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ABSTRACT

This bibliography suggests a number of introductory readings that will enable regional and urban planners to understand the systems approach. The main focus of the research study that gave rise to this review of the literature was on establishing ways in which decisionmakers in regional planning could be helped in making their choices. The bibliography is divided into six sections. These sections present references on the systems approach to regional planning, systems analysis, design and the planning process, general systems theory, models, and mathematical and technical background sources. In the majority of subsections, one or two of the references are annotated. The reader who studies at least one of the annotated references from each subsection will develop a broad and rigorous base on which to build his knowledge. The extra references in each section provide guidelines for those who wish to fill out their knowledge of particular aspects of the field. (Author/DN)

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**GENERAL SYSTEMS THEORY, SYSTEMS ANALYSIS
AND REGIONAL PLANNING:
An Introductory Bibliography**

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DEPARTMENT OF HEALTH
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INTRODUCTION.

In recent years the literature of both regional and urban planning has contained many references to the suggestion that systems analysis might be helpful in solving planning problems. In spite of these suggestions there have been very few books that deal explicitly with a systems approach to regional or urban planning. There are a number of possible reasons for this. In the first place there still appears to be some confusion as to exactly what systems analysis and systems theory are and what they can do. Secondly, it would appear that many people equate the building of a mathematical model with the process of carrying out a systems analysis whereas these exercises may not necessarily be a part of a systems approach. Finally, systems analysis is a technique or approach which can be demonstrated rather than a theory that can be discussed. The relative absence of regional plans using a complete systems approach has, therefore, made it difficult to display the concepts involved.

The purpose of this bibliography is to suggest a number of introductory readings that will enable regional and urban planners to gain their own well rounded view of the systems approach.

The majority of the works listed here were reviewed in the course of conducting a specific research study. The general aims and direction of this work are reported in the next section to provide the reader with some sense of the perspective from which the literature was reviewed. In the subsequent sections some attempt is made to provide a short introduction to the various aspects of the systems approach. The last section suggests the way in which this bibliography might best be used.

THE PERSPECTIVE.

The main focus of the research study, which gave rise to this review of the literature, was to establish ways in which decision-makers in regional planning could be helped in making their choices. A systems approach was used from the beginning. The environment of the decision-maker, the region, was explored and described. It was found that it could be conceptualised as a set of dynamic processes, some natural and some man-made, all of which were closely inter-linked. The three systems into which the region can be divided, the natural physical system, the man-made physical system and the institutional and cultural system, combined to form a structure within which man can act to change his environment. There are aspects of the activities of individuals and of society that display what might be called "cybernetic" qualities. This means that man as an individual and man as a society can adapt his behavior and change his goals in order to maintain some stability in a changing environment.

The concept of a region which is constantly changing and adapting gave rise to a view of planning as a process of making decisions about a future, much of which is unpredictable. This decision-making can be directed towards solving many types of regional problems or reaching a variety of objectives. The decision-maker, therefore, requires a means of obtaining information about the region that is relevant to the question facing him at that moment. Due to the highly related features of a region the actions of a decision maker can have wide ranging affect: it is therefore suggested that the decision maker needs three types of information. First, he needs information concerning the aspects

of the region that are under review; second, that which described the "side effects" of any action that might be taken; third, information on the means of constructing criteria for evaluating various states of the region.

The provision of this information constituted the aid offered to the decision maker in regional planning. There were three major features that together provided most of the guidelines required to carry out two of these tasks. The complexity of the region and its many unknowns provided some constraints upon what could be done and some criteria (e.g. the need for flexibility) for the decision making process. The nature of the mechanisms of reality, as understood by various disciplines, provided some objective information as to the aspects of a region that were important to control and the ways in which the reality is interrelated. Finally, the subjective elements in the decision maker's choice of which areas with which to be concerned, helped not only to provide criteria but also to focus the activity of the decision maker on one specific part of the regional reality at a time. The decision maker's choices may be supplemented by those of the planner, expert or society.

These guidelines provided two things - a set of criteria and a list of aspects of the region that were considered important or relevant to any specific question. The research project ended with a concentration upon the third task, that of providing a flexible "modelling" technique that could be used to respond to any question and provide the information pertaining to those aspects of the region considered important in the light of that question. This information would consist of the perceptions of the region and of reality provided by various disciplines.

It was found that general systems theory was useful in suggesting a technique for combining elements of this information which were selected from various sources and providing the information as an interdisciplinary answer to the question at hand. Some advances were made towards suggesting a system that could accomplish this task while also taking note of the uncertainties involved and the accuracy of the concepts and information used.

SYSTEMS ANALYSIS.

As was stated above, systems analysis is not a body of theory with ideas and concepts that can be logically developed and proved. It is more a technique or methodology whose merits can be debated and sometimes demonstrated in that it assists in providing an answer that is superior to one arrived at by any other method. Perhaps the most succinct definition is that by E. S. Quade who states that systems analysis is a systemic approach to helping a decision maker choose a course of action by investigating his full problem, searching out objectives and alternatives, and comparing them in the light of their consequences, using an appropriate framework-- in so far as possible analytic--to bring expert judgement and intuition to bear on the problem. (1).

The types of problems that can be tackled with the aid of systems analysis vary in complexity from well-defined engineering design questions to nebulous decisions in foreign policy. The aspects of systems analysis that are used depend very much on the problem under study. A foreign policy decision will include a great deal of intuition

(1) E. S. Quade and W. I. Boucher. Systems Analysis and Policy Planning-Applications in Defense. (New York: American Elsevier Co. Inc., 1968) p. 2.

and judgement whereas a well-specified engineering problem can yield to a mathematical analysis and the use of relatively objective criteria.

These two examples mark the extremes of a continuum of problem types.

The majority of questions in regional planning tend to be towards the more nebulous end of the scale: this is because regional planning decisions are broad in nature and have a wide ranging impact. There are also a large number of unknowns and uncertainties to be encountered when the present state of a region is reviewed, not to mention the future states.

