu market place operates.
3. *Sierra Leone*
   Elementary
   An experimental, computer-based game in which the student assumes the role of an American economic adviser attempting to improve various aspects of the economy in different parts of the country.
4. *Seal Hunting*
   5th grade
   A board game simulating some Eskimo strategies for securing seals. These include sharing patterns as well as technological strategies. Presently available only within trial teaching edition of "Man — A Course of Study."
5. *Caribou Hunting*
   5th grade
   A board game (map) simulating some of the difficulties Eskimos experience in hunting caribou. Students have an opportunity to compare results of two hunting techniques, one of which requires cooperation and the other of which does not. Presently available only within trial teaching edition of "Man — A Course of Study," a 5th grade course.
6. *Cargoes*
   Elementary - Junior High School
   A seafaring game — around the world trip in a cargo ship. Modern, large Mercator projection map is game board.
7. *Disaster*
   Junior High - Senior High Adult
   Simulates some problems faced by individuals when a community is hit by a localized natural disaster.
8. *Trade and Develop*
   Junior and Senior High
   Simulates the processes of international trade and economic development as players make decisions about production, trade, and investment.
9. *Point Roberts*
   Senior High
   Students play roles of Canadians and Americans in a simulation that approximates the way in which a boundary dispute might arise and be settled.
10. *Metfab*
    Senior High
    Simulates some factors involved in deciding where to locate a factory.
11. *Farming*
    Senior High
    Players assume the role of a farmer in Kansas during three different periods in American history, beginning in 1888.
12. *Inter-nation Simulation*
    Senior High - Adult
    A simulation of international relations, including the inter-relationship of domestic and foreign policy.

13. *City I*
Senior High - Adult
Involves various social, economic, and political relationships in a simulated urban center and its three suburbs and includes an integration of systemic and role-playing approaches. For information write Peter House, Director, Urban Systems Simulations, The Washington Center for Metropolitan Studies, 1717 Massachusetts Avenue, N.W., Washington, D.C. 20036.
14. *Region*
Senior High - Adult
Through economic and political decisions and interteam conflicts and compromises, participants obtain an interdisciplinary view of the problems of a growing urban region. For information write Urban Systems Simulations.

Advantages and Disadvantages

For the scientific community, simulations have quite specific advantages. They help to refine scientific thinking by developing and testing hypotheses.[13] They focus on the process rather than the product of scientific investigation. This is most important in a subject such as geography where information may be so transitory as to make it not worth knowing. It is important to recognize these values as we come to an assessment of educational simulations for they mean that we are dealing with a technique that has significance for scholar and teacher alike.

One of the fundamental advantages of educational simulations is their ability to act as a bridge linking the real world with our abstract ideas of reality. Direct study of the environment by the inexperienced usually fails to secure the kind of clear thinking necessary for decision-making. The jungle of sights and sounds hides its secrets. All the facts, processes, and strategies that the student should know can be better understood in the context of a simulation.

A more significant advantage relates to student interest. If a student is intensely interested in learning, he will work harder, remember longer, and make better use of what he has learned. The fact of student interest in simulation gaming is well-established. The long-standing interest of young people in role-playing, the freedom from direct teacher control for a large part of a lesson, the opportunity to learn from peers instead of adults — a mode of learning that is frequently underestimated — and the challenge of an unknown outcome all help to create this interest.

Outcomes too have significant advantages over traditional forms of learning. Empathy is heightened as a result of the high involvement demanded by a simulation activity. The real-life penalties of mistakes are realistically experienced. The role of chance in real life is better understood.

But just as there are advantages so there are disadvantages. The remarkable success that has attended the use of educational simulations must not be overrated. The validity of a simulation game may be affected by the personality of the players. A weak student acting as head of state may give quite a wrong impression of the constraints that operate in real-life situations. The political realism of some games and the experience of losing a game may be a shock for some students.

Most rewards in educational simulations are goods or money. It is difficult to arrange rewards in other ways. Some have suggested that this circumstance gives too materialistic a view of life. Perhaps alongside that limitation may be placed the criticism that simulation gaming constitutes too simplistic a view of life. In the light of this criticism, the role of the computer needs to be stressed.

To oversimplify the socioeconomic reality of a situation is not necessarily bad but, if it is an undesirable feature, then the computer is one outstanding device in which a complex reality can be closely matched. One example is the Urban Systems Simulations being developed in Washington, D.C. With computer-based simulations such as these, there are at least two outstanding advantages:

1. Accurate calculations may be made of large amounts of data in a very short period of time. There is no need for the student to know the complex formulas involved. Take, for example, the *Sumerian Game*, which was developed by IBM in cooperation with the Board of Cooperative Educational Services, Westchester, New York, as a computer game for sixth graders. The student assumes the role of a priest-king in Mesopotamia 5,000 years ago. In successive phases of the game, he is faced with problems of expanding population, irrigation, and foreign trade. The formulas involved are quite complex, yet all the student is required to do is to type his questions and read his answers. In the case of change in population from one season to the next, the following formula is employed:

ΔP, change in population between seasons i and i + 1, as a function of the number of bushels of grain fed to the people in season i(F), and the population in season i(P):

$$\Delta P(F,P) = \begin{cases} [(F/9P) - 1]\,P & \text{if } F/P \leq 9 \\ 0 & \text{if } 9 \leq F/P \leq 15 \\ 0.01[(F/P) - 15]\,P & \text{if } 15 \leq F/P \leq 18 \\ 0.03\,P & \text{if } 18 \leq F/P. \end{cases}$$

Thus, the player who feeds his people less than 9 bushels/person will face a loss in population while the player who feeds his people more than 18

bushels/person is wasting grain. Feeding exactly 18 bushels per person will allow the greatest rate of population growth without squandering resources.[14]

It is much better to have all this information hidden away in the computer than to expose the student to mathematical computations or to use mechanical devices for calculating results.

2. Changes may be made almost instantaneously in the most complicated formulas. This allows for the easy introduction of any complicating circumstances that the game may demand. Again, for example, in the *Sumerian Game*, if insufficient food has been fed to the people so that (a) more than one-half of the population would starve, and (b) there remains a large inventory of grain in the warehouse at midseason, the player is given the message: "Sir, your people are starving and there are NNNN bushels of grain in inventory. How much will you distribute to them?" In the model it is assumed in this situation that the people have shared the grain in such a way as to keep the maximum number alive through midseason. If the ruler releases enough grain from storage, his population loss will not be as severe as it would have been otherwise.

To return from this digression to the subject of disadvantages, there are some additional considerations. Games are time-consuming both in design and in use. We have to ask ourselves, "Are the results worth the time cost? Are there equally worthwhile results that cost less time"? Perhaps most serious of all is an objection which John D. Baldwin has raised.[15] Baldwin argues that game designers and administrators can exert subtle pressures that make players conform to expectations rather than respond to the structure of games. What he is really saying is that simulation games can be first-rate brain washers.

His argument goes something like this: In theory players develop strategies and behaviors for coping with the simulated environment, and these will correspond to the strategies and behaviors normally found in the environment that is being simulated. In practice the following elements of persuasion are found:

(a) Direct verbal or written instructions are given about how the players ought to behave. This is done with the best intention but, like the other elements listed here, they set a behavior mold for the players that often differs from their perception of the game situation.

(b) Labels are applied to the game elements, and these labels can have a powerful effect on people's expectations in social interactions.

(c) Excessive rules, constraints, and payoffs are built into the simulation as a result of tryouts.

(d) A sequence of increasing complexity is built into a simulation so that players can develop an increasing degree of sophistication in coping with the game. But the order in which successive strategies are arranged profoundly biases the options that may be exercised at an advanced stage.

Baldwin points out that all of these dangers can be avoided if they are recognized. His main reason for pointing them out is to stress a general lack of awareness among designers and administrators.

In conclusion, the central role of the student in any educational endeavor needs to be stressed. Educational simulations are means to an end, decision-making for students in real-life situations. The question must be asked at the conclusion of every simulation game: How real are these situations to the students? In a post-game class discussion, the students' game experiences can be compared with their perceptions of reality. Subsequent games can be redesigned in the light of this discussion. We may be surprised at the depth and scope of these perceptions. We may find that even young students can handle complex simulations and come up with surprising decisions.

FOOTNOTES

[1] See Walford, Rex. "Operational Games and Geography Teaching." *Geography* 54:34-42; Part 1, January, 1969; and *Gaming in Geography*. London: Longmans, 1969.

[2] "Simulation: The Game Explosion." *Social Education* 33:175-199; No. 2, February, 1969. See also the following: Zieler, Richard. *Games for School Use: a Bibliography*. Yorktown Heights, N.Y.: Center for Educational Services and Research, Board of Cooperative Educational Services, 1968; and *Instructional Simulation Systems: An Annotated Bibliography*. Corvallis, Ore.: Continuing Education Press, 1969.

[3] Foreign Policy Association. "Simulation Games for Social Studies Classrooms." *New Dimensions* Vol. 1; No. 1, 1968.

[4] Chorley, Richard J. and Haggett, Peter, editors. *Models in Geography*. London: Methuen, 1967.

[5] Klietsch, R. G. *An Introduction to Learning Games and Instructional Simulations*. Newport, Minn.: Instructional Simulations, 1969.

[6] Boocock, Sarane S. and Schild, E. O., editors. *Simulation Games in Learning*. Beverly Hills, Calif.: Sage Publications, 1968. p. 57.

[7] Boocock and Schild, p. 256.

[8] Cherryholmes, Cleo H. "Some Current Research on Effectiveness of Educational Simulations." *American Behavioral Scientist* 10:4-7; No. 2, October, 1966. p. 5.

[9] Twelker, Paul A. *Instructional Simulation Newsletter* 2; June, 1969. p. 5.

[10] Abt, Clark C. "Education Is Child's Play," in *Inventing Education for the Future.* Hirsch, Werner Z. *et al.,* editors. San Francisco: Chandler, 1967. p. 151.

[11] Based on High School Geography Project. *Political Geography* activity, "Game of Section," which was designed by Alice Gordon of Abt Associates, Cambridge, Mass.

[12] Based on High School Geography Project. *Cultural Geography* activity. "Game Illustrating the Spread of Ideas."

[13] Coleman, James S. "Games as Vehicles for Social Theory." *American Behavioral Scientist* 12:2-6; No. 6, July-August, 1969.

[14] Leonard, J. M. and Wing, R. L. "Advantages of Using a Computer in Some Kinds of Educational Games." *IEEE Transactions on Human Factors in Electronics.* June, 1967. p. 77.

[15] Baldwin, John D. "Influences Detrimental to Simulation Gaming." *American Behavioral Scientist* 12:14-20; No. 6, July-August, 1969.

Chapter 14

Evaluating Geographic Learning

Dana G. Kurfman

This chapter begins with a discussion of three purposes of evaluation that are important to teachers. Evaluation is discussed in terms of assigning grades, diagnosing student progress, and improving instruction. The largest single part of the chapter discusses a variety of geographic objectives and suggests ways by which achievement of each might be evaluated. A third part of the chapter provides suggestions for preparing geography tests and interpreting the results.

Three Purposes of Classroom Evaluation Data

When most teachers think of evaluation they think of classroom tests. This suggests that the best place to begin a discussion of the purposes of evaluation is with a test and the data that it yields. For simplicity, let us assume that a unit test on Latin America has been administered to a class. The data normally obtained from such a test administration consist of scores for individual students. In addition to this, it is possible to determine the percentage of students getting each of the questions right. As we shall see, both types of information are useful for evaluation purposes.

Although a number of other purposes could be mentioned, we will concentrate on just three. One of these is the assignment of grades to

students. Turning raw data from a unit test into a grade is one type of evaluative judgment. A second function of such test information is its use in diagnosing what individual students do and do not know so that this information can be used in improving their learning. Deciding that a student is either weak or strong in some particular area of learning is thus another type of evaluative judgment. Finally, the information obtained from administering a test can be used to improve teaching procedures and materials. This means that evaluative judgments can be made about the effectiveness of the procedures and materials used to teach the unit.

Surely the most common use of evaluation data by teachers is in grading students. A grade on a unit test, combined with other grades, finally results in a reported grade. This is a use of test data to make evaluative judgments that are essentially external to the learning process. Such evaluations of student performance, of course, may not be completely external because grades have a significant impact on some students, sometimes motivating them to try harder and sometimes motivating them to give up. But the essential function of a grade is the report it provides of how well a student is doing. Parents, other teachers, educational administrators, and sometimes future employers have an interest in this report.

A grade is evaluative in the sense that the student's performance is judged good, average, or poor in terms of some standards that the teacher is using. Clearly the label "satisfactory" or "unsatisfactory" is a form of grade as are the letters "A" or "C". Letter grades simply provide more gradations than the former. The most extreme example of trying to be refined in assigning grades is the use of a specific percentage score as a grade. Whatever the system used in a particular school, the teacher is called on to rate student performance in some manner that has meaning for parents and school administrators.

One of the problems in rating student performance is the basis on which the rating is made. Teachers tend to have two things in mind and quite commonly vacillate between the two. One is the idea of mastery, and the other is the standing of the learner in relation to other learners. The idea of mastery makes sense for a number of learning objectives, but it makes considerably less sense for others. Mastery is possible when the objective to be achieved can be clearly delimited. For example, a student can master the multiplication tables from one through twelve. He can master the spelling of a list of words. He can

master the identification of state capitals. In other words, for purely informational objectives of a specified sort, it is possible to talk about mastery as one hundred percent recall of the information. Teachers quite commonly require that students master some body of information in order to get an "A" and they then assign lower grades for varying percentages of mastery.

The idea that students can achieve mastery or some percentage of mastery has been transferred to other learning objectives for which it has less applicability. With more complex educational objectives, such as understanding a concept or performing some skill, there is no clearly established point of mastery. For most concepts and skills, there is no limit to human understanding or capability. For example, there can always be increased understanding of *accessibility* or *cultural relativity*. In a sense they can be thought of as continuous rather than discrete variables. Of course, teachers can specify a task to be performed and call its performance mastery, but it is clearly the task that is mastered and not an idea or a skill.

With such objectives it is only sensible to rate a learner's performance on a continuum in terms of other learners or in terms of some imagined potential of a given learner. Most teachers, in fact, evaluate student performance in terms of how well other learners are performing. This is the case even though they may retain some of the trappings of the mastery concept.

Another major purpose of classroom evaluation is the diagnosis of student progress.[1] The results of a unit test on Latin America can be used to help students understand their strengths and weaknesses. Implicit in this, of course, is the assumption that this information can be used by students to improve their succeeding performance. If such a unit test is indeed conceived to be the final test for the unit before going on with something different, it can be of little help in diagnosing strengths and weaknesses.

Ideally, however, after such a diagnosis the student would have other opportunities to demonstrate his ability and understanding with respect to Latin America. However, even if this is not the case, there is something to be gained by looking at test results in terms of what the student can learn about himself from the analysis. One of the things he can learn is how to organize his thoughts for an effective essay presentation. He might also see some of his weaknesses in reading and interpreting maps, or note that he has not devised ways by which to

recall major points of information. However, if the major purpose of the test is grading student performance, then an analysis-diagnosis session will have minimum effectiveness.

When people speak of evaluation as an inherent part of the learning process itself, they have in mind this diagnostic purpose. Conceived of this way, evaluation data constitute the information to be fed back into the learning system. Almost all learning of an informal sort involves trying out an idea or skill and revising it in terms of the results that are obtained. Clearly more of education should include a rapid cycling back of evaluation information so that the learner can revise his ideas and his practices.

A third purpose of evaluation data of significance for teachers is its use in improving instruction.[2] Instruction means both the procedures and the materials that are used in teaching a unit such as the one on Latin America. Presumably, the procedures and materials might have included one or more days of class discussion on the economic resources of the region, a film on its population problems, a reading analyzing the ethnic composition of the region, and a panel discussion or simulation dealing with inter-American cooperation.

The key to using test data in improving instruction is the ability to relate test and questionnaire items to some distinguishable feature of the unit. For this purpose the average score on each item is important and not the scores of individual students. As few as 20 percent of the students may get certain questions right while as many as 90 percent may get other questions right. When such item data are related to specific procedures and materials, they provide information about the effectiveness of the procedures and materials. Thus, especially positive results on items dealing with the population problems of Latin America would speak for the effectiveness of the film used. Likewise, rather poor results for items dealing with inter-American cooperation would suggest the ineffectiveness of the procedures used in teaching this part of the unit. Opinion questions can also be used on questionnaires to pinpoint parts of the unit that appeared to be unclear, insignificant, or uninteresting to students.

Of course, there are problems in interpreting test and questionnaire data. It is not always evident that some results are really positive and others are really negative; however, experience in using test and questionnaire data for this purpose will permit more and more intelligent evaluative judgments to be made about the teaching procedures

and materials used. When this purpose becomes important to a teacher, he will find that his instruction and evaluation are more carefully planned to make the results of tests and questionnaires useful in evaluating instructional procedures and materials.