One of the major techniques of systems analysis is to approach a problem by considering all its aspects in the broadest terms. This has the dual effect of helping the decision maker to see whether he is, in fact, asking the correct questions in the circumstances that exist and helping him to draw out criteria with which to judge alternative solutions. One can consider, as an example, the request by a city official for the development of a parking meter scheme. Exploration of this question might show that the real problem lies in the congestion of traffic in the inner city: there are many solutions to this problem that should be considered and the provision of parking meters may not necessarily be the best one.

Once it is established that the right questions are being posed, the analyst may now begin to suggest alternative solutions. The decision-maker needs to know what these solutions are and what effects they will have if they are carried out. He also needs a set of criteria with which to judge the alternative solutions. It is, in part, the analyst's job to help in the development of these criteria.

The analyst will prepare alternative solutions and display their effects by using various models of the environment within which the decision-maker is to act. These models will be of a widely varying nature ranging from rigorous mathematical models to the statement of expert opinion rather than any formal theory. The nature of the model depends very much upon the type of question asked.

When some alternative solutions have been developed they may be compared using the available criteria. This is by no means an easy task especially in a complex situation where there are many unknowns. The debate over decision-making affects planners as much as it does systems analysts and a number of references are given to various sides of the argument.

The final aspect of systems analysis is that it attacks problems in a cyclic and repetitive fashion. Thus, once a solution is found the whole problem is again reviewed to ensure that the means and ends involved will adequately meet the demands of the situation. It often happens that in the course of suggesting solutions new aspects of the problem come to light or the criteria are modified. Hence, to take a broad, "first cut" at a problem is very useful if it is then followed by a more rigorous repeat of the solution.

GENERAL SYSTEMS THEORY.

It should be emphasized at the beginning of this introduction that general systems theory is entirely different from systems analysis. Far from being a technique or methodology for problem solving, general systems theory is a set of logical deductions about the behavior of a class of objects called systems.

A systems is a group of components which are interrelated to each other in such a way that changes in one component can affect some, or all, of the other components. The concept of a system is, by now, well known and it is appreciated that many of the disciplines that examine the empirical world describe aspects of it in terms of systems. There are, therefore, many specific systems--the economic system, engineering systems, (water supply systems, telephone systems), social and biological systems and so forth. The theory of general systems has been developed in order to explain and explore the general behavior that is common to all of the various empirical systems found within the different disciplines. As such, it is interdisciplinary in nature and finds a place between the level of complete generalisation of mathematics and the level of specific relations within each academic field.

The relevance of this body of theory is threefold. First, many aspects of a region can be regarded as systems and a general understanding of system behavior adds to our knowledge of regional processes. The interdisciplinary nature of the approach is particularly useful to regional planners whose interests must be widespread. Some aspects of general systems theory are concerned with ways of understanding and predicting the behavior of very large and complex systems. This is clearly of relevance to those who would understand regional processes.

The second use for general systems is in the control of regional processes. The planner must not only understand, he must also be able to guide a region's development. Cybernetics, which is the "science of communication and control", provides a number of guidelines to the control of complex systems. Some of the ways in which these concepts may be used have been suggested by B. J. McLoughlin (2) where they are applied

(2) B. J. McLoughlin. Regional and Urban Planning: a systems approach. London: Faber and Faber, 1969.

to "process planning".

In order to aid his decision making, the regional planner will often marshal his information and understanding in the form of a model. Models usually consist of components linked together and are, therefore, systems themselves. Thus, in the third place, systems theory not only helps in the understanding of regional processes but also in the modelling of them.

The bibliography will provide an introduction to those aspects of general systems theory that are useful in the ways described above. This is not, however, the whole of the science. There is a large amount of sophisticated work that is concerned with communication or relevant to electronic systems that does not, as yet, seem relevant to regional planning. The reader should be aware that he is only being exposed to one part of a large field. Since the general systems approach is rigorous it employs mathematics in stating its arguments: the full implications of general systems theory can neither be explained nor understood without recourse to such mathematics. Some of the books suggested in the bibliography have extremely good introductions to the mathematics useful in general systems.

A SUGGESTED METHOD OF USING THIS BIBLIOGRAPHY.

Since this is an introductory bibliography it is assumed that those using it will want to gain an insight into the major concepts of the systems approach and the breadth of its application. In the majority of the sections one or two of the references are annotated. The reader who studies at least one of these annotated references from each section or sub-section will develop a broad and rigorous base upon which to build.

The extra references in each section will provide guidelines for those who wish to fill out particular aspects of the field. However, the list of references given is not comprehensive but is intended to bring the reader to the point at which he can pursue his own study without the aid of a bibliography. One exception to this is the section on the major land use models which is virtually complete.

ABBREVIATIONS.

I.E.E.E. - Institute of Electronic and Electrical Engineers.

J.A.I.P. - Journal of the American Institute of Planners.

I. A Systems Approach to Regional Planning.

As mentioned above, there are few examples of a full systems approach to planning problems. The following selections come closest to providing this view.

McLoughlin, B. Urban and Regional Planning: A Systems Approach. London: Faber and Faber, 1969.

This is the most explicit book available on the systems approach to planning. It emphasizes the continuous and cyclic aspects of process planning and suggests ways of improving and adapting regional models for use in the control of regional development.

Marquis, S. Systems Approach to Communities and Planning. Prepared for the Tri-County Regional Planning Commission by the Institute for Community Development Continuing Education Service, Michigan State University. 1963.

In this paper Marquis has tried to apply a systems approach to a specific region. This only provides an holistic way of looking at a region and does not go on to consider actual planning.

Similar systems approaches to regions are:

Alchin, E. "A Holistic Approach to Community Development". Michigan State Tech. Bulletin. B 41, 1964.

Wilson, A. G. "Research for Regional Planning". Regional Studies. Vol. 3, No. 1. April 1969, p. 3-14.

II. Systems Analysis.

Systems analysis involves many aspects, from the establishing of criteria and evaluation to modelling and decision-making. These various aspects will be considered in groups. The most helpful book for this whole area of study is that edited by E. S. Quade and W. I. Boucher.

A. General.

Quade, E. S. and Boucher, W. I. (Eds.) Systems Analysis and Policy Planning-Applications in Defense. New York: American Elsevier Publishing Company. 1968.

Much of the best work using systems analysis has been carried out on problems of defense. This book provides the best comprehensive study of the use of systems analysis while covering all its aspects in depth. The emphasis upon the need for intuition and judgement on the part of analysts is especially significant for complex planning problems. This book gives the lie to those arguments that suggest that systems analysis would make planning rigid and unsympathetic to human needs.

B. Evaluation and Criteria.

(a) General evaluation of planning, the urban environment and the setting of goals.

Appleyard, D.; Lynch, K.; and Meyer, J. R. A View from the Road. Cambridge, Massachusetts: MIT Press, 1964. 64 p., Illus.

Boulding, K. E. "The Formation of Values as a Process in Human Learning" in Transportation and Community Values. Special Report, Highway Research Board, No. 105, 1969. pp. 31-38.

Friend, J. K. and Jessop, W. N. Local Government and Strategic Choice. London: Travistock Publications, 1969. pp. 296.

Hill, M. "A Goals Achievement Matrix for Evaluating Alternative Goals". Journal of the American Institute of Planners, Vol. 34, 1968. pp. 19-29.

Lansing, John B. and Marans, R. W. "Evaluation of Neighbourhood Quality". JAIP, May 1969. pp. 195-199.

Leven, C. L. "Establishing Goals for Regional Economic Development." JAIP, Vol. 30, May 1964, pp. 100-110.

Lewis, P. M. "Environmental Values in Regional Highway Design". Highway Research Record, No. 161, 1961. 133 pp.

(b) Cost benefit and evaluation.

Eckstein, O. Water Resource Development--The Economics of Project Evaluation. Cambridge: Harvard University Press, 1958. xiii, 300 pp.

Krutilla, J. K. and Eckstein, O. Multiple Purpose River Development: Studies in Applied Economic Analysis. Baltimore: Johns Hopkins University Press, 1958. xiv, 301 pp.

McKean, R. N. Efficiency in Government through Systems Analysis with Emphasis on Water Resources Development. New York, Wiley, 1968. 336 pp.

Prest, A. R. and Turvey, Ralph. "Cost-Benefit Analysis: A Survey". The Economic Journal, December 1965, pp. 683-735.

Schick, A. "The Road to PPB". Public Administration Review, Vol. XXVI, December 1966, pp. 243-258.

Sonne, H. C. "Program Planning for National Goals". National Planning Association. Looking Ahead, Vol. 16, no. 7, October 1968.

Teitz, M. B. "Cost Effectiveness: A Systems Approach to Analysis of Urban Services". JAIP, Vol. 34, September 1968, pp. 303-41.

Wildavsky, A. "Symposium-PPB System Re-examined". Public Administration Review, March/April 1969, pp. 111-200.

C. Decision Making.

There are a number of aspects to the debate on decision making.

Two sides of the discussion are given here.

(a) Introduction.

Dyckman, J. Planning and Decision Theory. JAIP, Vol. 27, 1961, pp. 335-345.

This is an excellent review article which covers the major writers and their approaches to decision making.

(b) The critics of planning and "rational" decision making.

Braybrooke, D. and Lindblom, C. E. A Strategy of Decision: Policy Evaluation as a Social Process. New York: Free Press of Glencoe, 1963. ix, 268 pp.

This book provides an excellent introduction to disjointed-incrementalism. This is a method whereby decisions can be made in a complex and political environment. It also offers some excellent criticism of more formal decision theories.

Lindblom, C. E. The Policy Making Process. Englewood Cliffs, New Jersey: Prentice Hall, 1968. vi, 122 pp.

Popper, Karl. The Open Society and Its Enemies. London: George Routledge and Son, Ltd, 1945. 5th Ed. Rev. 1966. Princeton, New Jersey: Princeton University Press, 2 vols.

(c) "Rational" decision making.

Kaufmann, A. Science of Decision Making: An Introduction to Praxeology. New York: McGraw Hill, 1968. 256 pp.

This reviews the field of decision theory in a fairly elementary way, introducing and using the ideas of uncertainty, chance and probability.

Tribus, M. Rational Descriptions, Decisions and Designs.

This book covers decision theory more deeply than the one by Kaufmann, introducing the concepts of entropy and bayesian statistics. It is, of course, more difficult than Kaufmann's.

Chernoff, Hermann and Moses, Lincoln E. Elementary Decision Theory. New York: Wiley, 1959.

Isard, W. and Reiner, T. A. "Aspects of Decision Making Theory and Regional Science." Paper of the Regional Science Association, Vol. 9: 1962, p. 25-33.

Isard, W. and Reiner, T. A. "Use of Statistical Decision Theory in Regional Planning." Papers and Proceedings of the Regional Science Association, Vol. 10, 1963, pp. 1-7.

Raiffa, H. Decision Analysis: Introductory Lectures on Choices Under Uncertainty. Reading, Massachusetts: Addison Wesley, 1968. xxiii, 309 pp.

Simon, H. The New Science of Management Decision. New York: Harper and Row, 1960. 50 pp.

Wilson, A. G. "Entropy in Urban and Regional Modelling." Working Paper 26. London: Centre for Environmental Studies.

(d) Game Theory.

Luce, R. D. and Raiffa, H. Games and Decisions. New York: Wiley, 1967.

* Games theory has been most useful in simulating the environment of decision makers in the military world. It does have some application to the non-defense field but there are definite limitations.

McKinsey, J. C. C. Introduction to the Theory of Games. A Rand Corporation Study. New York: McGraw Hill, 1952.