It has been assumed throughout this discussion of the uses of evaluation data that the same test could adequately serve as an information gathering device for all three major evaluation purposes. To a certain extent this is true. However, it should be kept in mind that the traditional unit test was developed primarily as an instrument for obtaining information about students so that grades could be assigned.

For teachers who place a high value on the diagnosis of student progress, additional evaluation devices will come to mind. For example, such teachers might encourage students to evaluate their own performance. In the process they may become more conscious of the learning objectives that might reasonably be sought in a geography course. They might also begin to construct evaluation instruments that are made up of subtests to be used in analyzing a student's relative strengths and weaknesses. Since diagnostic evaluation is time-consuming, teachers might begin to think how students can help one another gather evaluative data. Self-help teams can be organized in the classroom to perform this function. With evaluation conceived of as a part of a process for improving learning, students can be encouraged to help one another, just as the teacher can come to serve the function of helper rather than grader.

In like manner, when improving instruction becomes a purpose of evaluation, teachers will use much more questionnaire data than they presently do. Questions can be used with students to obtain their opinions about the interest, clarity, and worth of various procedures and materials. Questionnaire data thus become a necessary supplement to data about student performance.

The Measurement of Geographic Objectives

The literature of geographic education is filled with statements of objectives, goals, and purposes. Discussion of what is educationally significant in geography makes a useful contribution to those who develop geography courses and teach them. Pattison[3] has done an excellent job in distinguishing some of the major schools of thought with respect to the educational purposes served by geography. Bacon,[4] Helburn,[5] and Scarfe[6] have all published statements of objec-

tives that may be helpful to teachers in clarifying what they wish to accomplish. However, it is not a purpose of this chapter to evaluate the objectives of geographers and teachers of geography.

There is a sense, however, in which the evaluation of geographic objectives warrants some consideration in this chapter. This is the way that geography objectives are conceived and stated. Advocates of behavioral objectives [7] suggest that one of the most important educational activities of teachers should be a careful statement of their objectives. A carefully stated objective suggests precisely what students will do to demonstrate their attainment of the objective.[8] Specificity is required in terms of the act tnat the student will perform, the standards that will be used to judge the quality of the performance, and the circumstances in which the act will take place. Because of the impossibility of busy teachers ever doing all of this for all of their objectives, they are likely to feel guilty about their failure or disdainful of all discussions of specific objectives.

Yet, in spite of this excessive emphasis on the format of objectives, the behaviorist movement in education does have something significant to say to geography teachers about their objectives. First, it says that objectives should be thought of and subsequently stated in terms of things that students will say or do. This means that it is completely inadequate for a teacher to describe his objectives as showing a movie or lecturing about the Soviet Union. Teachers should get into the habit of thinking of their objectives in terms of ideas, skills, and attitudes that can be possessed by students.

The second significant point made by advocates of behavioral objectives is that such objectives should imply some action by students demonstrating their acquisition or attainment of the objectives. If teachers are unable to formulate an objective in terms of student actions or expressions, then there is a serious question about its reality. An effective thing for a teacher to do is ask himself what sorts of statements, responses, or behaviors would indicate a student has accomplished the objective.

A way of stating objectives in this limited behavioral fashion is suggested by the following formulation of a unit objective and its subsequent reformulation in two different activities of a unit taken from the High School Geography Project: [9]

At the conclusion of the unit the student should be better able to . . . illustrate how people have both modified their physical environment and adapted to it.

At the conclusion of the activity the student should be better able to . . . describe examples of human adjustment to the physical habitat. For example, . . . describe the influence of the river on the pattern of settlement in New Orleans and such adaptations as bridges, canals and above ground cemeteries.

At the conclusion of the activity the students should be better able to . . . cite examples showing how people have modified their physical environment and adapted to it. For example, . . . give several examples of how the people of Portsville used and changed their physical environment.

Thus, it is possible to evaluate how objectives are stated in terms of whether they suggest what can be done to indicate their attainment. It is relatively simple for teachers to become practiced in using acceptable verbs, such as "describe," "demonstrate," and "identify," rather than "know," "understand," and "appreciate." The critical matter, however, is that teachers begin to think in terms of how students will demonstrate their grasp of objectives and, therefore, be prepared to answer probing questions about the meaning of an objective in terms of student verbal and nonverbal behaviors.

If we examine existing geography programs, as described in courses of study and in such new courses as the HSGP's *Geography in an Urban Age,* it is clear that a wide variety of objectives is considered important. These range from an openness in considering alternative hypotheses to skills of map and graph reading; from attitudes about peoples and processes to knowledge of locational information; from a sense of how things are distributed throughout the world to an awareness of factors influencing the location of things.

Most Americans and many geography teachers accept locational knowledge as a major geography objective. The problem is that the number of nations, mountains, cities, and bays seems to be unlimited. Moreover, those which have significance in one era, may not have significance in another era. Nevertheless, it is acknowledged that knowing where Communist China, the Soviet Union, Japan, and the United States are in relation to one another helps people in their thinking about current affairs. What is clear is that throughout geography instruction there needs to be some degree of attention given to the location of physical and cultural objects.

However, when place location knowledge becomes the major objective of geography teaching, the result is often a sad spectacle of students seeking to memorize all the capes and bays of an area, or all the counties in a state, or all the capitals of all of the states. Place

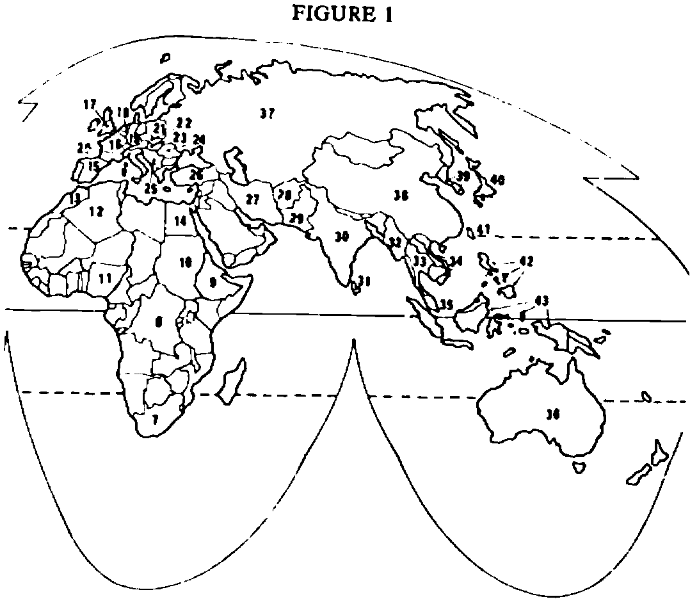
location knowledge learned this way is nonfunctional for most students; consequently, such knowledge is quickly forgotten. A better perspective is obtained when the place location objective is understood as knowing where things are in relation to other relevant things. This also suggests the way that test questions should be formulated.

A world or regional map, such as the one shown in Figure 1, with places indicated by numbers, can be used. The places can be nations, cities, or various types of natural features. When numbered maps are prepared for use over and over again, they can serve as the basis for a variety of questions. The following is an elementary type of question:[10]

Which nation is identified by the number ten?
- (a) Burma
- (b) Peru
- (c) The Sudan
- (d) Ethiopia

Note that such a question can be used to indicate whether or not students know precisely the location of The Sudan, approximately where

FIGURE 1



it is, or are quite unsure about its location. In other words, if options are carefully chosen, the hits and near misses can be distinguished from the far misses. On a number of items of this sort students can be given credit for being close rather than far from the target, as well as hitting the target precisely.

A numbered map lends itself to other test uses than the one just indicated. Such questions as the following are possibilities:

Nations 14 and 43 are similar with respect to
(a) climate
(b) topography
(c) religion
(d) political makeup

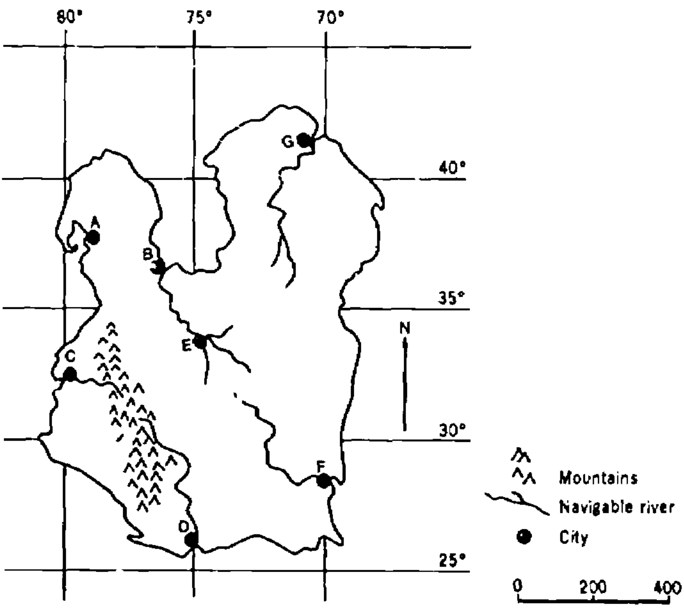
Which of the following nations had the greatest cultural influence on nation 36?
(a) 14
(b) 16
(c) 17
(d) 43

The above examples show that place location testing can range from the most discrete items of information to measures of locational relationships.

A great number of map and graph skills can be measured simply by providing the right sort of map or graph as the basis for the questions. Most of the time real maps should be used, but sometimes hypothetical maps are more suitable. When asking relatively simple questions about direction, scale, and the use of a grid, real maps are probably desirable. Also, questions about the characteristics of variables distributed on a map, and the relationships between two or more distributions, can best be handled using real maps. Likewise, if a teacher wishes to test student ability to read information on one kind of map projection and find the counterpart information on another projection, real maps would be the most suitable medium.

There are times, however, when the teacher wishes to determine whether students can make probability inferences from some data. If a real area is portrayed, then the teacher is never sure whether the student simply knew that area and could answer from this knowledge, or whether he, in fact, was able to make intelligent inferences from limited data. A map of an imaginary area (Figure 2) provides the basis for the two questions that follow:

FIGURE 2



This land must be located in the

(a) eastern hemisphere south of the equator
(b) western hemisphere south of the equator
(c) eastern hemisphere north of the equator
(d) western hemisphere north of the equator

If there were highlands not shown on the map, they would probably be located between

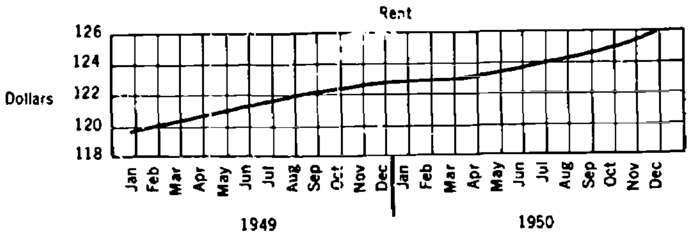
(a) the rivers on which F and G are located
(b) F and G on the coast
(c) A and B
(d) B and E

In all cases when preparing questions, the teacher's key is the information or ability he wishes students to demonstrate. In other words, clear objectives suggest to the teacher the kind of measures that are needed.

Graph reading can be almost as complex a set of skills as map reading. A number of straight reading questions can be devised for any graph. Higher level interpretive skills can be measured by graphs, too.

The following graph (Figure 3) and question indicate an elementary way of determining whether or not students can extrapolate from information provided on a graph:

FIGURE 3



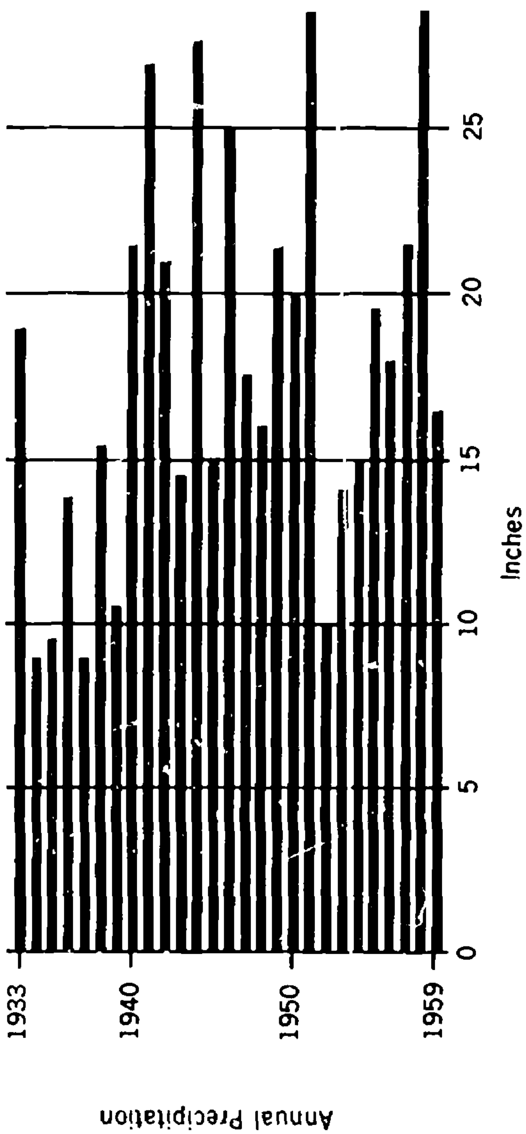
Which of the following figures would you expect to be the cost of rent for the average American family in December, 1951?
  (a) $120
  (b) $123
  (c) $126
  (d) $129

Graphs can also provide the basis for measurement of complex relationships (Figure 4) Such questions, of course, are not of much use unless students are capable of obtaining information from the graph:

Without irrigation a place having an annual precipitation similar to that shown on the graph above would probably grow
  (a) rice
  (b) wheat
  (c) corn
  (d) sugar beets

Similar reading and interpretation objectives can be measured with respect to topographic maps and aerial photographs. Such representations are sufficiently difficult to reproduce on test copy that a teacher is advised to use actual topographic maps and aerial photos as a basis for the questions that are posed. It is relatively easy to draft a number of questions that ask about the elevation of particular points on a topographic map. Inferential questions can be asked about other features likely to be associated with elevation. Interesting kinds of questions can also be asked about the relationship between a topographic map and aerial photographs of the same area. The ability to work

FIGURE 4


Annual Precipitation
1933
1940
1950
1959
0
5
10
15
20
25
Inches

back and forth between maps and photographs may be an important geographic objective in some circumstances.

All geography teaching places considerable emphasis on learning generalizations and relationships. Many of these will vary from teacher to teacher and curriculum to curriculum. Whatever the generalizations or relationships may be, an effective way of measuring them is the straightforward multiple choice question. The following three questions are examples that could be used to measure various relationships involved in urban geography:

A suburban residential area developed during the 1970's would most likely be located near the crossing of
- (a) a railroad and a river
- (b) a railroad and a major highway
- (c) a river and a freeway
- (d) two freeways

If a factory producing electronic equipment were built in a small community, it would influence the economy of that community in many ways. Which of the following would be the *least* important of these influences?
- (a) the factory would buy products and services from other businesses in the community
- (b) the factory would sell its products to local customers
- (c) the factory would employ the people of the community
- (d) the factory would pay taxes to the local government

Land with the highest value in the central business district of a city would *most* likely be used for
- (a) a factory
- (b) public parks
- (c) a ten-story office building
- (d) an automobile sales room

Geographic relationships and associations appropriate for courses emphasizing economic geography can also be measured by objective questions:

Wheat, rice, and corn crops are usually not major crops in the same areas primarily because they require different
- (a) amounts of moisture
- (b) kinds of machinery
- (c) soils
- (d) kinds of workers

The widespread use of farm machinery is common in nations of
- (a) high per capita income
- (b) high population density

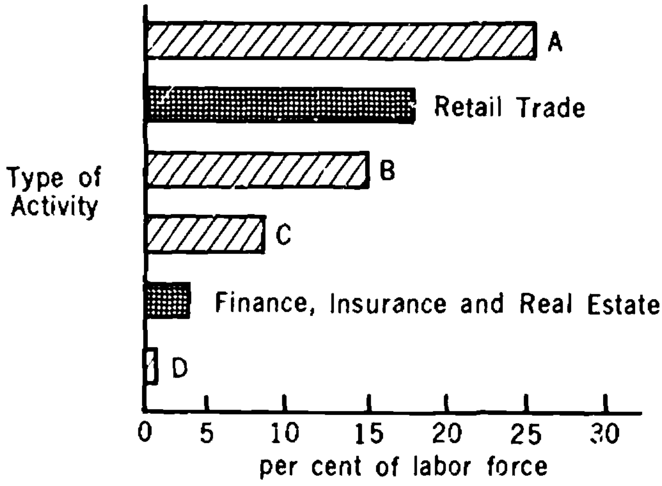
(c) small farms
(d) non-commercial agriculture

The use of stimulus material on which to base questions is particularly effective in measuring relationships. It should be kept in mind, though, that students are called on to interpret the material used, such as a graph or a paragraph, and then to relate this to further knowledge. The following are examples of questions measuring geographic relationships based first on a graph (Figure 5) and then on a paragraph.