Neumann, John Von and Morgenstern, Oskar. Theory of Games and Economic Behavior. Princeton, New Jersey: Princeton University Press, 1944.

Williams, J. D. The Compleat Strategyst: Being a Primer on the Theory of Games of Strategy. A Rand Corporation Study. New York: McGraw Hill, Rev. Edition 1966. xvi, 268 pp.

(e) The Mechanism of Making Decisions.

Gore, W. J. Administrative Decision Making: A Heuristic Model. New York: Wiley, 1964. viii, 191 pp.

Gore provides an interesting and informative model which describes the changes and pressures within an organization as it reacts to the problem of making choices of varying importance.

D. Models.

Models are an important part of systems analysis and should be mentioned in this section. However, modelling is an art in its own right which exists outside systems analysis. For this reason the references on models are placed in their own section at the end of the bibliography.

E. Long Range Planning, Projection and Scenarios.

The systems approach to regional planning demands that planners be aware of the environment that is likely to exist in the future. This means that planners must not only project trends for the near future but also make some creative and intelligent attempts to describe the possible states of the region in 50-70 years time.

(a) Long Range Views.

Jungk, R. and Galtung, J. Mankind 2000. London: Allen and Unwin, 1969.

This set of papers presents a useful introduction to the scope and methods of those people, not necessarily planners, who are concerned with the study of the possible future states of men and nations.

Anderson, S., Ed. Planning for Diversity and Choice: Possible Futures and their Relations to Man Controlled Environment. Cambridge, Massachusetts: MIT Press, 1968. xii, 340 pp., Illus.

Ansoff, H. Igor. "A Quasi-Analytic Method for Long Range Planning". Paper presented at the First Symposium on Corporate Long Range Planning, College on Planning, The Institute of Management Sciences, Chicago, Illinois, June 6, 1959.

Ayres, R. U. Technological Forecasting and Long Range Planning. New York: McGraw Hill, 1969. xv, 237 pp.

Ayres, R. U. "Technological Forecasting and Long Range Planning". IEEE Transactions, March 1967.

Baade, Fritz. The Race to the Year 2000. Our Future: A Paradise or the Suicide of Mankind. Garden City, New York: Doubleday, 1962, pp. 246.

Bell, D. (Chairman). "Toward the Year 2000: Work in Progress". Daedalus, Vol. 96, No. 3, Summer 1967.

Bell, D. "Twelve Models of Prediction--A Preliminary Sorting of Approaches in the Social Sciences". Daedalus, Summer, 1964, Vol. 93, No. 3, pp. 845-880.

Calder, N., Ed. The World in 1984. 2 Vols. Baltimore, Maryland: Pelican Original Paperbacks, 1965.

Clarke, Arthur C. Profiles of the Future: An Inquiry into the Limits of the Possible. New York: Bantam, 1967. xv, 234 pp.

- Cornell Aeronautical Laboratory, Inc. Metrotran 2000: A Study of Future Concepts in Metropolitan Transportation for the Year 2000. Transportation Research Department, C.A.L., Buffalo, New York: Cornell University, October 1967. Final Report by Wolf, Robert R. iv., illus.
- Gabor, D. Inventing the Future. London: Secker and Warburg. 1963. 231 pp. Illus.
- Gordon, K. Agenda for the Nation: Papers on Domestic and Foreign Policy Issues. Washington: Brookings Institution, 1968. viii, 620 pp.
- Gordon, W. J. J. Synecletics. A New Method of Directing Creature Potential to the Solution of Technical and Theoretical Problems. New York: Harper and Row, 1961. 180 pp.
- Helmer, O. Analysis of the Future: The Delphi Method. The Rand Corporation P-3558, (DDC No. AD649640). Santa Monica, California: The Rand Corporation. March 1967.
- Jantsch, Erich. Technological Forecasting in Perspective. Paris: Organisation for Economic Co-operation and Development, October 1966.
- (b) Projection.
- Many of the models reviewed in the final section of this bibliography are, of course, used to project the future state of some part of a region. There are, however, other methods and techniques of projection, some of which are mentioned here.
- Bayliss, D. Some Recent Trends in Forecasting. Centre for Environmental Studies, London, Working Paper 17.
- Chevan, A. Population Projection System Technical Report No. 3. Penn-Jersey Transportation Study. Philadelphia, Delaware Valley Regional Planning Commission, 1965.
- Martin, B. V.; Memmott, F. W.; and Bone, A. J. Principles and Techniques of Predicting Future Demand for Urban Area Transportation. Cambridge, Massachusetts: MIT Press, 1965, xvii, 214 pp.
- Young, M., Ed. Forecasting and the Social Sciences. London: Heinemann, 1968, ix, 166 pp.

III. Design and Planning Processes.

The references in this section form something of a link between planning and the systems approach. They also enable the reader to appreciate the similarities between design and planning in that each is a sequential decision making process.

Alexander, C. Notes on the Synthesis of Form. Cambridge: Harvard University Press, 1964. 216 pp.

Although this book, with its method of breaking a problem into a simple hierarchy, is now a little outdated, it forms a classic statement of a design problem in "systems" terms.

Friend, J. K. and Jessop, N. N. Local Government and Strategic Choice: An Operational Research. London: Tavistock Publications, 1969. xxvi, 296 pp.

This is an excellent description of the actions of a real planning group. The sequential nature of the decision making is very clear.

Simon, H. A. The Sciences of the Artificial, Cambridge, Massachusetts, MIT Press, 1969.

Simon, in this series of lectures, provides some interesting insights into the problems of understanding a complex environment and designing and making decisions within one.

Alexander, C.; Ishikawa, S. and Silverstein, M. A Pattern Language which Generates Multi-Service Centers. Berkeley, California: Center for Environmental Structure, 1968. 283 pp., Illus.

Catanese, A. J. and Steiss, A. W. "Systematic Planning for Very Complex Systems". Planning Outlook, Vol. 5, August 1968, pp. 7-27.

Cripps, G. L. "A Management System for Planning". Town Planning Institute Journal, Vol. 55, No. 2, (May 1969) pp. 187-195.

Faludi, A. "The Planning Environment and the Meaning of Planning". Regional Studies, Vol. 4, No. 1, May 1970, pp. 1-9.

Friedmann, J. "Comprehensive Planning as a Process". JAIP, Vol. 31, 1965. pp. 195-197.

IV. General Systems Theory.

There are many aspects to general systems and it has wide application. This selection of references attempts to provide readings which cover some of the basic theoretical work in general systems theory, including cybernetics, and also to provide examples of its use in many fields.

A. General Systems Theory.

Klir, G. J. An Approach to General Systems Theory. New York: Van Nostrand, 1969. xii, 323 pp.

This book forms an excellent introduction to a rigorous definition of systems and some of their properties. It touches on many aspects of general systems theory and mentions the work of some of the major students in the field.

Boulding, K. L. "General Systems Theory: The Skeleton of Science." Management Science. Vol. 2, 1956, pp. 198-199. Reprinted in General Systems, Vol. 1, p. 11-17, 1956.

Berrien, F. K. General and Social Systems. New Brunswick, New Jersey: Rutgers University Press, 1968. vii, 231 pp.

Bertalanffy, L. Von. "An Outline of General System Theory". British Journal for the Philosophy of Science, Vol. 1, 1950, pp. 134-165.

Bertalanffy, L. Von. "General System Theory." General Systems, Vol. 1, 1956, pp. 1-10.

Bertalanffy, L. Von.; Hempel, C. G.; Bass, R. E.; and Jonas, H. "General System Theory: A New Approach to Unity of Science." Human Biology, Vol. 23, 1951, pp. 302-361.

Hall, A. D. and Fagen, R. E. "Definition of System." General Systems, Vol. 8, 1963, pp. 227-232.

Rapoport, A. "Remarks on General Systems Theory." General Systems, Vol. 8, 1963, pp. 123-128.

B. Systems Engineering and System Theory.

General systems theory has gained much from studies that have been made of engineering systems, especially in the field of electronics.

Equally, the application of systems theory to design and decision processes has been well developed within the fields of engineering design. The first two books deal with design and the second two with theory.

Hall, A. D. Methodology for Systems Engineering. Princeton, New Jersey: Van Nostrand, 1962. 478 pp.

Wymore, A. W. Mathematical Theory of Systems Engineering. New York: John Wiley, 1967. xii, 353 pp.

Zadeh, L. S. and Desoer, L. A. Linear System Theory. New York: McGraw Hill, 1963. xxi, 628 pp.

C. Cybernetics.

Cybernetics, the science of communication and control, is very useful to regional planners. It can tell them, first, what is possible in a complex environment, second, the forms of control that are necessary, and third, how to begin investigating the behavior of a complex system.

Ashby, W. R. An Introduction to Cybernetics. New York: Wiley, Science Editions, 1963. ix, 295 pp.

This book is an extremely good introduction to cybernetics, giving a good idea of the scope and power of cybernetic concepts. The reader who is prepared to study the book carefully and do most of the examples will obtain a good grasp of the fundamentals of the subject.

Ashby, W. R. Design for a Brain. 2nd Edition. London: Wiley, 1960. 259 pp.

Beer, S. Decision and Control. London: Wiley, 1966. xii, 556 pp.

Beer, S. Cybernetics and Management. New York: Wiley, 1964. 214 pp.

Bell, D. A. Intelligent Machines: An Introduction to Cybernetics. London: Pitman, 1962. vi, 98 pp.

Foerster, H. Von, and Zop., G. W., Eds. Principles of Self Organisation. New York: Pergamon Press, 1962.

Greniewski, H. Cybernetics without Mathematics. Oxford: Pergamon Press, 1960.

Howland, D. "Cybernetics and General Systems Theory". General Systems, Vol. 8, 1963, pp. 227-232.

Klir, G. J. and Valach, M. Cybernetic Modelling. Princeton, New Jersey: Van Nostrand, 1967. 437 pp.

Von Neumann, J. Theory of Self Producing Automata. Urbana, Illinois: University of Illinois Press. 1966.

D. General Readings.

These books are not expositions of general systems or cybernetics but express some of the philosophy behind these subjects.

Boulding, K. E. The Image: Knowledge in Life and Society. Ann Arbor: University of Michigan Press, 1956, 1959. 175 pp.

Ellis, D. O. and Ludwig, F. J. Systems Philosophy. Englewood Cliffs, New Jersey: Prentice-Hall, 1962. xi, 387 pp.

Wiener, Norbert. The Human Use of Human Beings. Garden City, New York: Doubleday, 1956. 199 pp.

E. Systems Theory in Fields Relevant to the Regional Planner.

The interdisciplinary nature of general systems theory stems from the fact that it is based on the behavior of many systems found in the empirical world. In the following sections some of these more specific systems are highlighted. Many of the references consider the explicit application of systems theory. However, some are studies in the particular discipline that lend themselves to a systems interpretation.

Buckley, W., Ed. Modern Systems Research for the Behavioral Scientist: A Sourcebook. Chicago: Aldine Press, 1968. xxv, 525 pp.

The collection of readings in this book is a useful introduction to some of the concepts of systems theory. It is especially useful in providing articles from a wide range of disciplines all of which make use of general systems theory.

Young, O. R. "A Survey of General Systems Theory." General Systems, Vol. 9, 1964, pp. 61-80.

This article lists the various authors who have used general systems theory and the fields to which they have applied it.

(a) Sociology and Political Science.

Berrien, F. K. General and Social Systems. New Brunswick, New Jersey: Rutgers University Press, 1968. vii, 231 pp.

Beshers, J. M. Population Processes in Social Systems. New York: Free Press, 1967. x, 207 pp.