Which bar on the graph (A, B, C, or D) would be correctly labelled "manufacturing"?

FIGURE 5

Percentage of the Labor Force Engaged in Various Activities in an Average American City.



Farmers in parts of southern Nigeria use hoes instead of plows. The farmers produce crops mainly for food for their own families and not for cash income. Their families include distant relatives and are based on marriage customs different from ours. The soils are generally not very fertile. As a result, fields must be left idle for some time after a crop is harvested. Thus, the farmers cultivate first one field and then another. There are no work animals because the tsetse fly brings a disease that kills work animals.

Which of the following parts of the way of life of these people is most likely to resist change?
(a) the practice of leaving some fields idle
(b) their use of hoes rather than plows
(c) the practice of producing for family use rather than for sale to others
(d) their marriage customs

On which of the following grounds could a proposal to invest all foreign aid money in tractors and plows be most soundly criticized?
(a) it would do nothing about the more basic tsetse fly problem
(b) the people apparently have little interest in raising their living standards
(c) the people are probably unable to use and maintain the tractors properly
(d) the practice of leaving fields idle shows that these people are unable to farm efficiently

What is the probable attitude of these people toward the customs described in the paragraph?
(a) "If we put up with the inconvenience, things will get better."
(b) "This is the natural and proper way to do things."
(c) "If we had more education, things would improve."
(d) "With a lot of hard work, maybe we can be more like Americans."

Most teachers of geography subscribe to attitudinal objectives; however, very few teachers obtain evaluation data about student attitudes. Most teachers even have a difficult time clearly indicating their attitudinal objectives. One commonly accepted attitudinal objective for geography teachers is the development of positive, if not sympathetic, attitudes toward peoples in other cultures. Another type of attitude sometimes mentioned is the set of tendencies characteristic of scientists; for example, open-mindedness with respect to alternative hypotheses. Still other teachers would mention that they wish students to become more interested in geographic studies.

One of the problems with obtaining evaluation data on attitudes is the fact that the real beliefs of people can be faked, especially when they think they may be helped or harmed by the opinions they express. Thus, when the primary function of evaluation data is the determination of grades, students are unlikely to express their real opinions. In fact, most teachers would have serious reservations about including attitudinal data as a basis for the grades they assign. On the other hand, when the teacher wishes to diagnose student progress, there is some basis for a discussion of student attitudes. Great care needs to be taken,

however, especially if the true feelings of students are contrary to the attitude the teacher would like to develop. The student then is put in a coercive situation in which honest expression of opinions might lose out.

Attitudinal data are probably of greatest importance when the purpose of the data is the evaluation of teaching procedures and materials. In evaluating a single geography course, or perhaps a series of courses, teachers have a legitimate interest in determining whether some of their attitudinal objectives are, in fact, being accomplished. If they are not, this is significant evaluation data which may suggest changes in course organization, teaching procedures, or materials. As mentioned above, valid attitude evaluation data depend on student awareness that the data are to be used in evaluating the course itself. In such instances, it is by far the best procedure to assure the anonymity of the students as they respond to the questions posed.

One way to get information about student attitudes is demonstrated by the following question:

Some of the peoples of East Africa have a practice of inserting a hollow tube into the veins of their cattle and drawing out blood. The blood is used as part of their diet. What is your opinion about such a practice?

(a) it does not appeal to me, but it probably makes sense to the people involved
(b) using cattle for milk and beef is a more natural thing to do
(c) these people probably do not know that cattle provide milk and beef
(d) these people are probably not aware that this will hurt the cattle

Probably a more useful way of obtaining information about attitudes is the preparation of statements about a number of objects to which students respond on a five-point scale from strongly agree to strongly disagree.[11] Statements such as the following could be used to find out about the impact of a geography course on student tendencies to see more than one answer to questions:

I am confident there is one right answer to the question, "What has made Chicago a large city?"

There are probably several generally acceptable answers to the question, "Where should the new boundary of eastern Nigeria be drawn?"

Encyclopedias and textbooks are likely to give the same answers about when something happened.

Most questions that come up in a chemistry class seem to have one right answer.

Most questions that come up in a geography class seem to have one right answer.

It should be pointed out that scores can be obtained for each statement. They will range from one to five. A mean score for a group of students after instruction can then be compared with the mean for the group of students on the item before instruction. Procedures are available to determine whether the difference is significant, and thus whether a change of student attitude probably took place.

When the purpose of obtaining evaluation data is course improvement, other questions can be formulated to provide information about student attitudes toward various sources of information, and toward specific features of one's course. To do this, the following questions might be useful:

How do you rate newspapers as sources of information?
(a) poor
(b) not so good
(c) all right
(d) very good

How do you rate maps as sources of information?
(a) poor
(b) not so good
(c) all right
(d) very good

How worthwhile was the discussion of Communist China in your textbook?
(a) quite worthwhile
(b) somewhat worthwhile
(c) not very worthwhile
(d) a waste of time

Compared to other movies you see in school, how interesting was the movie we had on the population explosion?
(a) very interesting
(b) somewhat interesting
(c) slightly interesting
(d) dull

Clearly the number of questions that can be devised to help in evaluating course materials and procedures is unlimited. Suggestions for obtaining the data have included the use of regular multiple choice questions and statements to which students express degrees of agreement. More complex ways of getting at attitudes, of course, are avail-

able. Teachers who are interested might explore Osgood's semantic differential.[12]

Little has been said about the use of essay questions. Little can be said about such questions other than that the teacher should attempt to make them as clear and unambiguous as possible.[13] One type of learning that would appear to be more effectively measured through essay questions than objective ones is the students' sense of what may be relevant in working with a problem. When the objective deals with factors influencing the growth of urban areas, the following question might be appropriate:

> Three settlements of equal size are located on the west coast of Africa. If you want to predict which city will be largest in 1980, what questions would you ask to obtain useful information?

Another way to get at this same thing, through using objective questions, is suggested by the following two questions asked about the same problem of three settlements in Africa:

Which do you think is the most important question to ask?
- (a) Does the settlement have a good fort?
- (b) Are there raw materials of value near by?
- (c) Is the climate desirable for people?
- (d) Is the settlement in a country with a democratic government?

Which do you think is the least important question to ask?
- (a) Does the settlement have a good fort?
- (b) Are there raw materials of value near by?
- (c) Is the climate desirable for people?
- (d) Is the settlement in a country with a democratic government?

The students' additional insight into a sense of relevance can probably be obtained by asking them to justify their answers to the two questions. They can do this orally or in writing.

Preparing and Interpreting Tests

Once a teacher is clear about his purposes in obtaining evaluation data, as well as clear about the objectives whose attainment he wishes to measure, he has some definite guidelines for the instruments he needs to prepare. What we will discuss now is the development of a plan for a test, the preparation of appropriate test items, the interpretation of scores obtained on the test, and the desirability of retaining and reusing good questions.

Developing a plan for a test is primarily a task of specifying what the test will cover and in what proportions. On many occasions when a teacher wishes to obtain test data there is no need to take the care indicated here in planning a test. However, for semester tests and possibly also for unit tests, it is usually desirable to prepare a grid that will indicate what to incorporate in the test. A ninth-grade semester examination in world regional geography should give an appropriate degree of attention to each of the regions that the students studied. It should give attention to the kinds of objectives that the teacher wants to measure. Thus, one direction of a grid would indicate the several regions to be tested and another direction of the grid would indicate the objectives. The following is an illustrative grid of the sort described:

WORLD REGIONAL GEOGRAPHY TEST GRID

	Latin America	*Anglo America*	*Western Europe*	*Southeast Asia*	*Cross Regions*	
Understanding relationships	15	9	12	10	10	56
Ability to interpret maps	5	3	2	2	0	12
Ability to assume the culture's perspective	3	0	2	5	0	10
Knowledge of place location	7	3	4	8	0	22
Number of items	30	15	20	25	10	100

If a hundred item test is intended, then such a grid as that shown above indicates the number of items of each type that are needed. For example, it indicates that ten items dealing with an understanding of relationships about Southeast Asia are needed. Such a grid system makes it possible to check that certain things one wishes to test for are not forgotten. In effect it becomes a check list for the planning of a test.

Writing good test questions is considerably more difficult than it seems, as most teachers are aware. Even elementary factual questions can often sound unclear and ambiguous. Some types of test questions are more subject to ambiguities than others. As students, many of us were aware of the problems faced when we tried to understand what the teacher meant by a particular essay question. Similarly, true and

false questions and fill-in questions often leave a student uncertain about the type of answer he is expected to give. Multiple choice questions, in spite of other difficulties they may have, at least present a student with the alternatives from which he must choose. Even multiple choice questions can have two or three plausible solutions from among the options provided. In fact, one of the functions of item analysis procedures, which will be discussed shortly, is to identify those multiple choice questions that cause more problems for better students than for poorer students.

Most teachers have difficulty in preparing items so that unintended clues are not imbedded in them. In an attempt to have the correct option actually be correct, most teachers make it much longer than the other options. This leads astute students to eliminate the shorter ones and select the longer choice when they don't have any idea of what the answer should be. Unintentional clues are also provided in questions for which the correct answer is the conclusion of a statement. This kind of question works well only when all of the options available provide a grammatically correct conclusion for the statement. Other unintended clues are provided by using such words as "always" or "never" in questions. Most students are aware that few things in the world "always" happen or "never" happen.

But the most important thing necessary in good questions is that they deal with objectives the teacher considers to be significant and that they are, in fact, relevent to such objectives. By this is meant that the teacher is confident that students who get the questions right understand or are able to do what the objective indicates. To have truly significant questions posed in a way that calls on a student to apply his knowledge in a somewhat new context is the ideal in question writing. There are good reasons for not reaching this ideal — such questions are difficult to write — but there is little reason to have questions containing essential ambiguities in them. Perhaps the teacher's best check on the clarity of his questions are the critical reviews his colleagues can provide.

Once a test has been designed, and items prepared that fit the design, the scores that are obtained need to be interpreted. When a teacher is very confident of what constitutes mastery and very sure also that the test he has devised reflects this, then he can interpret test scores in such a way that perhaps 95 percent constitutes an "A" and 75 percent a "D". Some teachers have such confidence, but many who do

should not. As indicated earlier, most teachers find meaning in a test score only in terms of the scores of a group of students. For some tests 70 percent right is better than most students could and do obtain. On other tests 90 percent right constitutes relatively poor performance. The point is that no test score has meaning in itself.

This is not to suggest that an individual student's score should be interpreted only in terms of his class of thirty students. It is suggested that a teacher should take some care in interpreting test scores for grading purposes. He can do this by being clear about the reference group he has in mind. It is perfectly justifiable to use all sorts of reference groups; for example, a group having certain socioeconomic characteristics or a group encompassing a certain verbal aptitude range. When a teacher is asked how well a student is performing in geography, the teacher's response should be formulated in terms of the reference group he is in fact using, whether this be other students in that school, or inner-city students generally, or college-bound students generally.

Because it is difficult to prepare significant and interesting questions, a teacher is wise to retain the ones he thinks are particularly good for use at other times. Certain kinds of information can be obtained about each question that permit preparation of even more effective tests in the future.

One type of information that proves useful is the difficulty level of the question. To know that 10 percent, 50 percent, or 90 percent of the students get a test item correct is worth recording. When such information as this has been obtained on a large number of items, it is then possible to create a test of any difficulty one wishes. If the teacher wants a mastery test, then relatively easy questions that measure what is to be mastered should be included in the test. If the teacher wants to prepare a test that permits him to rank students, then he should use questions which are of average difficulty. Very difficult questions, as well as very easy questions, contribute little to spreading students out on a continuum. The common sense expectation that difficult questions are needed to spread students out is the case only when most questions in the test are very easy for the better students. In such cases, a few very difficult questions may indeed distinguish among these students.

Another type of information of use in improving future tests is information about the ability of a test question to distinguish better students from poorer students. There are a number of relatively easy

ways of determining how well an item discriminates between the group which does best on a test and the group which does poorest on a test.[14] Clearly, the percentage of students in the higher group getting the item right should be greater than the percentage of students in the lower group. When there is some doubt about this, or when a higher percentage of the lower group gets a question right, then that question is not helping to distinguish the better students from the poorer students in terms of what the test measures. A test containing a large number of such poorly discriminating items would provide a very unsound basis for assigning grades. Thus, test questions that show little difference in performance by a high achieving group compared to a low achieving group should be examined for possible ambiguities that were not seen originally. It is well established that tests having items which discriminate well between better and poorer achievers are highly reliable tests.

Most of what has been said about preparing tests, interpreting the results, and analyzing the questions has relevance primarily for tests used in grading. This is because the evaluation of individuals should be done in terms of as highly reliable information as possible. What needs to be avoided is giving a student a letter grade he does not deserve. If the scores obtained on tests do not accurately or reliably represent an individual's performance, or his true performance score, it might well mean a different letter grade. In a society where grades are taken seriously, reliable scores for individual students are a necessity.

On the other hand, there is little need to worry about the reliability of data obtained for purposes of evaluating instructional content and procedures. The percentage of students getting a question right has a high degree of reliability because it is group rather than individual data. This means simply that the percentage of students getting an item correct is likely to change little if the item were given to the same students another time.

Problems of data reliability also exist when the purpose is to diagnose student progress. This is the case again because an individual is involved, rather than a group. What needs to be watched for here is the use of a few items to make judgments about an individual's performance. It is very likely that on different but comparable items he would have indicated a different level of performance. However, if the test data simply serve to suggest possible areas of strength and weakness for discussion by the teacher and the student, little harm is involved.

Clearly, the purposes for which evaluation data are obtained influence the way tests are developed and used. Because of what is at stake for students, teachers should take their testing procedures most seriously when they use the results for grading purposes. Whether the purpose is determining grades, diagnosing student progress, or improving instruction, however, clear and meaningful geography objectives are essential.

FOOTNOTES

[1] Wilhelms, Fred T., editor. *Evaluation as Feedback and Guide*. Washington, D.C.: Association for Supervision and Curriculum Development, 1967.

[2] Kurfman, Dana. "Improving the New Geography Through Evaluation." *Bulletin of the National Association of Secondary School Principals* 51:37-43: No. 316, February, 1967; and Mager, Robert F. *Developing Attitudes Toward Learning*. Palo Alto: Fearon, 1968.

[3] Pattison, William D. "The Four Traditions of Geography." *Journal of Geography* 63:211-216; No. 5, May, 1964.

[4] Bacon, Phillip. "General Objectives of Geography." *Methods of Geographic Instruction*. Waltham, Mass.: Blaisdell, 1968. Chapter 2, pp. 15-24.

[5] Helburn, Nicholas. "The Educational Objectives of High School Geography." *Journal of Geography* 67:274-281; No. 5, May, 1968.

[6] Scarfe, Neville V. "The Objectives of Geographic Instruction." *Journal of Geography*. 67:4-5; No. 1, January, 1968.

[7] The interested reader should consult Chapter 11 of this Yearbook for further detail on this topic.

[8] Mager, Robert F. *Preparing Instructional Objectives*. Palo Alto: Fearon, 1962.

[9] High School Geography Project. *Teacher's Guide, Geography in an Urban Age*. New York: Macmillan, 1969. pp. vii, 13, and 41. Incidentally, teachers interested in obtaining a pool of behaviorally stated geography objectives can write to the Instructional Objectives Exchange of the Center for the Study of Evaluation, University of California at Los Angeles, Graduate School of Education.

[10] The test items cited in this chapter were prepared in connection with the author's work as evaluation specialist for the High School Geography Project.

[11] Oppenheim, A. N. *Questionnaire Design and Attitude Measurement*. New York: Basic Books, 1966.

[12] Osgood, C. E. *et al*. *The Measurement of Meaning*. Urbana: University of Illinois Press, 1957.

[13] Solomon, Robert J. "Improving the Essay Test in the Social Studies." *Evaluation in Social Studies*. Thirty-Fifth Yearbook. Washington, D.C.: National Council for the Social Studies, 1965. pp. 137-153.

[14] Ebel, Robert L. "Using the Results of Measurement." *Evaluation in Social Studies*. Thirty-Fifth Yearbook. Washington, D.C.: National Council for the Social Studies, 1965. pp. 202-217.

Chapter 15

Emerging Social Studies Curricula: Implications for Geography

Lorrin Kennamer, Jr.

Curricular Change

It is well-known that this is an age of rapid development in curriculum construction and study. National curriculum studies, projects, and "new curricula" confront us at all levels of education. Involvement is more broad than in previous times with school systems, professional organizations, university faculty, project staffs, and state and federal agencies being active in the 1960's.

Another aspect of this era of educational change is the flux one finds in the various academic disciplines. Especially in the social sciences, scholars in anthropology, economics, geography, history, and sociology are questioning the basic structure and philosophy of their fields. Thus, today the curriculum worker must give close attention to both the evolving curriculum patterns and to the academic disciplines involved.