Beshers, J. M. (Ed.) Computer Methods in the Analysis of Large Scale Social Systems. Cambridge, Massachusetts: MIT Press, 1968. vii, 266 pp.

Beshers, J. M. "The Social Theorist: On Line Theory Construction and Theory Validation," in J. M. Beshers, Computer Methods in the Analysis of Large Scale Social Systems. Op cit. pp. 250-261.

Beshers, J. M. "Substantive Issues in Models of Large Scale Social Systems", in J. M. Beshers, Computer Methods in the Analysis of Large Scale Social Systems. Op cit. pp. 121-129.

Beshers, J. M. Urban Social Structure. New York: Free Press of Glencoe, 1962. 207 pp.

Bredemeier, H. C. and Stephenson, P. M. "The Analysis of Social Systems." New York: Holt, Rhinehart and Winston, 1962. xiii, 411 pp.

Buckley, W. "Society as a Complex Adaptive System", in W. Buckley, Ed., Modern Systems Research for the Behavioral Scientist: A Sourcebook. Chicago: Aldine Press, 1968. xxv, 525 pp.

Buckley, W. Sociology and Modern Systems Theory. Englewood Cliffs, New Jersey: Prentice Hall, 1967. xii, 227 pp.

Deutsch, K. The Nerves of Government: Models of Political Communication and Control with a New Introduction. New York: Free Press, 1966. xxxvi, 316 pp.

Deutsch, K. W. "Toward a Cybernetic Model of Man and Society" in W. Buckley, Ed., Modern Systems Research. Op cit. pp. 387-400.

Easton, D. "A Systems Analysis of Political Life", in Buckley, W., Ed., Modern Systems Research for the Behavioral Scientist. Op cit. pp. 428-436.

Morse, P. W. and Bacon, L. N., Ed. Operations Research for Public Systems. Cambridge, Massachusetts: MIT Press, 1967. ix, 212 pp.

Nadel, S. F. "Social Control and Self Regulation", in W. Buckley, Ed., Modern Systems Research for the Behavioral Scientist. Op cit. pp. 401-408.

(b) Human Behavior.

Barker, R. G. Ecological Psychology: Concepts and Methods for Studying the Environment of Human Behavior. Stanford, California: Stanford University Press, 1968. vi, 242 pp., Illus.

Maslow, A. H. Motivation and Personality. 1st Edition. New York: Harper and Row, 1964. 411 pp.

Rosenblueth, A.; Wiener, N.; and Bigelow, J. "Behavior, Purpose and Teleology", in Buckley, Ed., Modern Systems Research... Op cit. pp. 221-225.

Simon, H. A. Models of Man, Social and Rational: Mathematical Essays on Rational Human Behavior in a Social Setting. New York: Wiley, 1961. 287 pp.

Vickers, G. "The Concept of Stress in Relation to the Disorganisation of Human Behavior", in Buckley, Ed., Modern Systems Research... Op cit. pp. 354-358.

Zipf, G. K. Human Behavior and the Principle of Least Effort: An Introduction to Human Ecology. Cambridge, Massachusetts: Addison Wesley, 1949. xi, 573 pp.

(c) Behavior and Communication.

Ackoff, R. L. "Towards a Behavioral Theory of Communication," in Modern Systems Research for the Behavioral Scientist, Edited by W. Buckley. Chicago: Aldine Press, 1968. xxv, 525 pp. Illus.

Cherry, C. On Human Communication: A Review, a Survey and a Criticism. 2nd. Edition. Cambridge, Massachusetts: MIT Press, 1966. xiv, 337 pp., Illus.

Meier, R. L. A Communications Theory of Urban Growth. Joint Center for Urban Studies. MIT and Harvard. Cambridge, Massachusetts: MIT Press, 1962. viii, 184 pp.

(d) Economics.

Murphy, R. E. Adaptive Processes in Economic Systems. New York: Academic Press, 1965. xvi, 209 pp.

Theil, H. Economics and Information Theory. Amsterdam: North Holland Publishing Co., 1967. xxii, 488 pp.

Tustin, A. The Mechanism of Economic Systems. London: Heinemann. 1953; and Cambridge, Massachusetts: Harvard University Press, 1953. xi, 161 pp.

(e) Water Resources.

Chow, V. T. "Systems Design by Operation Research", in Chow, V. T., Ed. Handbook of Applied Hydrology. Part II, Section 26. New York: McGraw Hill, 1964.

Chow, V. T. "Hydrologic Systems for Water Resources Management", in Conference Proceedings: Hydrology in Water Resources Management. Water Resources Research Institute, Clemson University, Clemson, South Carolina, March 1968.

Maas, A. et al. Design for Water-Resources Systems: New Techniques for Relating Economic Objectives, Engineering Analysis and Governmental Planning. Cambridge, Massachusetts: Harvard University Press, 1962.

V. Models.

Models are useful to the planner for two reasons. The activity of building a model requires that the processes being studied are carefully and rigorously represented. Thus the modeller learns a great deal about the subject he is studying. Once the model is built it becomes useful because it can be used to test the effects of proposed planning activities or to predict the consequences of normal, regional development.

All of the models referred to in this section are mathematical ones but this need not be so. For this reason, the introductory section contains some references to the uses of the opinions of experts since these could loosely be called models. In the following sections various types of models are suggested, the majority have some spatial aspects and many are concerned with economic growth. However, there are many econometric models of a regional and inter-regional nature. These are not covered in this bibliography since they form a large, separate,

specialized field. By reading the references in the sections "Some Major Land Use Models" and "Important Regional Simulation Models" the reader will gain a good overall grasp of the present state of the art of urban and regional modelling: the other sections are no more than introductions.

A. Introduction.

The following references give reviews of the major urban models and some insights into the processes of modelling:

(a) Reviews of Models.

Harris, B. "Quantitative Models of Urban Development: Their Role in Metropolitan Policy Making", in Issues in Urban Economics by Perloff, H. S. and Wingo, L., Jr. p. 363-412. Baltimore: Johns Hopkins Press, 1968. vii, 668 pp.

Lowry, I. Seven Models of Urban Development - A Structural Comparison. A Rand Corporation Study, P 3673. Santa Monica, California: Rand Corporation, 1967.

Wilson, A. G. "Models in Urban Planning: A Synoptic Review of Recent Literature", Urban Studies, Vol. 5, No. 3, November 1968.

(b) Aspects of Modelling.

Brown, B. B. Delphi Process: A Methodology Used for the Elicitation of Opinions from Experts. RAND P-3925. Santa Monica, California: Rand Corporation, September 1968.

Dalkey, N. C. Families of Models. Rand Corporation, P-3198, (DDC No. AD6 0777). Santa Monica, California: Rand Corporation, 1965.

Dalkey, N. C. and Hermer, O. An Experimental Application of the Delphi Method to the Use of Experts. The RAND Corporation, RM-727-PR (Abr). Santa Monica, California: Rand Corporation, July 1962. (Also published in Management Science, Vol. 9, No. 3, April 1963, p. 458-467.)

Kilbridge, Maurice. "A Conceptual Framework of UP Models", Management Science, XV, No. 6, February 1969.

Loewenstein, L. K. "On the Nature of Analytical Models." Urban Studies, Vol. 3, No. 2, June 1966. p 112-119.

Lowry, I. "A Short Course in Model Design". JAIP, Vol. 31, No. 2, May 1965. p. 158-166.

B. Some Major Land Use Models.

Many of the land use models that have been used for planning come as a series or family of models. In some cases the family is a result of the development and refining of a model: in other cases the family acts as a group, each one providing information that another uses.

(a) Econometric Location Models.

(I) The Boston EMPIRIC Model.

Hill, D. M. "A Growth Allocation Model for the Boston Region". JAIP, Vol. 31, May 1965. p. 111-120.

Hill, D. M.; Brand, D.; and Hansen, W. "Prototype Development of a Statistical Land Use Prediction Model for the Greater Boston Area." Highway Research Record. No. 114, 1965. p. 51-70.

(II) The POLIOMETRIC Model.

Bolan, R. S.; Hansen, W. B.; Irwin, N. A. and Dieter, K. H. "Planning Application of a Simulation Model." New England Section, Regional Science Association, October 1963.

Delaware Valley Regional Planning Commission. A Linear Interaction Model for Manufacturing Location. DVRPC. January 1964.

Seidman, D. R. A Decision Oriented Model of Urban Growth. International Federation of Operations Research Societies in Boston, 1966.

(III) The Connecticut Model.

Voorhees, A. M. and Associates. A Model for Allocating Activities into Sub-areas in a State. Connecticut Inter-Regional Planning Programs. Washington: 1966. 1 vol.

(IV) Model by Kain and Meyer.

Kain, J. F. and Meyer, J. R. "Computer Simulations, Physio-Economic Systems and Interregional Models". AER Papers and Proceedings, Vol. 58, May 1968. pp. 171-181.

(b) Hybrid Models.

Crecine, J. P. A Time Oriented Metropolitan Model for Spatial Location. CRP Technical Bulletin. No. 6. Department of City Planning Pittsburgh. 1964. (By CONSAD.)

Lowry, I. Model of a Metropolis. A Rand Corporation Study. (RM-4035-RC). Santa Monica, California: Rand Corporation, 1964. 136 pp.

Putman, S. H. "Intra-Urban Industrial Location Model: Design and Implementation." Regional Science Association Paper. Vol. 19, 1967. p. 199-214.

(c) Land Use Change Models.

Chapin, F. S., Jr. "A Model for Simulating Residential Development." JAIP, Vol. 3, No. 2, May 1965. p. 120-125.

Kaiser, E. J. and Weiss, S. F. "Public Policy and the Residential Development Process." JAIP, Vol. 34, No. 1, January 1970, pp. 30-37.

(d) Market Demand Models.

Harris, B. "Linear Programming and the Projection of Land Uses." Penn-Jersey Paper No. 20. Philadelphia; Penn Jersey Transportation Study, 1963.

Harris, B. Basic Assumptions for a Simulation of the Urban Residential Housing Market and Land Market. Philadelphia: Institute of Environmental Studies; University of Pennsylvania, 1966.

Herbert, J. and Stevens, B. J. "A Model for the Distribution of Residential Activities in Urban Areas." Journal of Regional Science, Vol. 2, No. 2, 1960. p. 21-36.

(e) Market Supply Models.

A. D. Little, Inc. "San Francisco Community Renewal Program-Simulation Model for Renewal Programming." San Francisco Community Renewal Program Technical Paper No. 1. October 1964.

A. D. Little, Inc. "Model of the San Francisco Housing Market." San Francisco Community Renewal Program Technical Paper No. 8. January 1966.

Robinson, I. M.; Wolfe, H. B.; and Barringer, R. L. "A Simulation Model for Renewal Programming." JAIP, Vol. 31, May 1965. p. 126-134.

(f) Land Use Models.(I) The Chicago Area Transportation Study.

Hamburg, J. R. Land Use Forecast. Document No. 32, 610. Chicago: Chicago Area Transportation Study, 1961.

Chicago Area Transportation Study. Final Reports:

- Vol. I. Survey Findings. December 1959.
 Vol. II. Data Projections. July 1960.
 Vol. III. Transportation Plan. April 1962.

(II) Model for Buffalo, New York.

Lathrop, G. J. and Hamburg, J. R. "An Opportunity - Accessibility Model for Allocating Regional Growth." JAIP, Vol. 31, No. 2, May 1965, p. 95-105.

(g) Urban Growth Models.

Berman, B. R.; Chinitz, B. and Hoover, E. M. Projection of a Metropolis: Technical Supplement to the New York Regional Study. Cambridge, Massachusetts: Harvard University Press, 1960. 119 pp.

(h) Retail Growth Models.