This curriculum-reform movement of the 1950's and 1960's is nation-wide in that its impact is being felt or will be felt from coast to coast. As John Goodlad points out, the reform is not toward a "national curriculum" per se, but its impact will be national.[1] There are many influencing forces and factors generating this reform that have had their impetus since World War II.[2] After that war there was

concern expressed about the mathematical and scientific illiteracy among high school graduates. The advent of the Russian Sputnik dramatized and polarized this concern, and the funding at the federal level of various curricular projects was soon to follow. These first projects in mathematics and sciences soon led to other disciplines coming under scrutiny.

Another factor for change has been the changing nature of our society as old institutions and values have been questioned. This vigorous questioning of the status quo and seeking of relevance by active groups is part of the whole climate of change present today. It is obvious that the social studies curriculum should be under continuous study across the country as school systems adjust to the changing times.

This modern curricular reform has stressed the identification of the structural elements of each discipline. The emphasis has been on the discreteness of the academic disciplines: not science but biology, chemistry, and physics. In the social sciences it has not been so much on social studies but on history, geography, anthropology, and economics. It is practically universal, whether a national project or a local school system study, that attention is given to the basic concepts and structures of the various individual sciences. Thus, we find today there are over one hundred different projects across the country involving the social studies curriculum with some being a single discipline approach, some multidisciplinary, and some comprehensive.[3]

It is the purpose of this chapter to abstract from many of the projects the patterns and trends that might have special implication for geography as it relates to the social studies of tomorrow. The concern here is not about special projects now underway in geography per se, but an examination of the social studies trends and what they might mean for geography.

Changes in School Geography

The role geography has had in the school curriculum in this country has undergone major changes since colonial times. A perspective on this changing nature of school geography is helpful if implications of the modern curricular changes are to be understood fully.

As Chart 1 shows, geography in its earlier stages was in the schools as a descriptive and locational study. It remained such until physical geography appeared in the mid-1800's. At the beginning of the present century, geography enjoyed a widespread status as a physical science

oi, as was known then, physiography. Much of what was in the early physical geography has since been absorbed into the general science movement, which has now been updated in the new earth science curriculum.

The demise of physiography in the schools was followed by geography entering the curriculum as commercial geography, later known as economic geography. After the 1916 Committee on Social Studies of the National Education Association and the 1918 report of the Commission on the Reorganization of Secondary Education, geography was viewed by curriculum planners as social geography. This meant that geography could make a contribution to good citizenship through its emphasis on the interdependence of men while showing their common dependence on nature.

However, the social studies curriculum that developed in the 1930's and 1940's relegated geography mainly to a study of man-land relationships. Geography in the schools was more limited in its interpretation than was academic geography at the same period of time. A geographic factor came to mean an environmental factor, while human relationships continued to be presented in the curriculum mainly from historical and political viewpoints. In other words, the environmental determinism that had plagued the field of geography in the early 1900's was carried over into the school curriculum in the social studies after the discipline of geography had rejected it.

By the 1950's regional geography was widespread in the academic side of geography as it was also in the school social studies curriculum. In the main, this was a descriptive regional geography that set about to cover the major world regions. A pattern developed such that cultural-political regions were organized and studied rather than just political regions. It is interesting to note that this pattern prevails today in the elementary curriculum, where geography is found, while at the same time general regional geography is now held in disfavor among many geographers. In the 1950's and 1960's geographers began to take more interest in making systems or topics their frame of reference. Along with this new development was the introduction of sophisticated quantitative techniques and their application to geographical problems — a force for change that affected all the social sciences. This change in approach gave birth to what John Ball calls the Era of Spatial Analysis in geography — a new direction for the field.[4] Man and his culture became equal in importance to the earth's physical features.

CHART 1
CHANGE IN GEOGRAPHY

	The Discipline of Geography	*Geography in the Schools*	*The Social Studies Curriculum*
1970's	Spatial Distribution Spatial Interaction	*Spatial Characteristics of Human Earth System, New Regional Analysis	*Multi-Disciplinary, Cross-Disciplinary
1960's	Cultural-Historical Region-Formal and Functional	Regional Geography Coverage of World	Discipline Oriented, Structure, Inductive, Inquiry (National Projects)
1950's	Elements of Geography: Physical and Cultural		
1940's	Descriptive Regional Geography	Descriptive Regional Geography Geographic Factors Meant Physical Aspects, Not Human	Child Centered, Societal Needs, Fused, Core Curriculum
1930's	Morphology of Landscape Possibilism—Geography as Human Ecology	Rise of Economic and Commercial Geography	
1920's	Physiographical Studies Environmental Determinism	Rise of General Science Decline of Physiography	NEA Commission on Social Studies
1910's	Physiographic Emphasis		
1890's	William Morris Davis and Physical Geography at Harvard	Physiography in High Schools	Committee of Seven
1870's	Human Element and Deterministic Thesis		Discipline Oriented, Descriptive, Deductive

Chart 1 (Continued)

	The Discipline of Geography	*Geography in the Schools*	*The Social Studies Curriculum*
1960's	Physical Geography and Natural Teleology	Physical Geography in the High School—Guyot and Maury Influence	
Mid-1800	Rise of Physical Geography	Descriptive Facts within Political Regions, Memorization	
1820's	Systematic	Preparatory Schools Descriptive and Locational Content	
Colonial America	Descriptive Mathematical	Descriptive Mathematical Use of Globes	

*Tentative and yet to be determined

The earlier environmental determinists had assumed that earth shapes man, i.e., man merely reacts to and adjusts to physical phenomena; the humanistic view of the newest geography is that man sees, uses, and shapes the world to accommodate his needs.

Once again there is the situation of academic geography having changed significantly, or being in the process of doing so, while geography in the school curriculum is lagging behind. An exception is the High School Geography Project, which is an example of the new developments in the field. If geographic concepts and skills are to be found in the school curriculum, will they be of the old geography or of the newest? The more serious question is, however, what era of geographic thought is in the minds of curriculum planners who are developing multi-disciplinary or comprehensive social studies curricula? Thus, in Chart 1, geography in the schools in the 1970's is undecided and is, thus, marked by question. The social studies curriculum for the 1970's is also not clear because the more firm curricular patterns have yet to be established from the hundreds of projects and curriculum revisions taking place across the nation.

Curricular Change in the Social Studies

The first wave of curriculum reform began on the secondary level in mathematics, the natural sciences, and modern foreign languages. In the 1960's this reform reached the social studies, beginning also at the secondary level. By the end of the 1960's both elementary level and secondary level social studies were under study by projects federally financed, supported by foundations, and undertaken by independent school systems.

Whereas in the past the social studies curriculum had been "handed down" by national commissions or committees, the recent curriculum studies are proceeding along a broken front. Many of the national projects employed the services of specialists in subject matter, education, curriculum design, and evaluation. Most of the new curricula emphasize the structure (concepts, principles, and methods) of the various social science disciplines. They stress the inductive method of learning over the deductive. Previously neglected social sciences as anthropology, economics, political science, and sociology are receiving more attention than in the past, as are social psychology and jurisprudence. This is true especially on the elementary level. There is an

effort to replace "coverage" of a social science with an understanding of unifying concepts and competence in appropriate scientific methodology.

An intensive study of twenty-six of the national projects by Norris Sanders and Marlin Tanck [5] reveals the following categories of projects: comprehensive; discipline-oriented; area-oriented; and special purpose. The comprehensive projects seek to develop complete social studies programs for many grades by using objectives and ideas from many different disciplines. The discipline-oriented projects use concepts and methods from mainly one of the social science disciplines with some possible content from other disciplines. The area-oriented projects focus on broad world areas such as Latin America, Africa, etc., involving a number of disciplines. The special purpose projects emphasize one or more special goals quite different from the other categories.

In addition to the many diverse projects in the social studies funded from a variety of sources, the United States Office of Education in the spring of 1963 invited universities and state departments of public instruction to submit research designs and programs of action to stimulate research in the social science fields and to establish curriculum development centers.[6] Under the title of "Project Social Studies" major curriculum projects were initiated with all of them sharing these four objectives: (1) to redefine the scope and goals of the social studies curriculum; (2) to develop techniques and materials to achieve these goals; (3) to submit newly created materials to a sequence of experimentation, evaluation, and revision; and (4) to disseminate the materials and relevant information. The centers are located at universities and are headed by professors. They seek to identify the structure of social science disciplines and to develop new curricula around social science concepts. They involve the collaboration of university scholars with public-school teachers. Also, they usually employ teaching and learning techniques referred to as the inductive method and they use a multi-media approach on materials.

The "new social studies" is in process of being created.[7] The many projects and studies have been supported by independent school systems, state departments of education, the United States Office of Education, the National Science Foundation, professional organizations, independent nonprofit corporations, and groups of universities. The

curricular reform movements of the 1930's and 1940's were concerned with the needs of the child and of society, while the reform now underway can be described as discipline- or subject-centered. It is in the 1970's that the many diverse projects will come into focus in schools or be rejected. It will be a most interesting decade for curriculum planning.

Sample Curricula

Six social studies programs have been selected as samples of the variety of approaches being developed in the country today. It is not the intent that these examples be thought to be the best or the worst, but be viewed solely as examples of the kind of diversity in social studies curriculum. The programs shown at the conclusion of this chapter are: California Statewide Social Science Study Committee Proposed K-12 Social Science Education Framework; Greater Cleveland Social Science Program, Lexington, Massachusetts, Elementary Social Studies Program; Madison, Wisconsin, Elementary Social Studies Program; Minnesota Elementary Social Studies Program; and the Providence, Rhode Island, Social Studies Curriculum Project.

The California Plan is the result of the work of more than 200 social scientists and social studies educators who produced a program focused on an inquiry-conceptual approach to the study of man. The disciplines of history, geography, economics, political science, anthropology, sociology, and psychology are the basic sources of modes and processes of inquiry, concepts, and data underlying the program. The program sets up a model emphasizing inquiry processes which are grouped according to three different modes of thinking: analytic; integrative; and policy. The studies composing this K-12 Program sequence the processes and modes along with key concepts and settings so that by the end of Grade 12 the student should be proficient in all three modes and in inquiry processes belonging to each.

The Greater Cleveland Program represents the thinking of the basic social sciences as well as contributions from psychology and philosophy as scholars from these fields developed the program for the Educational Research Council of America. Many school systems were used in field testing throughout the development of the Program. Each of the social science disciplines is dealt with at each grade level with specific concepts and skills within these disciplines successively treated at increas-

ing levels of sophistication. The Program encourages the pupil to acquire basic understanding of the disciplines of social science in order to apply his understanding in analyzing and judging many varieties of human situations at home and abroad, in the past, present, and in western and nonwestern cultural contexts.

In the Lexington, Massachusetts, Program, scope and sequence have been established by selecting for each grade level a theme, stated as a generalization. Each generalization is considered to be significant for the pupil's understanding of his own and other cultures. In each unit pertinent content is drawn from the various social sciences and organized on an interdisciplinary basis. At the secondary level the courses are organized as separate subjects, broadly interpreted.

The Madison, Wisconsin, Program is built on the state framework that was developed by the State Department of Education and the University of Wisconsin. The expanding environment framework underlies the Program, thus making this Program somewhat midway between the traditional social studies curriculum and newer programs that have discarded the expanding environment sequence. Key disciplines are emphasized at each grade level with supporting work from other disciplines.

The Minnesota Plan appears at first glance to be following the expanding environmental sequence, but study of the unit titles shows that much new material is added. There is much more flexibility in the primary grades in studying not only local areas but many significant world-wide areas as well. The study of families and communities ranges widely over space and time, making this Program significantly different from the more traditional plan. This Program is interdisciplinary in organization but has a major focus on a particular discipline at each grade level, thus, in this regard, being similar to the Wisconsin Program.

In the Providence Program, history and geography are the integrating disciplines with the other social sciences woven into the units. In the development of this Program, curriculum theorists, administrators, and classroom teachers worked with subject matter specialists as well as with specialists in human growth and development. The scope and sequence K-12 show a modified and more flexible use of the expanding environment scheme. This Program gives much more attention to the many cultures of the nonwestern world than have traditional plans.

Curricular Implications for Geography

The variety of approaches in these six curricular plans, as well as differences found in other programs, indicates the following elements of importance to the field of geography as it relates to social studies curriculum:

(1) No longer is the elementary social studies curriculum dominated by the disciplines of geography and history. The curriculum builder is using all the social science disciplines from which to draw concepts and skills as needed to meet their goals. This means that in the field of geography, geographic educators must present clearly what the basic concepts of the field are as well as the basic skills. The type of geography found in the traditional elementary curriculum, characterized by Phillip Bacon as "strange lands and funny people," is no more. As all the social sciences are called on by the curriculum builder, it behooves geography to be specific in its possible contributions — not only in broad global concepts but also in concepts and methodology applicable to the study of specific areas and cultures.

(2) Concepts in cultural geography have equal if not greater importance than physical geography in the new social studies. No longer will the geographic factor be thought to be environmental only, but will include as well the ideas, values, and perceptions of man. The methodology of historical geography should have a major role to play in interdisciplinary curricula as it offers a way of looking at man in the twin perspectives of time and space.

(3) There is a greater attention to sequence of learning. Readiness for learning is now seen to be closely related to the individual's background of experience. This means that geographic concepts and their grade placement must be re-thought. Many geographic concepts and skills reserved for intermediate grades are being moved downward. Students today are bringing a more cosmopolitan background in local, national, and world affairs than students of a generation ago. Tradition is now a faulty guideline for placement of geographic concepts. Much more experimental work is needed to determine at what age a learner understands which geographic concepts.

(4) The new social studies is directing much more attention to the cultures of nonwestern peoples, and many more comparative studies of families, cultures, and governments are taking place. No longer should geography treat areas of the world in the traditional descriptive regional sense, but should develop regional analysis such that comparative studies can be made.

The New Social Studies and Geography

In recent years Dorothy Fraser, John Michaelis, Jack Allen, John Jarolimek, Norris Sanders, and Marlin Tanck, in *Social Education* and in NCSS Yearbooks, have identified emphases and issues in the developing new social studies. Chart 2 below presents some of these major emphases in the new social studies and suggests the implications these emphases have for school geography.

CHART 2

Possible New Directions for School Geography

Emphases in New Social Studies	*Suggestions for School Geography*
(1) Curricular programs are organized around concepts and generalizations; orientation is toward conceptual approaches rather than toward problem approaches.	Abandon descriptive regional geography and general world survey; continue to identify major conceptual framework and methodology of the field; present concepts in a manner that can be applied in curricular planning.
(2) There is an inter-disciplinary approach to social studies curricular development; multi-disciplinary approach used to show contributions of different social sciences.	Concepts in cultural geography relate well at elementary level with other social sciences; the methodology of historical geography can contribute especially to historical themes and settings; geographers must take the initiative in making available basic concepts to show how they relate with the other social sciences.
(3) Programs are treating process as content in the curriculum so the learner can experience how the scholars in each field proceed in their collection of data and the analysis of it.	The methodology of geography needs simple statement so teachers and students not trained as geographers can understand it and apply it to solution of problems; techniques of data collection, use of census, cartographic presentation need to be shown in the solution of geographic problems.
(4) The use of the expanding en- ...nment as a plan for sequencing ...iculum is being modified greatly ...s not being used.	Geographers should present alternate plans for sequencing the elementary curriculum; such plans should be sufficiently flexible to include contributions of all the social

CHART 2 (Continued)

Emphases in New Social Studies	*Suggestions for School Geography*
	sciences; the automatic inclusion of geography in the elementary curriculum is no longer assured.
(5) Programs no longer have full "coverage" of each social science but rather focus on fewer topics and treat them more in depth.	Type studies centered on a few concepts would be useful; cease surveying every country with the same systematic topics; show geographic problems and solutions with the emphasis on methodology; the social science discipline with clearest presentation of concepts and methodology is most apt to be used widely in curriculum plans.
(6) Curricula will include more topics and problems of societal change as the contemporary world (local, national and international) receive more attention.	Continued development of concepts and methodology in urban geography offers great application to new curricula; increase studies in environmental perception as related to problems in resource use.
(7) Teaching strategies encouraging students to think inductively have become a built-in goal and teachers are urged to let students discover meanings for themselves . . . the word "discovery" is widely used.	Seek wider application of strategies of instruction used in the High School Geography Project; develop strong emphasis on problem solving in geography; have students use maps, photos, census data, statistical techniques as part of their observations in solving problems; use more primary source data in instructional materials as well as simulations.
(8) Programs require a much greater variety of materials in their multi-media approach; no longer is the single textbook the main source of data.	Greater development of a variety of special purpose maps; stress local and state map sources; encourage student's preparation of single-purpose maps; prepare booklets on different skills in mapping, photo interpreting, data collecting, statistical charts; prepare single-concept film strips and film loops; develop further transparencies; case studies/type studies on problems of industrial location, cultural diffusion, etc.