Lakshmanar, T. R. and Hansen, W. G. "A Retail Market Potential Model." JAIP, Vol. 31, No. 2, May 1965. p. 134-143.

C. Two Important Regional Simulation Models.

The Staff. Jobs, People and Land -- Bay Area Simulation Study (BABSS). Berkeley, Center for Real Estate and Urban Economic, Institute of Urban and Regional Development, University of California, 1968.

Battelle Memorial Institute. Final Report on a Dynamic Model of the Economy of the Susquehanna River Basin, by H. R. Hamilton and others. Columbus, Ohio, The Institute, August, 1966.

D. Retail Location Models.

Berry, E. L. J. "The Retail Component of the Urban Model." JAIP, Vol. 31, No. 2, May 1965, p. 150-155.

Berry, B. L. J. "Spatial Structure and Behavior Interdependency". Regional Science Association Papers and Proceedings. Vol. 21, 1968, pp. 205-227.

Cordey, Hays, M. Retail Location Models. Working Paper 16. London: Centre for Environmental Studies, 1968.

Rogers, A. "Stochastic Analysis of the Spatial Clustering of Retail Establishment." Journal of the American Statistical Association. Vol. 60, 1965. pp. 1094-1103.

E. Techniques in Urban Modelling.

- Forrester, J. W. Industrial Dynamics. Cambridge, Massachusetts: M.I.T. Press, 1961. 464 pp.
- Forrester, J. W. Urban Dynamics. Cambridge, Massachusetts: M.I.T. Press, 1969.
- Massey, D. B. Problems of Location: Game Theory and Gaming Simulation. London: Centre for Environmental Studies, Working Paper 15.
- Meir, R. L. and Duke, R. D. "Gaming Simulation for Urban Planning." JAIP, Vol. 32, January 1966. pp 3-17.
- Sarnoff, R. W. "Social Uses of Computer Forecasting: Simulation of Social Problems in a City". Computer Digest, April 1969. pp 3-6.
- Steinitz, C. A Systems Analysis Model of Urbanization and Change: An Experiment in Interdisciplinary Education. Cambridge, Massachusetts: Graduate School of Design, Harvard University, 1968, vii, 147 p. illus. (part fold) maps.
- Wilson, A. G. Entropy in Urban and Regional Modelling. London: Centre for Environmental Studies, Working Paper 26.
- Wilson, A. G. The Integration of Accounting and Location Theory Frameworks in Urban Modelling. London: Centre for Environmental Studies, Working Paper 2.
- F. Transportation Models.
- Kain, J. F. "A Contribution to the Urban Transportation Debate: An Econometric Model of Urban Residential and Travel Behavior." Review of Economics and Statistics. Vol. 46, No. 1, 1964. p 55-64.
- Litton Industries. Towards a Systems Approach for a California Integrated Transportation Network. Beverly Hills, California: Litton Industries, Economic Development Division, December 1964.
- Wilson, A. G. "Advances and Problems in Distribution Modelling", Transportation Research, Vol. 4, No. I, April 1970. pp 1-18.
- Wilson, A. G. "The Uses of Entropy Maximising Models in the Theory of Trip Distribution, Mode Split and Route Split." Journal of Transport Economics and Policy, Vol. 3, No. I, 1969. pp. 108-126.

G. Economic Models.

Adelman, Irma and Morris, C. J. An Econometric Model of Socio-Economic and Political Change in Undeveloped Countries. Unpublished Manuscript. Northwestern University, December 1967.

Artle, R. "Planning and Growth--A Simple Model of an Island Economy, Honolulu, Hawaii." Regional Science Association Paper, Vol. 15, 1965. pp 29-44.

Brech, R. Planning Prosperity: A Synoptic Model for Growth. London: Darton, Longman and Todd, 1964. viii, 189 pp.

Isard, W. and Isard, P. "General Social, Political and Economic Equilibrium for a System of Regions". Occasional Papers. Series No. 2, Philadelphia: Regional Science Research Institute, December 1965.

Keeble, D. E. "Models of Economic Development", in Chorley, R. J. and P. Haggett. Models in Geography. London: Methuen, 1967. 816 pp.

H. Models in Geography.

Grigg, D. "Regions, Models and Classes", in Integrated Models in Geography by Chorley, R. S. and Haggett, P. (Ed.) London: Methuen, 1969. 816 pp. pp 461-509.

Haggett, P. "Network Models in Geography", in Chorley and Haggett. Op cit. pp. 609-668.

Haggett, P. and Chorley, R. J. "Models, Paradigms and the New Geography", in Integrated Models in Geography, by Chorley and Haggett. Op cit. pp. 19-41.

Phal, R. E. "Sociological Models in Geography", in Chorley, R. S. and Haggett, P. (Eds.) Models in Geography. Op cit. pp. 217-242.

VI. Some Mathematical and Technical Background.

The references in this section are self-explanatory.

Ackoff, R. L. and Sasieni, M. W. Fundamentals of Operations Research. New York: John Wiley, 1968. ix, 455 pp.

Busacker, R. G. and Saaty, T. L. Finite Graphs and Networks: An Introduction with Applications. New York: McGraw Hill, 1965. xiv, 294 pp.

Kaufmann, A. Graphs, Dynamic Programming and Finite Games. New York: Academic Press, 1967. xvii, 484 pp.

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- McFadden, M.; Moore, J. William; and Smith, Wendell I. Sets, Relations and Functions: A Programmed Unit in Modern Mathematics. New York: McGraw Hill, 1963. 299 pp.
- McKinsey, J. C. C. Introduction to the Theory of Games. New York: McGraw Hill, 1952. x, 371 pp.
- Sasieni, M.; Taspan, A.; and Friedman, L. Operations Research: Methods and Problems. New York: Wiley, 1959. 316 pp.
- Shannon, Claude E. and Wever, Warren. The Mathematical Theory of Communication. Urbana: University of Illinois Press 1969. (First published 1949). 125 pp.

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