As suggested on Chart 1, there is much change taking place not only in the social studies but in geography as it has been practiced in the schools and colleges. Once again we have a "new geography" just as we have a "new social studies." School geography must change on two counts if it is to remain viable in the schools. First, the changes in the academic discipline itself are quite sweeping and the generation gap is vast. Geography today, which includes the study of culture, spatial distribution, spatial interaction, and functional regions, is quite different from the geography of yesterday which emphasized the physical environment and the descriptive study of world regions. The second thrust for change is coming from the many facets of the new social studies. The old school geography is not so structured as to survive in relation to the new curricula.

Thus, there are two dangers in the 1970's for geography in the schools. If school geography does not represent the best of the discipline of geography, then it will not be acceptable in its own house. Furthermore, if curriculum planners use the old school geography, thinking it represents the field, then school geography will not survive in the emerging social studies curricula. Even if the best of geography is available for curriculum planners, it must still meet the test that all the social science disciplines will face, that is: shall the integrity of each discipline be maintained in the curriculum, or should the approach be interdisciplinary? Should specific subject areas be identified at separate grade levels, or should there be a sequential arrangement of nongraded units throughout the curriculum? If curriculum planning is to be concept-oriented in the social studies, it must itself have a conceptual framework exhibiting coherency and consistency. Are these frameworks now emerging? There are many houses to place in order before a clear picture can be seen as to the role geography will have in the new social studies curriculum of the 1970's.

CALIFORNIA STATEWIDE SOCIAL SCIENCE STUDY COMMITTEE

Proposed K-12 Social Science Education Framework*

SOURCE: James M. Becker. "Organizing the Social Studies Program," *Social Studies Curriculum Development: Prospects and Problems*. 39th Yearbook. Washington, D.C.: National Council for the Social Studies, 1969, pp. 87-95.

Grade K-2: Mankind

1. What is a man?
2. How are man and animals affected by the land they live on?
3. Why do things have names?
4. Why are there rules for everyone?
5. How are people alike and how are they different?

Grades 3-4: Man and Land: Cultural and Geographic Relationships

1. Why are particular animals found only in certain kinds of environments, while men live almost anywhere?
2. Why do different groups of men develop different ways of living in the same or similar environments?
3. How does urbanization alter man's relation to the natural environment?
4. What happens when different groups of men come in contact?
5. What happens when a new group enters an established society?
6. How do different groups of men interact with each other in the modern urban environment?

Grades 5-6: Mankind and Men

1. What is human about human beings?
2. How do human groups differ?
3. How is any man like no other man?

Grades 7-9: Economic and Political Systems and the Urban Environment

1. How do societies decide what is to be done and who is to do it?
2. How do societies decide who gets what?
3. How do market economies develop and function?
4. How do democratic political systems develop and function?
5. How are decisions made in the command political economy of the Soviet Union?
6. How are decisions made in the mixed political economy of the present-day United States?
7. How can underdeveloped societies cope with the demand for rapid modernization?
8. How does the emergence of cities change the life of man?
9. How have cities varied in their functions and characteristics?

**A highly abstracted summary. The complete report includes by blocks of grades the critical inquiry processes, the key concepts, and the suggested settings used for each concept.*

10. How has modern urbanization changed the life of man?
11. How can the quality of urban life be improved?

Grades 10-11: The Relation of Past and Present

1. How did the United States come to be the way it is, and how is it changing?
2. How have national groupings and conflicts affected the life of man?
3. How has India maintained its cultural unity over such a long period and with such a diversity of peoples?

Alternate Topic 3. How did China develop mankind's most durable socio-political system, and why has it been replaced?

Grade 12A: Decision-Making in the United States

1. How do ordinary citizens influence the decisions that affect them?
2. How are ordinary citizens influenced in making and accepting policy decisions?

Grade 12B: Reserved for Capstone Elective Courses in the Social Sciences and History

GREATER CLEVELAND SOCIAL SCIENCE PROGRAM

KINDERGARTEN

Learning About The World
- Learning about my school
- Learning about myself
- Learning about my family and my home
- Learning how my family buys goods and services

Children in Other Lands
- The globe and land and water on earth
- Children in other lands (Japan, Mexico, England, American Samoa)
- Review of year's work

GRADE ONE

Our Country
- How people live in our country
  (review of home, school rules and authority, globe; introduction to concepts of community)
- Our country: the United States of America
  (map and globe, allegiance to our country, capital city)
- Transportation in the United States
- The capital of our country: Washington, D.C.
- Biographies of famous Americans: George Washington, Abraham Lincoln, Clara Barton, Amos Fortune

Explorers and Discoverers
- Learning about globes and maps
- Selected studies of various explorers and discoverers

People the explorers met
(Mongols, Tahitians, Indians of the Southeast Woodlands of the United States, the Ganda of Africa)
Review

GRADE TWO

Communities at Home and Abroad
Review of geography
The study of three communities:
Our Community
The Aborigines of Central Australia
The Eskimos of Northern Alaska
American Communities
Concepts emphasized:
Economic specialization
Transportation
Interdependence
Geographic skills
The study of types of American communities:
An Historical Community — Williamsburg, Virginia
A Military Community — Fort Bragg, North Carolina
An Apple-Growing Community — Yakima, Washington
A Forest-Products Community — Crossett, Arkansas
A Steel-Making Community — Pittsburgh, Pennsylvania
A Rural Community — Webster City, Iowa

GRADE THREE

The Making of Anglo-America
Physical and human geography of Anglo-America
Seven major factors influencing Anglo-American history:
Exploration
Colonization
The War for Independence and the Constitution
The Westward Movement
The Civil War
Industrialization
Urbanization
The Metropolitan Community
Earth-sun relations
Natural and cultural environment
The history of an imaginary city
A study of local (or nearest) metropolitan community:
Parts of a metropolitan community, its people, services, government, and problems (pollution, slums, traffic, sanitation, race relations, crime, riots, unemployment)

Grade Four

The Story of Agriculture

Social consequences of the discovery of agriculture
Contrast between Javanese and Texan techniques of rice-growing
Slavery
The American Civil War
History of the Great Plains
A review of the problems of developing areas

The Story of Industry

Roles of specialization, research, and capital investment in our mass-production, mass-consumption society
Changing nature of society
Social, political, economic implications of the industrial-technological revolution
Contrast between democratic and totalitarian societies

Area Study #1: India: A Society in Transition

With Grade 4, the program begins to include an "area study" at each grade. The aim of the area studies is twofold:

(1) to expose the student to all major regions and countries; and
(2) to permit the application of conceptual analysis to a specific region.

Grade Five

The Human Adventure:

Part One — Ancient Civilization
Sumerian culture
Meaning, origins, features of civilization
Egyptian and Indus Valley civilizations

Part Two — Four World Views
Civilizations of China, India, Israel, Greece by the 6th century B.C.
Confucianism, Buddhism/Hinduism, Judaism, Greek naturalism and rationalism

Part Three — The Classical World of Greece and Rome
Influence of Greek and Roman civilizations on Western culture
Athens under Pericles
Alexander's conquests
Republican and imperial Rome
Early Christianity and origins of Western civilization
Synthesis of the Judeo Christian and Greco-Roman traditions

Part Four — Medieval Civilization
Islam, dominant civilization of Middle Ages
Physical environment of Arabia
Life and teachings of Muhammad
The conquests and flowering of Muslim empires
African kingdoms of the Middle Ages

Latin Christendom from Dark to High Middle Ages
Mongols under Genghis Khan

Area Study #2: The Middle East

GRADE SIX

The Human Adventure

Part Five — The Coming of the Modern Age
- Formation of civilization from 15th to 17th century
- Decline of medieval institutions
- Religious schism, fragmentation of Latin Christendom,
- Nationalism, capitalism, humanism, Protestantism, Catholic renewal
- Technological advance and exploration
- Influence of Spain and England on Western Civilization

Part Six — New World and Eurasian Cultures
- Aztec and Mayan civilizations
- Impact of colonization on the New World and Europe
- Emerging nation-states of Russia under Ivan IV, Japan under Hideyoshi

Part Seven — Nation-States and Revolutions
- France under Louis XIV
- England under the Stuarts and Parliament
- American and French Revolutions
- Rise of natural science
- Contrast between old and new social science
- Technological-industrial revolution and its social implications

Part Eight — The Coming of World Civilizations
- Nationalism, imperialism, democracy, capitalism, industrialism, socialism
- Examples of imperialism — Islamic in Mogul India, Chinese under the Manchus, expansionism under the British
- Impact of the West on pre-civilized societies — the Ganda and the Hawaiians
- The Russian Revolution and World War I

Area Study #3: Latin America

GRADE SEVEN

Challenges of Our Time Studies of World War II

The Cold War, world economic trends
The problem of racism, and America's world responsibilities

State Geography and History

(May be studied concurrently with United States history over three semesters, in Grades 7 and 8.)

Area Study #4: Africa

GRADE EIGHT

Six Generations of Americans

United States history from c. 1735 to c. 1910

Area Study #5: North America and the Caribbean

GRADE NINE

The Price of Freedom
Essentials of political science and economics, with especial emphasis on the United States and the Soviet Union
Area Study #6: Western and Eastern Europe

GRADE TEN

Studies in the History of Civilization and Ideas
Area Study #7: Asia and the Far East

GRADE ELEVEN

Topics in American History
Area Study #8: Regional Geography of the United States

GRADE TWELVE

Studies in Recent and Contemporary World History
Area Study #9: Lands, People, and Resources of the World

CONTENT OF LEXINGTON, MASSACHUSETTS, ELEMENTARY SOCIAL STUDIES PROGRAM

SOURCE: *Teaching Social Studies, Grades 1-12.* Lexington, Massachusetts: Lexington Public Schools, 1965.

Grade and Themes	*Units*
I. Man Has Varied Ways of Meeting Similar Needs	Shelter, Celebrations, Work, Schools
II. Man Has Adapted to a Variety of Natural Habitats	Pioneer, Navajo, Eskimo, Polynesian
III. Man Finds Ways to Control His Relationships to His Environment	Mining, the Oceans, Water Control, Agriculture
IV. Technology Has Changed the Production and Distribution of Goods and Services and Has Created New Opportunities and Problems for Human Society	Food and Population, Power and Technology, Cities, Trade (Lexington)
V. There Is a Variety of Patterns of Development and Interdependence within and among Nations	Migration, Exploration, Revolutions, Cultural Development
VI. Man's Acts of Inquiry, Creativity, and Expression Evolve from and Influence His Culture	Law and Government, Archaeology, Architecture, Writing Systems

CONTENT OF MADISON, WISCONSIN, ELEMENTARY SOCIAL STUDIES PROGRAM

URCE: *Supplement to Guide to Teaching Social Studies, K-6.* Madison, Wisconsin: Madison Public Schools, 1966.

Grade and Theme	*Units*	*Key Disciplines*
K. The Child and His Immediate Environment	Living Together in the Home, Families Around the World, School Life and School Plant	Sociology
I. Families and Their Needs	The Family and Its Economic Role; Home, Family, School in Other Cultures; Living in a Neighborhood	Economics, Sociology
II. Communities and Their Activities	Living and Working in a Community, Communities Around the World, Communities Change	Sociology, Economics, Political Science
III. Communities and Their Development	Growth and Development of a Community, Different Community Developments, Interdependence of Communities	Economics, Geography, History
IV. World Regions and Changing Cultures	Identifying World Regions (Mapping, Understanding Climates), Investigating Selected World Regions (Natural Environment, Ways of Living, and Culture Pattern in Each Region), Surveying World Progress (Changes Within a Culture, Contributions Through Change).	Geography, Economics, Sociology, Anthropology

Our Nation and Its Growth (Wisconsin Focus)	Our Land and People: A Framework (Structure of Land, Composition of Population, Wisconsin's Land and People), Our Land and People: The Past, Our Land and People: The Present	History, Geography, Economics, Political Science
Man and His World Community	Man and His Nature (Archaeological and Anthropological Evidence, Factors Essential for Civilization), Man and His Struggle for Survival Through the Ages (Interaction with Environment, Communication, Transportation, Government, Cultural Growth, Interdependence), Contemporary Problems of Man	Anthropology, History, Geography, Economics, Sociology, Political Science

CONTENT OF UNIVERSITY OF MINNESOTA
ELEMENTARY SOCIAL STUDIES PROGRAM

URCE: *Progress Report No. 2*, Minneapolis: University of Minnesota Project Social Studies Curriculum Center, November 1965.

Grade and Theme	*Units*	*Major Focus*	*Other Disciplines*
K. Earth as Home of Man	1. Overview: Earth as the Home of Man	Geography	Anthropology
	2. Our Global Earth		
	3. A Home of Varied Resources		
	4. A World of Many Peoples		
	5. Man Changes the Earth		
I. Families Around the World, I	1. Chippewa Family (or local Tribe)	Anthropology	History, Sociology, Economics
	2. Hopi Family (Change over Time)		
	3. Quechua Family, Peru		
	4. Japanese Family		

. Families Around the World, II	1. Boston Family, Early 18th Century 2. Soviet Family, Urban Moscow 3. Hausa Family, Nigeria 4. Kibbutz Family, Israel 5. Culminating Period: Focus on Concepts — Culture, Social Processes, Social Organization — *in* Relation to Family Life	Anthropology	History, Sociology, Economics
I. Communities Around the World, I	1. Urban and Rural Communities: A Contrast (Local Community Included) 2. Early California Mining Camp: An American Frontier Community 3. Paris Community 4. Manu Community: 1930's, 1950's	Anthropology	History, Sociology, Economics, Political Science

(Continued on following page)

IV. Communities Around the World, II	1. Our Own Community	Economics	Geography, Anthropology
	2. Community in Soviet Russia		
	3. Tobriand Islander Community		
	4. Indian Village South of Himalayas		
V. Regional Studies: United States, Canada, Latin America	1. The United States	Geography*	History, Anthropology, Sociology, Economics
	A. Overview: Development of System of Regions		
	B. *Sequence Occupance* Case Studies (Local Area plus Six Others)		
	2. Canada		
	A. Overview: Development of System of Regions		

V. Regional Studies: United States, Canada, Latin America (Cont'd.)	B. Historical-Geographic Case Studies of Six Regions 3. Latin America A. Overview: Discussion of Various Ways of Regionalizing B. Historical-Geographic Case Studies of Four Regions 4. Case Study, One Region, Africa		
VI. Formation of American Society	Five Chronological Units to 1876, with Emphasis on Culture, Culture Contact, Culture Change, and Cultural Continuity	History*	Geography, Economics. Anthropology, Political Science, Sociology
VII. Man and Culture		Sociology,* Social Psychology	Anthropology, Political Science
VIII. Our Political System		Political Science*	History, Geography, Anthropology, Sociology, Economics

* *Primary source of content for the grade, with systematic treatment.*

PROVIDENCE SOCIAL STUDIES CURRICULUM PROJECT

SOURCE: *Social Education.* 34:405; No. 4, April, 1970.

Grade	*Subject*		
K	The Family—Functions and Patterns	Neighborhoods	Integrating Discipline Geography
1	Man's Basic Needs	Neighborhoods	Integrating Discipline Geography
2	Analysis of Neighborhood Patterns	Neighborhoods	Integrating Discipline Geography
3	Analysis of Community	Neighborhoods	Integrating Discipline Geography
4	A Type Study of Regions: Physical Cultural—Metropolitan Extractive	Regions	Integrating Discipline Geography
5	An Analysis of One Culture Region: Anglo-America	Regions	Integrating Discipline Geography
6	A Comparison of Two Culture Regions: Africa and Latin America	Regions	Integrating Discipline Geography
7	Studies of Three Culture Regions: Southeast Asia, Western Europe and the Soviet	Regions	Integrating Discipline Geography
8	A Study of Contemporary Civilizations East Asian Muslim (Optional Study—Classical Greece— for technique of analysis with a "closed" civilization)	Civilizations	Integrating Discipline History
9	A Study of Contemporary Civilizations Indian Western	Civilizations	Integrating Discipline History
10	American Studies—Social	Civilizations	Integrating Discipline History
11	American Studies—Economic and Political	Civilizations	Integrating Discipline History
12	Issues in Contemporary Societies	Civilizations	Integrating Discipline History

FOOTNOTES

[1] Goodlad, John I. "The Curriculum." *Changing American School.* Sixty-Fifth Yearbook. National Society for the Study of Education. Chicago: University of Chicago Press, 1966. Chapter 3.

[2] Allen. Jack. "Assessing Recent Developments in the Social Studies." *Social Education* 31:99-103; No. 2, February, 1967.

[3] Marin Social Studies Project. *A Directory of Research and Curriculum Development Projects in Social Studies Education,* Corte Madera, California: 201

Tamal Vista Blvd.; 1969. Bureau of General and Academic Education. *Directory of Social Studies Curriculum Projects.* Harrisburg, Pa.: Pennsylvania Department of Public Instruction, 1968; Harrison, Sylvia E. *A Summary of Current Social Studies Curriculum Projects.* Princeton: Educational Testing Service, 1964; Hill, Wilhelmina, Carnett, George S., and Werth, Douglas M. "A Directory of Social Studies Projects." *Social Education* 31:509-511; No. 6, October, 1967; Michaelis, John U. "Supplemental List of Social Studies Projects and Related Studies." *Social Education* 31:511, No. 6, October, 1967; "Available Curriculum Materials Analyses." *Social Science Education Consortium Newsletter* 7:5-8; May, 1969; Office of Education. *Directory of Research in Social Studies/Social Sciences.* Washington, D.C.: Department of Health. Education, and Welfare, 1969.

[4] Ball, John M. *Introducing New Concepts of Geography in the Social Studies Curriculum.* Georgia Curriculum Project, Occasional Paper No. 1. Athens, Georgia: University of Georgia, 1970.

[5] Sanders, Norris and Tanck, Marlin. "A Critical Appraisal of Twenty-Six National Social Studies Projects." *Social Education* 34:383-449, No. 4, April, 1970.

[6] Fenton, Edwin and Good, John. "Report on Project Social Studies." *Social Education* 29:206-227; No. 4, April, 1965.

[7] Fraser, Dorothy M. "Status and Expectations of Current Research and Development Projects." *Social Education* 29:421-434; No. 7, November, 1965; Michaelis, John U. "Social Studies." *New Curriculum Developments.* Washington, D.C.: Association for Supervision and Curriculum Development, 1965. pp. 68-77; Michaelis, John U. "A Review of New Curriculum Developments and Projects." *The Social Sciences, Foundation of the Social Studies.* Boston: Allyn and Bacon, 1965. Chapter 10, pp. 275-305.

Chapter 16

An Analysis of Teaching Strategies in Emerging Geography Curricula

Theodore Kaltsounis

One must start this chapter with the realization that there are very few geography curricula that have emerged since the ferment in social studies education began about ten years ago. Most likely this is due to the emphasis placed on the interdisciplinary approach in developing elementary and secondary school social studies programs.

In a strict sense, there is only the course of study prepared by the High School Geography Project of the Association of American Geographers that would deserve to be referred to as a geography curriculum. All other programs dealing with geography are segments of a multidisciplinary social studies program in the form of units or a course of study for one year.

In an attempt to analyze the teaching strategies of the new geography curricula, the need arises to establish a set of criteria on the basis of which these strategies will be judged. It appears that, as a rule, most of the new social studies curricula reflect in their strategies an investigation-oriented approach that is mostly inspired by the method used by the social scientist. It would be appropriate, therefore, to examine first the method used by the geographer in his work, and to identify in some

detail the elements of the investigation-oriented approach as they emerge from nationally acclaimed recent social studies programs.

The Method of the Geographer and the Investigation-Oriented Teaching Strategies

In the widely circulated book entitled *Geography: Its Scope and Spirit,*[1] written specifically for teachers by Jan O. M. Broek, a geographer, there are two methods defined which are characteristic of the geographer's work. They are the regional method and the cartographic method. Geographers also use a variety of quantitative techniques. Though these techniques are being used by all social scientists, they need to be emphasized because in the last few years they have assumed a considerable amount of importance as far as the geographer is concerned.

The regional method is based on the modern concept of region which rejects the rigid notion of defining a region only on the basis of major relief features, climate, or main economic activities. The study of such uniform or formal regions is not as prevalent today as the study of another category of regions which, as Broek points out, "emphasizes homogeneity in internal structure or functional organization as, for instance, the trade area of a city." [2] In verbalizing the modern concept of regions, Charlotte Crabtree states that it "is an abstraction, the outcome of defining a precise area of study on criteria which accomplish two things: (a) which maximize homogeneity of features within the boundary; and (b) which maximize contrasts between the region and its surrounding or bordering areas." [3]

Concerning the method of examining a region, Jan Broek states:

> In a regional study one starts with the hypothesis that the area is a region and then examines its components and connections. In light of the knowledge gained, one confirms or revises the initial boundaries and interprets the "personality" of the region. Throughout the procedure the guiding idea is to provide a synthesis of the region as a complex association of features.[4]

In light of the above paragraph, there is no doubt that the regional method is an investigation-oriented approach to the study of geography.

The cartographic method, consisting of map making and map use, is an important element in the regional study. In the process of defining a region, maps are used to accomplish two things: to record data, and to compare these data to discover relationships. In the past, when geography was largely descriptive in nature, maps served the purpose

of showing the location or distribution of things, people, and phenomena. The regional method, placing more emphasis on areal associations of physical and cultural features, makes more use of maps which show relationships. Examples of such maps would be those showing density of population, the relationship between malnutrition and disease, and percentage of farmland in crops.

The importance of relationships in the study of regions, and the need to measure precisely these relationships, made the use of quantitative techniques a widespread phenomenon in the geographer's work. The most common quantitative techniques applied are *correlations,* to show areal associations between phenomena, and the *location quotient,* to show the degree to which a phenomenon is present in a sub-area as compared to the total area.

Turning to the investigation-oriented teaching strategies, one is not reaily departing from the meaning and the general procedure of the regional method. The only difference, probably, between the regional method and the investigation-oriented approaches which have recently emerged in social studies lies in the fact that the geographer and the elementary or secondary school child are different in one important respect. The geographer does possess the investigative skills, and the thrust of his involvement is the discovery of geographic relationships. The elementary or secondary school child is not in complete possession of the investigative skills and his involvement must be designed in a way that will allow him to gradually develop these skills as he attempts to intellectualize about phenomena and discover relationships. Taking this into consideration, it can be said that the application of the investigation-oriented teaching strategies involves more than the proper study of geography or any other discipline; the teacher must also take into consideration the various psychological factors extremely influential in the various developmental levels of the students.

An examination of current nationally recognized curriculum projects in social studies education reveals a number of specific teaching strategies. The most observable one in a classroom situation is the result of the elimination of the single textbook. Recognizing the fact that children in a particular class are at various intellectual and developmental levels, and that textbooks are written by people who have their own biases, it is not considered proper to use one textbook when teaching about people and their relationships. A variety of materials, and as many points of view as possible, are more appropriate.

The above change gave prominence to individualized instruction as compared to the centuries-old notion of looking at the class as a unit and teaching everyone in the same way, at the same time, and using the same materials for every child. The goals for a class remain the same, but the avenues for reaching them are tailor-made for each child or for a number of categories of children.

In an investigation-oriented type of teaching, questions become centrally important. A science of questioning was practically developed to lead the children beyond simple recall and recitation into higher levels of thinking. Most questioning strategies are based on a variety of thinking models designed to facilitate intellectualization or inquiry. The models consist of a number of thinking processes, hierarchically arranged from simple to the increasingly complicated. Probably the best known thinking models among social studies educators are those developed by Benjamin Bloom and his associates [5] and by Hilda Taba.[6]

Bloom's model identifies six thinking processes: Knowledge, Comprehension, Application, Analysis, Synthesis, and Evaluation. Knowledge consists of the ability to recall specifics, facts, terminology, events, and principles. The process of comprehension implies that the child is capable of translating one form of communication to another. The application process means that the child is capable of using what he learned in his efforts to deal with new problem situations. Analysis implies that a youngster has developed the ability to see parts and understand the principles of organization of a particular area or object of study. Synthesis is of a higher mental level and implies that the youngster is capable of putting together parts to create a new whole. Evaluation demands yet more intellectual involvement and refers to the ability of the individual to make judgments on the basis of internal and external criteria.

Taba's thinking model consists of three different categories of processes which she calls the three cognitive tasks. The first task is concept formation. "Concepts are formed," Taba wrote, "as students respond to questions which require them: (1) to enumerate items; (2) to find a basis for grouping items that are familiar in some respect; (3) to identify the common characteristics of items in a group; (4) to label the groups; and (5) to subsume items that they have enumerated under those labels." [7] The second cognitive task enhances the thinking processes of interpreting, inferring, and generalizing. Finally, the third cognitive task consists of the ability to apply known principles

and facts to explain unfamiliar phenomena, or to predict consequences from familiar and known conditions. When a teacher keeps in mind the preceding processes, or a program is designed to stimulate their development, questions are systematically differentiated and structured. It thus becomes easier to depart from the traditional practice of asking only low level questions.

Social studies programs in the past tended to perceive society to be more or less static in nature. The physical environment was given great influential power over man's activities, and man's relationships with other men were usually governed by rules of conduct generally thought to be unchanged. The new programs stress the dynamic nature of society and a variety of ways are applied to describe it to the students as realistically as possible. In this respect, the case study method and the use of profiles of ac' al people have become popular. A multimedia approach to teaching brings the youngsters into contact with the raw data and allows them to reach their own conclusions about man's capabilities, achievements, failures, problems, and conditions.

Since the beginning of the so-called revolution in social studies during the early 1960's, the development of concepts and generalizations was for some time considered to be the ultimate objective of instruction. The latest trend is to go beyond concepts and generalizations by concentrating on the child's capability to make decisions in a rational way. One of the most fundamental aspects of decision-making is that it involves, besides knowledge, the affective domain of the individual—what are commonly referred to as feelings, values, attitudes, and beliefs. Decision-making, then, requires that the social studies program be concerned with the affective domain of the learner just as much as it has been and continue o be concerned with increasing his knowledge, whether this knowledge is in terms of factual information or in terms of concepts and generalizations. Also, a program designed to enhance the development of the ability to make decisions must be an active program, one that would require involvement on the part of the learner.

Emphasis on decision-making, and the conscious involvement of the affective domain in the learning process, generated some rather stimulating teaching strategies. Role-playing, games, and simulation are among them. Such strategies help to bring to the classroom realistic social problems, and afford for the students opportunities to identify with various roles and to actively engage in the intellectual and psycho-

logical strains imposed by the context within which decisions are usually made.

In examining, then, the emerging geography curricula in regard to the teaching strategies inherent in them, one should ask the following questions:

1. Do the new curricula use the regional method?
2. Do they facilitate the use of quantitative methods and maps to show relationships between the various physical and cultural features of a region?
3. Is there a multi-media approach, as compared to the use of only printed materials, a basic aspect of the new geography curricula?
4. Is questioning important, and are the questions designed systematically to elicit higher levels of thinking and maintain a spirit of open-endedness and open-mindedness?
5. Does the program lead the learner beyond the development of concepts and generalizations into the application of the decision-making process?
6. Do the new programs recognize the role which the learner's affective variables play in the learning process, and do they apply such value-oriented strategies as role playing, games, and simulation?

High School Geography Project

As pointed out above, the program developed by the High School Geography Project is probably the only genuine geography program that has emerged thus far. It represents a massive effort on the part of a good number of well-known geographers and many teachers. In its initial stages the work of the Project was exploratory in nature. A group of professional geographers attempted "to define basic ideas in geography, outline geographic methods of inquiry, and state the skills which it (the group of geographers) thought should be developed at the high school level." [8]

On the basis of the results produced during the exploratory period, tens of units were designed, written, tried in the classroom, redesigned, and rewritten. At the time of this writing three units have been released by the Project in their final form. The units are *The Geography of Cities, Manufacturing and Agriculture*, and *Cultural Geography*. It is by examining the materials produced for these three units that the teaching strategies advocated by the High School Geography Project will be described and analyzed.

Neville Scarfe, in discussing what came to be known in geographic circles as the regional method, stressed that "there are intricate relationships between man and land. The problem in geography is to find, describe and explain these relationships." [9] At another point in the same article, Scarfe states that "Geographical problems are usually associational in character. Geographers seek to discover those associations of the two types of distributed phenomena (man's life and work and nonhuman conditions) which give character to regions and which are of *significance to man*." [10]

The curriculum developed by the High School Geography Project does apply the regional method. Cities, for example, are studied in terms of the relationships between what people do and the conditions of the place in which they live. The problems, the trends, and the future developments of cities are examined in the light of these relationships. Of the three units that have been released, the title of one, *Manufacturing and Agriculture*, gives the impression that the traditional topical method is used. A careful examination of the unit, however, reveals that both manufacturing and agriculture are singled out as the main activities of people found in particular places, but they are not treated in isolation. All factors that were influential in leading an area to become a manufacturing center or an agricultural area are carefully examined. At the same time the effect of manufacturing or agriculture upon the lives of people and the overall physical environment is, also, a primary objective of the unit.

Characteristic of the regional method is the use of the problem-solving or the inquiry method. The High School Geography Project is structured around problems that are of high social significance. Agriculture, for example, is studied in Unit 2 in relation to the world-wide problem of hunger. Students are presented with a variety of opportunities to develop hypotheses, analyze, make inferences, synthesize, generalize, and evaluate. Indicative of this is the raising of such basic questions as: "How do you explain the fact that some poorly fed countries have plenty of land and some well-fed countries have very little?" [11]

Questioning was presented earlier in this chapter as an important element in recent investigation-oriented social studies programs. In examining the teacher's guides developed to accompany each unit, it becomes quite obvious that the High School Geography Project uses the technique of questioning extensively. Though there are questions at the various levels of thinking, they do not appear to follow any of

the developed models of thought processes. In a way this is probably for the better, because following one particular model imposes unnecessary restrictions. In view of the traditional tendency of the teachers, however, to limit themselves to low level questions, the inclusion of a general discussion on the various levels of questioning would have been most appropriate and helpful.

As one examines the teacher's guides, it appears at times that the lack of an overall questioning philosophy might have somehow affected the quality of the entire program. Activity after activity point to an overstructuring of many of the interactions between the students and the teacher. As it is stated by Trujillo, Ostrom, and Masters, "Many times the materials call for the teacher to become a questioner, a leader of students from one logical step to another, and eventually assisting the students to discover some of the concepts being considered." [12] It might be that there is too much of this type of convergent questioning, as opposed to the open-ended type that tends to be more associated with creativity and divergent thinking.

The High School Geography Project is probably one of the very few new social studies projects that has developed a wide variety of instructional materials and aids. A classroom set of materials needed for Unit 3, *Cultural Geography*, for example, includes, besides the Teacher's Guide, the following:

Enough copies of *Student Resources* and *Student Manual* for the class
1 box of 32 slides
1 transparency Packet containing:
- 2 transparencies as follows:
  - Map showing core region of Islam
  - Overlay showing present extent of Islam
    - (The transparencies showing red and blue circles used in Unit 1, Activity 6, may be used in this unit too.)
- 6 masters for making transparencies as follows:
  - "Population Diagram"
  - "No Barrier — Blockade"
  - "Blockade — Pass Route"
  - Southeastern Canada (base map)
  - Diagram at start of graduation rehearsal
  - Diagram after students mingle

4 tablets as follows:
- "Quiz on How Sports Spread"
- "Ethnic Origin in Southeastern Canada"
- "Language in Southeastern Canada"

"Religion in Southeastern Canada"
1 packet of tracing paper (1 sheet for every 2 students)
Enough copies of a world outline map for the class [13]

The variety of these materials makes it possible for all students to participate and interact. Most maps are designed to show relationships. The utilization of the maps, as well as of all other materials, is well-structured and prescribed in the manual. The specific questions to be asked in relation to a map, for instance, are given in the Teacher's Guide, along with the anticipated or desired answers. In spite of the apparent overstructuring, the materials are sufficiently flexible and open-minded in nature to allow a good teacher to be creative and innovative.

Another aspect that makes the program of the High School Geography Project attractive is the fact that it is activity-oriented. The activities range from analyzing the contents of a slide picture to becoming involved in a sophisticated simulation game. The content becomes the means for accomplishing an activity. As a result, the program has a strong potential for motivating students and for providing for learnings that could change the children's behavior rather than merely helping them to accumulate factual information.

The shortsightedness of the new social studies in making concepts and generalizations at the end of instruction has already been pointed out. Going beyond concepts and generalizations and placing decision-making as the ultimate objective of social studies makes sense. Even though this trend is a recent one, the High School Geography Project utilizes it. Simulation games are included in the published units, but to emphasize the importance of simulation the Project published recently a program to train teachers in the application of simulation. "As conceived here," the authors of this publication stated, "the essential characteristic of simulations is student involvement in making choices within small groups." [14] Needless to say that in involving students in the process of decision-making, the program brings into play not only the knowledge of the student but his feelings, values, and attitudes as well.

Finally, the High School Geography Project has made every effort to be as realistic as possible in dealing with the problems selected to become the primary focus of the program. In connection with the unit on agriculture, for example, actual farmers in various parts of the world have been interviewed to help the student focus on the individual

decisions that determine what is grown and how it is grown in these selected areas.

An overall reaction to the curriculum developed by the High School Geography Project, in terms of its teaching strategies, is rather positive. It emphasizes relationships and uses a multi-media approach including maps, graphs, charts, and tables. Though at times the questioning strategies appear limited in their open-endedness, the overall program is reflectively-oriented. It emphasizes decision-making and values student involvement in meaningful problems. If there is one big mistake that the Association of American Geographers made, it is the fact that they did not plan a kindergarten through grade twelve program, and start developing it from the lower grades upward. For a ninth- or tenth-grader who grew up in a traditional program, it will be difficult to adjust to the fine strategies advocated by the Project. It would have been easier for this to happen in the lower grades.

Other Geography Programs

Charlotte Crabtree developed a program for grades one through three "to test whether young children, with appropriate instructional support, can engage in the relational thinking these inquiry methods require, and whether they will, as a consequence of instruction, demonstrate statistically significant increments in their ability to apply the geographic concept of areal association appropriately in analyzing unfamiliar problems." [15] The overall strategies applied by Crabtree appear in the following sequence: (1) definition of the region under study (2) examination of particular features distributed within the region (3) understanding of patterns of areal association within the region (4) understanding of the unique character of the region under study (5) generalizations concerning similarities between regions.

In connection with the above strategies, activities such as the following were undertaken:

1. visiting a freeway under construction
2. visiting a number of other construction sites in the city
3. visiting rail facilities to see construction materials, especially rock products, arriving in the city
4. using a terrain model of the Los Angeles area to help children raise hypotheses in regard to the origin of rock products used in construction
5. building a soil box to simulate a mountain system and to demonstrate the action of water on the mountain slopes in creating rock deposits

6. using overlays and large pictures to show the physical features of the area to help children apply their knowledge from the demonstrations and locate the rock deposits
7. using maps and air photos to discover that residential expansion and zoning laws prevented some seemingly good rock supply locations from being exploited.

Crabtree summarized the results of her experiment as follows:

> Thus over a series of inquiries, a geographic generalization was refined and revised in light of the data marshaled in its support. . . . Although the purpose of these lessons was not to recapitulate the history of geographic theory-construction, those familiar with the course of geographic thinking in the last 60 years will recognize how these young children were grappling with certain problems which, at far more advanced levels, have occupied professionals in the discipline. Practice in these lessons sensitized children to seeking multiple causation for phenomena in the social world.[16]

The Crabtree program has not been published as an instructional program with all its detailed procedures and materials. From published descriptions, however, it appears that it is a sound program. It uses the regional method, involves the children through a multi-media approach, and it brings them close to reality. Even the cartographic method and quantitative techniques were applied to some extent, but "with young children such operations are too advanced," [17] says Crabtree. Also, difficult to handle at this level, she claims, are policy questions.

During the 1960's Lawrence Senesh advanced the concept of the "orchestrated curriculum." According to this concept, the social studies program is interdisciplinary in nature, but in specific units or grades a particular discipline plays the solo part while the other disciplines are in the background. Some of the new social studies programs do follow this approach and geography is at times in the forefront. The program in which geography is definitely stressed as a discipline is *The Greater Cleveland Social Science Program*, which devotes the entire first semester of the seventh grade to the study of geographic concepts. It is probably the only new program that has a section strictly devoted to geography and it should be examined in terms of the teaching strategies that are applied.

The geography section of the Greater Cleveland Social Science Program consists of two different parts. "Part One follows the systematic approach in which single elements are studied. The main theme of

Part One is the wide variety of geographical patterns over the earth's surface: the patterns of population, the patterns of physical and biotic landscapes, and the patterns of key resources. Part Two, which follows the topical approach, comprises five case studies designed to show the range and the depth of specific topics within the over-all field of geography." [18]

Obviously the Greater Cleveland Social Science Program applies the topical approach to the study of geography more than the regional approach that appears to be more prevalent in today's programs. This should not be interpreted, however, to mean that the program is descriptive in nature. The value of developing concepts representing basic relationships is evident throughout the program. Maps showing relationships are used extensively. Also, graphs, charts, and tables which facilitate the application of quantitative techniques are in abundance.

The materials provided by the program consist mainly of teachers' manuals and working texts. Also available is a *Teachers' Kit*, an envelope with 67 different prints of maps, charts, graphs, and tables. Each teachers' manual includes a series of lesson plans for each part of the course. The lesson plans correspond to the chapters to which a particular part of the course is divided. The so-called working texts are in many ways similar to the traditional workbook; children use them to do certain exercises or answer questions by referring to information presented in previous pages or to other sources.

The lesson plans are not specific enough. Much of the burden for planning is left with the teachers. The lesson plan dealing with "The Cultural Habitat of the Lower Mekong Basin," [19] for instance, starts with the suggestion: "Show films, filmstrips, or have guest lecturers meet with the students in large group session." Three films and two filmstrips are cited as possibilities, but the teacher must decide which one to use and how to use it. As far as guest lecturers are concerned, no specific suggestions are offered. More serious than this, is the vagueness of the purpose of this activity. Somehow the teacher must tie the activity to the general purpose of the lesson which is "to help the students develop an understanding of the way of life in the four countries of the Lower Mekong." The rest of the activities are of the familiar small-group type such as discussing the content of pictures, defining terms, making reports and murals, and independent study.

The Greater Cleveland Program definitely represents an improvement over the traditional descriptive geography programs in terms of

its content. Basic geographic concepts are substituted for the usual travelogue type of information of the old programs. In terms of methodology, however, the program appears restricted. No systematic strategy is available for the development of intellectual skills. The questions in the working texts look more like traditional test questions rather than the kinds of questions that would be open-ended and challenging to the child's imagination. Even the maps, pictures, charts, tables, and graphs are used to obtain answers to specific questions rather than to deal with basic problems.

The Greater Cleveland Social Science Program definitely appears to be cognitively-oriented. There has been no apparent effort to relate the content to important contemporary issues, an approach that tends to stimulate involvement on the part of the students. In an effort to present what is basic to the discipline of geography, the child and what he needs to understand about the contemporary scene are ignored. The involvement of the affective domain is at a minimum. Such teaching strategies as role-playing, games, and simulation are completely absent. At a time when the ability to make decisions is becoming one of the main objectives of social studies instruction, the techniques just mentioned and the affective domain should not be overlooked and ignored. In fairness, however, it should be noted that this geography unit of the Greater Cleveland Social Science Program represents a first draft, experimental design and will likely be altered as feedback from the classrooms is utilized in revisions.

The three programs examined represent probably the only geography curricula that have become nationally known. It should be pointed out, however, that various school boards have produced their own geography programs. The development of one such program for grades kindergarten through three has been announced by the School Board of Santa Monica, California. In this particular program the integrative discipline will be geography. The announcement gives some indications as to the teaching strategies to be used. "Special attention," the announcement says, "will be given to field study. . . . The students should learn to 'think geographically.' Special maps, terrain and scale models, films, cameras, overhead projectors, and other multimedia materials will be purchased or developed for the program."[20] It sounds like a promising geography curriculum, but to this writer's knowledge no materials have been available so that an analysis of the strategies could be made.

Research and Teaching Strategies in Geography

Generally, very little fundamental research in geographic education has been undertaken. Consequently, studies dealing with strategies of teaching geography are rather scarce. Most of them can be grouped into three categories. The first category attempts to determine the value of conceptual teaching or the inquiry-discovery approach to teaching geography as compared to the expository method. According to studies by Arnsdorf,[21] Connors,[22] Carmichael,[23] and Crabtree[24] the investigation-oriented methods proved to be superior to expository teaching.

The second category of studies deals with the use of a variety of media and materials, in addition to or in the place of one textbook, in the teaching of geographic concepts. Studies such as the ones by Shafer,[25] Uslan,[26] and Ryan[27] appear to encourage the use of programmed materials, and a variety of audio-visual aids.

A number of studies in geographic education deal primarily with the use of maps and the development of map skills. McAulay[28] found that a functional approach for teaching map skills to fourth graders as a part of the regular social studies program gives better results than when map skills are taught separately. Davis[29] discovered that illustrative maps do not facilitate learning of geographic text material. Fluitt[30] attempted to determine the effects of wall maps, desk atlases, and slide projected maps on student achievement. There were no differences, but students tended to prefer desk atlases to wall maps. Savage and Bacon attempted to find out whether map symbols could be taught to first graders without the use of the usual manipulative concrete materials. It was concluded that "first grade children do have the skill and sophistication to begin on a more abstract level than had been previously assumed."[31]

Closing Remarks

The emerging new curricula in geography, and whatever related research there is, quite clearly favor the investigation-oriented teaching strategies. This, of course, is in harmony with the trends in social studies education. One cannot help but notice the limited number of geography curricula. On the one hand, this is to be expected in view of the emphasis on the interdisciplinary approach to designing social studies programs. On the other hand, however, one can argue that purely geography curricula are needed to provide the basis and to serve as sources from which to obtain whatever elements from geog-

raphy are needed for the interdisciplinary programs. Besides, courses in separate disciplines appear to be desirable toward the end of senior high school.

FOOTNOTES

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Chapter 17

The Preparation of Geography Teachers

John Jarolimek

It has long been the dream of some geographers that their subject would establish a separate identity for itself in the curriculum of the common schools. The events of the past decade of curriculum reform suggest strongly that such a development is unlikely. Geography, along with history and the other important disciplines of the social sciences, will have to find its place in the school curriculum within the framework of social studies education.* This does not preclude the possibility, of course, that there can be geography courses available to students on an elective basis in the secondary schools.

It is also important to recognize at the outset that the performance requirements of teachers of geography and for those of professional geographers are not identical, and therefore the training programs for each should not be the same. It goes without saying that a teacher of geography will be solidly based in this subject. Nonetheless, there are requirements for the teacher that are different from those of the pro-

* *In this essay the designation "geography teacher" should be understood to mean social studies teachers in elementary and secondary schools who have had the major thrust of their preservice preparation in the field of geography.*

fessional geographer. The reverse is also true. An undergraduate preparing to be a professional geographer should engage in a sequence of studies in geography that is in some respects different from the undergraduate preparing to be a teacher.

The fundamental components of teacher-education programs are fairly well established. These components have constituted the basic structure of training programs for teachers since the turn of the century. They are:

(1) *General Education.* This component is intended to help the teacher-candidate develop a general background of culture and aesthetics; to be informed about the affairs of the day; to be able to express his ideas in an articulate, coherent way; and to be able to carry on discourse and dialogue with other educated persons. It is believed that a social studies teacher should first of all be liberally educated.

(2) *Field of Specialization.* This component is intended to help the teacher-candidate develop special expertise in the subject fields he will be expected to teach, in this case, geography and related social science disciplines.

(3) *Professional Studies.* This component consists of educational theory and those specific tasks related to the teaching process itself — planning lessons, preparing examinations, conducting discussions, asking questions, responding to students, cuing, reinforcing, motivating, and others.

(4) *Practice.* This component provides the teacher-candidate with an opportunity to do supervised teaching and to try out his own skills as a teacher under the direction of a master teacher.

The changes that have taken place in the preparation of teachers in recent years have not altered this basic structure of programs. What has happened, and what we will be concerned about in this essay, is that there have been many changes in the way each of these basic components has been implemented. Even the names attached to the components have been modified through the years. For example, terms such as "clinical experience," "field experience," "laboratory experience," and "practicum experience" are used to designate experiences that were formerly subsumed under the general rubric of practice teaching. In a recent publication of the National Council for Accreditation of Teacher Education, the term "Professional Studies" [1] is used in connection with the components numbered 2, 3, and 4 above.

Despite changes in teacher-education programs in recent years, it seems clear that the success of a training program is highly dependent on the candidates selected for it. That is, those candidates who are only marginally qualified for teaching in terms of personal characteristics are not likely to be transformed into first-rate teachers even by the best training programs. A competently prepared teacher is the product of an interaction between personality and training variables. Success is not likely when one or the other is deficient.

Although personality variables are difficult to deal with in the selection of teachers, more attention needs to be given to them than has typically been the case. Teacher-education programs should require the candidate to make formal application for admission, and the screening procedure should include attention to personality variables. Sooner or later the personal qualities of the teacher become an important consideration. This may be at the time of initial selection for teaching, during the student-teaching experience, or later when the teacher is in service. For those candidates who are likely to have difficulty in teaching because of personal qualities, the earlier this is detected the better. Early detection will allow for some opportunity for remedial work or, in severe cases, will permit the candidate to transfer to another field more consistent with his personal characteristics.

General Education

The standards for accreditation adopted by the National Council for Accreditation of Teacher Education (NCATE) recommend " . . . that at least one-third of each curriculum for prospective teachers consist of studies in the symbolics of information, natural and behavioral sciences, and humanities." [2] This portion of the program should be designed to acquaint the teacher with knowledge and appreciation of several fields — languages, literature, music, art, science, mathematics, and the social sciences. It should not be highly prescriptive but designed in terms of each student's background of strengths and limitations. What is important is to maintain a balance in the work taken to build a solid, broad, general background of knowledge rather than to build a specialty.

Often the bulk of the general education requirements are completed during the lower division years of the student. There is some reason to believe that more effective general education would result if it were

spread throughout the college experience. The relationship between general education, special education (in this case, geography), and professional education does not need to follow a strict sequence as here listed. In fact, there is good reason to believe that general education is closely related to life experience and that maturity adds to the meaningfulness of general education. This is particularly true in such fields as literature, philosophy, and some of the social sciences. It is recommended, therefore, that the general education requirement be extended throughout the student's college experience. Indeed, some work of a general studies nature could profitably be taken during the fifth year subsequent to initial teaching experience.

General studies are intended to have a broadening, liberalizing effect on the student's education, yet this is often difficult to achieve because of some of the realities of college programs. Two conditions are particularly constraining. One of these is the policy of prerequisites; the other is the need to maintain a minimum grade point average. Better college programs would result if the traditional policies surrounding these two issues were revised.

Prerequisites to courses are written into college catalogs and enforced as though they were based on scientific study. The fact of the matter is that prerequisites in the social sciences are, with a few exceptions, based partly on common sense, partly on intuition, and mainly on tradition.

The writer has before him a university catalog. In examining upper division courses in the social sciences, humanities, and literature, one almost invariably sees a prerequisite lower division course. In looking at the lower division prerequisite, one sees that *it* has a prerequisite such as introductory psychology, introductory anthropology, or introduction to literature. On the face of it, these prerequisites appear as though they are sensible ones. The only problem is that every professor knows students who have slipped into a course by some way circumventing the prerequisite, and not only survived the course but earned an "A" grade! In the social sciences and humanities, such variables as reading ability, study habits, and personal motivation are doubtless more significant in successful achievement than are the prerequisite requirements for the course.

What does all of this have to do with general education of future geography teachers? It has a great deal to do with it. The student may find an especially attractive upper division course that would be an

excellent choice in terms of background for social studies teaching. The course happens not to be in his major or minor fields. Typically he will not be allowed to take such a course because he has not had a lower division prerequisite. The system contradicts itself. On the one hand, it wants students to be broadly educated, but on the other, it severely narrows the choices available to students. The recommendation is made here that unless there is an empirically supported case for the need for a prerequisite, that one should not be listed for any course.

Another condition that restricts course choices of students is the grade point requirement. Students are not likely to experiment with courses outside their areas of strength if, by so doing, they place their grade point average in jeopardy. No matter how valuable a course may be, students do not want to risk earning a low grade. There is one solution to this problem that many institutions are now using, namely, the pass-fail grade option. Students usually are not worried about failing a course; they are more concerned about getting a "C" or "D" grade. A pass grade ordinarily does not affect the student's grade point one way or another. Thus, he can move out of his field, experiment with a variety of courses for general education, without being concerned that in so doing he will be penalized by earning a low grade. A second recommendation, therefore, is that students be allowed to meet at least part of their general education requirements under a pass-fail grade arrangement.

Content for the Field of Specialization

The standards for teacher education published by the National Council for Accreditation of Teacher Education speak of content in terms of (1) that to be taught to pupils and (2) supplementary knowledge of subject matter in a teaching field and allied field.[8] It is fair to say that in the case of social studies teachers with a geography major, more attention has been paid to the second than to the first of these requirements. Years ago the teacher training institutions — normal schools and teachers' colleges — provided courses in "professionalized subject matter." These courses were designed to teach the candidate *that* specific content he in turn would teach his pupils. Often these courses paid some attention to methods of teaching, including the use of teaching strategies not unlike those to be used by the candidates with pupils.

Through the years these courses gradually disappeared. Because they were associated with normal schools and teachers' colleges — institutions that were being replaced by multipurpose colleges — professionalized subject-matter courses were not highly regarded. If anything, there was a strong movement *away* from labeling courses as being specially designed for teachers. To so label them was to imply that they were less good than regular courses. As a result, the courses in the field of specialization for a prospective geography teacher may differ very little from those taken by the student who plans to become a professional geographer. Programs that are designed in this way presume that the young, beginning teacher is capable of translating and converting the knowledge of geography that he gains in his college classes into forms that are suitable for learners in the public schools. Two practices suggest that this presumption is almost wholly in error. One is the widespread use of textbook teaching; the other is the frequent use of the lecture as a method of teaching at the junior and senior high school levels. Teachers use these methods precisely because they *do not* know how to convert the subject matter of their discipline into a form suitable for younger students. Almost all supervisors of beginning secondary teachers have encountered those who use notes taken in a college class as their own lecture notes in the secondary school classes they teach.

If we take professionalized subject-matter courses of the normal schools as representing one end of a continuum, we can place geography courses that make no reference whatever to the jobs of future teachers at the other end. The sad truth of the matter is that in some of our most prestigious and high-rated colleges and universities in this country today the latter set of circumstances prevail. Future teachers who major in geography report that they cannot recall a single instance of a professor of geography making any reference to the relationship of the content of his course to the job of teaching in the elementary or secondary schools. In fact, the only reference to the elementary or secondary schools that students report their geography professors make are ones that are critical of the geography curriculum of these lower schools! This is akin to the man who prepares his own lunch and then complains to his fellow workers about how bad his lunch is.

If the subject-matter background of social studies teachers is to be improved and strengthened, efforts to reform this component of the preparation program *must* come from the professors in those substan-

tive fields, meaning specifically, in this case, the professors in the department of geography. If that corps of professors assumes no responsibility for the upgrading of the geography curriculum for prospective geography teachers, the job will simply not get done. The liberal arts professors in fields such as geography have both a heavy investment and a responsibility for the preparation of future teachers. Unfortunately, these professors have not often involved themselves in a constructive way in the redesigning of their own offerings for those students planning to become social studies teachers. There is a place for constructive criticism of current teacher-education programs; there is a greater need for active participation in improving them. With a few exceptions, the liberal arts professors have functioned in the first of these roles but have done little with the second. It is precisely here that breakthroughs are needed.

Often geography departments sense some need to become involved in teacher education, and to meet this need in a token way will make a special faculty appointment for this purpose. Almost invariably the geography credentials of such a faculty member are suspect by his colleagues in his own department. The prevailing attitude seems to be that such a professor could not possibly be much of a geographer or he would not involve himself in teacher education. Unhappily, the same attitude prevails in many departments of the arts and science colleges — departments that need to be vitally and centrally concerned about the quality of teacher education. Just how these faculty members can contribute to the improvement of teacher education without themselves becoming involved in the process is difficult to understand.

Geography professors who teach classes with large enrollments of undergraduate students can be sure that a significant number of those students are preparing to be elementary and secondary school teachers. No one expects such a professor to commit his total professional career to teacher education. It would be reasonable to expect, however, that through his presentations such a professor would be sensitive to the special needs of those students in his class who are planning to become teachers. He might show in a constructive way how the programs in the lower schools could be improved in the handling of his subject. He might be able to comment on the soundness of the geography major in terms of those who are preparing to be teachers. But how can he know anything about the viability of the geography major as presently constructed if he isolates himself from the public school enterprise?

Is it too much to ask that professors in the substantive fields on our college and university campuses have a continuing professional contact with their colleagues and counterparts who happen to teach in the lower schools?

Conversations with social studies teachers would indicate to the college professor that many of them spend only a part of their time teaching geography. He would find, for example, that in most schools the social studies teacher may also teach the history of our nation, government, state history, perhaps world history, and/or a problems course. Because of this diversity in what the teacher of social studies is expected to do, the National Council for the Social Studies Advisory Committee on Teacher Education recommended that preparation programs include subject matter and modes of inquiry of one or more disciplines from each of the three categories of the social sciences: the synoptic (history and geography); the systematic (economics and political science); and the holistic (anthropology, sociology, and social psychology). The report continues:

> Prospective elementary teachers should have, in addition to these foundations, some advanced study in one social science requiring intensive studies in the literature of the field and an independent plunge into research.
>
> Beyond the same basic introduction to the social sciences, the prospective secondary social studies teacher should ordinarily have a close acquaintance with three social sciences and a specialization in one. Again, there should not be a set of standard course requirements; yet the student and his advisors cannot ignore those abiding characteristics of American social studies curricula: American and world histories, and American government. Nor can they ignore the ever more insistent demands for Black Studies or Afro-American history; a combination of righteous indignation among the burgeoning black populations of our cities and an awakening of conscience among whites guarantees the need for grounding in these subjects.[4]

In order to meet the requirements set forth in this statement, some new combinations of courses are needed. It seems unreasonable to expect prospective teachers to take courses, or even a single course, in *all* of the social sciences. Colleges and universities need to experiment with year-long courses in social science that combine concepts and modes of inquiry from several of the disciplines. These should be specially designed courses for social studies teachers that would provide them not only with information inputs but would give them experience in converting these concepts and skills into forms suitable

for use with elementary school pupils and secondary school students. Such courses could include some instruction in methodology and laboratory experiences in school classrooms. It is suggested that this work be taken in addition to that in the major field, in this case, geography.

The complex social problems relating to ethnic minorities in this nation need to be seriously studied by prospective social studies teachers. Some formal course work dealing specifically with the ethnic diversity of American communities should be required of all teachers and most especially those teaching social studies. The phenomenon of racism so prevalent in its various forms needs to be well understood by social studies teachers. There can be little hope of eradicating this evil so long as teachers are provided little if any preparation in understanding it and dealing with it.

As for the major in geography for teachers, this is badly in need of an overhaul. Most of the programs for majors with which this author is familiar are inadequate. This is because they were designed years ago and have not been brought up to date. It is difficult to understand why geography, which is perceived by geographers as a unifying discipline, constructs majors that seem to lack this unifying quality. After talking with many geographers about this matter, this author has concluded that majors are as they are because geographers have not spent much time thinking about the adequacy of these programs as related to modern social studies curriculums in the lower schools.

Here again it would help considerably if geography professors had a continuing contact with the social studies teachers in the public schools. Perhaps it would help, too, if the professors in the education department and social studies teachers in the public schools would extend an invitation to their colleagues in the geography department to join with them in considering problems relating to teacher education. Often the professor from the liberal arts does not feel comfortable or even welcome in those professional circles where decisions relating to teacher education are made.

Professional Studies and Related Field Experiences

This discussion will not concern itself in detail with the full range of work in professional education that comprises the preparation of elementary and secondary teachers. All teachers are expected to have some understanding of the body of knowledge and theory relating to

human learning, to the psychology of children and youth, and to measurement and evaluation of learning. Such understanding provides the teacher with a framework within which he makes decisions regarding his day-to-day teaching. That these components of the teacher-education curriculum are often not well-received by students is well known. Part of the reason for this attitude is to be found in how such courses are taught. Often they are taught as lecture courses in educational theory far removed from classrooms, schools, and children. The students are not able to relate what the instructor is talking about to problems of teaching because they have had little, if any, background of experience in teaching. To be effective, these courses should be handled in a laboratory setting with frequent use of children in order to provide direct, firsthand contact with problems of teaching.

More central to our concern here is *that* specific portion of the professional-studies component that deals with the methodology of social studies education and the related field experiences that accompany — or follow — it. These courses, the methods courses, have been roundly criticized. The criticisms tend to fall into two categories. On the one hand, they are often said to lack intellectual content and that they consist mainly of doing little projects not unlike those that elementary and secondary school pupils do. On the other hand, these courses are also criticized for being just the opposite — too theoretical, unrelated to practice, too general, too "intellectual."

Whatever the shortcomings of these courses have been in the past, the experiences of the last decade in curriculum reform clearly and unequivocally indicate that methods of teaching social studies are critical to the success of programs. There are still a few critics who persist in their insistence that "teachers are born, not made," that "you don't teach a good teacher his methods," but most who have worked with curriculum reform projects know better. To think that one comes into this world somehow knowing the methods of the geographer is sheer nonsense. One learns these methods along with the content of geography. Similarly, one learns methods of teaching it. And because they are learned, we can assume they can be taught to prospective teachers.

The basic purpose of the methods course is not to make the teacher-candidate a student of education, but to help him understand and to be able to perform certain critical and essential tasks related to teaching. They are courses that are intended to teach a *process* or

processes, not to teach a body of content. When they are taught as content courses, as for example, teaching them as one would teach a course dealing with urban spatial patterns, they almost always fail. Because they are courses that are intended to teach a process, they should be taught in ways that other process courses are taught. Teacher educators might examine the ways counselors, social workers, nurses, physicians, and lawyers are taught the processes in which they engage. Methods courses should always be behaviorally oriented. The tasks to be learned should be specifically targeted, and instruction should be directed toward those tasks. They should be taught to small groups of individuals with many opportunities to try out what is being taught.

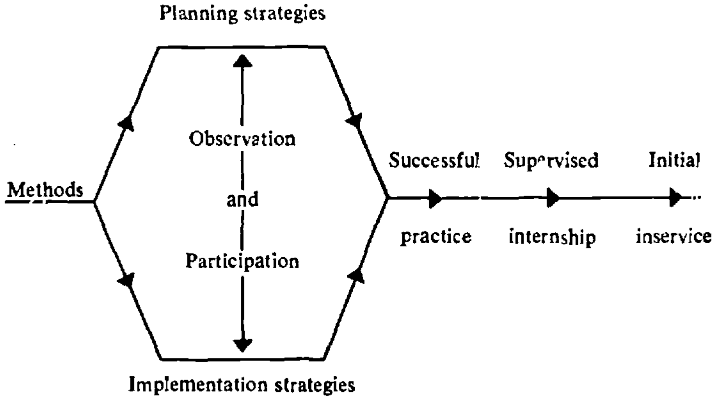
It is helpful to think of methods courses as consisting of planning strategie and of implementation strategies. Each of these involves certain special skills; these skills are, nonetheless, functionally related. The two groups of skills differ sufficiently from each other, however, so as to make it impossible to predict an individual's performance of one from a knowledge of his performance of the other. Most traditional methods courses deal mainly with teaching the skills needed for *planning* strategies, the assumption being that these will transfer into the implementation phase. Students are taught how to write lesson plans, how to use multiple learning resources, how to select content, how to evaluate student progress, and so on. Unfortunately, a student may do all of these and do them well, yet fail as a teacher. The reason being, of course, that a well-planned lesson does not ensure a well-taught one. Planning is one thing; teaching a class is something else.

As long as methods classes only stress the essential components of planning, they can be taught in almost any classroom on a college campus. A laboratory setting, where materials of instruction can be viewed, studied, or even constructed, is helpful but not essential in this type of course. If we are concerned, however, in teaching the candidate how to actually work with students in a classroom, we must have him work with students in his training for teaching. This is what is most often missing in the training program. Methods courses are frequently courses *about* how to teach; they should be courses that instruct the candidate in *how* to teach, and he should not be permitted to complete the course until he has demonstrated to someone that he can perform the essential tasks at a satisfactory level of competence.

Contrast this with what typically happens. The student takes a methods course far removed — physically and literally — from schools and pupils. Perhaps it is a lecture course. Let us assume for a moment that it is a well-taught course. The student learns a great deal about the social studies curriculum and emerging trends in teaching. He completes the course with a satisfactory grade, which, in most institutions, allows him to move to student teaching. Yet neither he nor his methods instructor knows whether or not he can teach at all. It should be abundantly clear that methods courses without the opportunity to work with children are really not methods courses at all.

Methods courses should make clear to the student what teaching behaviors he is expected to develop and what level of expectancy is required. As has already been indicated, he should not be given a signal to go ahead with his professional preparation until these requirements are adequately met. This may mean one term or more in conventional course credit requirements. Or, it may mean that some students may not qualify at all. During the period of instruction, the student should have ample opportunity to practice and learn the requisite skills in situations involving learners. He should be given supervisory feedback in order to help him to learn and to help him sharpen his skills. In recent years the use of micro-teaching has become popular as a helpful way for beginners to learn important skills without having to confront whole class settings with their attendant management and control problems.

When the student moves into his student teaching or interning experience, the same set of expectations should obtain that applied in his earlier training. That is, what was represented to him as good teaching of social studies in his methods course should be reinforced in his practice teaching. One of the most unfortunate practices in the training of teachers is the inconsistency of messages that the trainee gets from different authorities — his geography professor tells him one thing, his methods instructor tells him something else, and his practice teaching supervisor tells him something different from the other two. The situation may be additionally confounded for the new teacher by his employing school district that sets forth still other expectations once he is on the job! The training program clearly needs to be brought more in line with the institutional expectations (i.e., those of the school districts) of social studies teachers, and the training program needs to have a degree of internal consistency.



This chart is intended to show the relationship of various experiences in the methods-practice component of the teacher-education program. It also illustrates the flow of experiences from initial work in methodology to a successful inservice placement.

The diagram above is intended to illustrate how methods courses should lead to successful practice. It shows that in teaching methods to prospective teachers two strategies need to be combined, i.e., planning and implementation. These are combined through working with learners in observation and participation experiences. In the process, the prospective teacher learns to combine planning and implementing into a successful teaching performance on which he is checked out before leaving the methods course. This leads, then, to a supervised internship that provides additional practice for him. It, in turn, leads to his initial inservice post. It should be stressed again that throughout this entire process, which may extend over a period of two or three years, there is consistency in the expectations set forth for him. It is neither professionally ethical nor educationally sound to represent good social studies teaching differently at each of these several stages of the candidate's professional development.

In order to achieve the degree of internal consistency suggested here, it is clear that some coordination of the instruction given the prospective teacher is needed. The responsibility for such coordination quite clearly rests with the college or university faculty working in close cooperation with the public schools. The specific faculty member who coordinates and directs the program can be based either in the educa-

tion department or in a department of one of the disciplines, in this case, geography, but must be able to work comfortably in both departments and with field personnel.

Ideally, the training of teachers is done by a team consisting of persons from the liberal arts, education, and the field. The day when teacher training was the sole province of the education department, or the geography department, or even the college or university alone is fortunately behind us. Teacher preparation today is a cooperative and joint effort by all concerned units, and this, of course, cannot be achieved when they work at cross-purposes.

Developing Professional Awareness and Responsibility

The preparation of the geography-social studies teacher cannot be considered complete unless some attention is given to his role as a professional teacher. This part of his training goes beyond subject-matter competence and skill in classroom teaching, and involves more than simply obtaining membership in one of the several professional organizations. It has to do with the candidate's developing an identity with the professional field of teaching and particularly social studies teaching.

The teacher cannot and should not see himself as a finished product at the conclusion of his initial training for teaching. He must understand that preparation for teaching is a career-long process. In some of the rapidly changing fields in science and industry, reference is often made to the notion that a fully trained and competent person will become a "half-man" in five years unless he gets new inputs of knowledge on a continuing basis. In ten years he would be so far behind in his field that he would be almost wholly ineffective. This same idea can be applied to teaching — especially in the social studies where changes are taking place at such a rapid pace. In both the substantive fields and in the process of teaching, one must keep up-to-date if he is to stay alive professionally. This means additional college work, attendance at professional meetings, reading current literature, becoming involved in curriculum development at the local level, and contributing professionally in appropriate ways.

How does a teacher-education program provide the trainee with an opportunity to develop a professional awareness and a sense of professional responsibility? Quite clearly the prospective teacher develops these attitudes as a result of the example set for him by his mentors, particularly those for whom he has an especially high regard. If he sees those professors and teachers whom he perceives as professionally high

status individuals active in professional associations, concerned about professional matters, discussing professional issues, and attending professional conferences, he, too, is likely to develop such an interest. If, on the other hand, those professors and teachers have never heard of the national professional associations concerned with social studies education and geography, and profess no interest in professional matters, it is difficult to know how the prospective teacher will develop much of a professional interest or concern.

In addition to providing a good example of responsible professional concern to prospective teachers, the institution can provide information about and experience with a broad range of professional matters. No social studies teacher should leave his preservice training without knowing, for example, what his rights and responsibilities are in dealing with controversial issues. He should have some understanding of the ethics of the teaching profession. He should know what opportunities there are for continued professional growth through the professional associations and their publications. He should be aware of the various dimensions of teacher-welfare programs available in most school districts. These can probably best be handled outside regular class offerings through student professional associations, special seminars, programs with a professional focus, informational brochures, conferences, and institutes.

As we move into the decade of the 1970's, there are great challenges to the profession to elevate the quality of teacher education in geography and social studies. For the first time in about thirty years, this nation is experiencing an oversupply of teachers in many fields including social studies. This should present us with many opportunities to be more highly selective in deciding who enters the field and to develop preparation programs that produce high quality geography-social studies teachers — young men and women who not only are professionally competent but who are deeply committed to the service of young people, and will remain so throughout their professional careers.

FOOTNOTES

[1] National Council for Accreditation of Teacher Education. *Standards for Accreditation of Teacher Education*. Washington, D.C.: The Council, 1970. p. 4.

[2] *Ibid.*

[3] *Ibid.*

[4] "The Education and Certification of Social Studies Teachers." An Interim Report on Professional Standards from the Advisory Committee on Teacher Education (mimeographed, unpublished). Richard Whittemore, chairman, National Council for the Social Studies, February, 1970. pp. 6-7.

Cover

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