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ABSTRACT

The central problem that American education poses for society is that the enterprise is appreciably underproductive when judged against standards and requirements of the postindustrial era. This generic problem will not be appreciably ameliorated until the instructional system design (ISD) process is better understood and explicated and then made central to problem amelioration. The objectives of the ISD process are explored in the context of education in general, and many of its functions are inventoried. Consonant with emerging views on process structure, components and structure of an instructional learning situation addressing cognitive skills are illustrated. An analysis of the instructional situation includes discussion of instructional media, the instructional milieu, performance factors, a sketch of the ISD process, transfer and generalization, and broader media. The use of the ISD process in simulating time-referenced useful expansion of a knowledge base apt to solving the educational problem is briefly outlined. (Author/SH)

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Joseph F. Follettie

ABSTRACT

The central problem that American education poses for society is that the enterprise is appreciably underproductive when judged against standards and requirements of the postindustrial era. It is contended that this generic problem will not be appreciably ameliorated until the instructional system design (ISD) process--thus far underconsidered--is better understood and explicated and then made central to problem amelioration. The ISD process is placed in the larger universe to which it belongs; major functions of the process are inventoried. Consonant with emerging views on process structure, components and structure of an instructional learning situation addressing cognitive skills are illustrated. Use of the ISD process to stimulate time-referenced useful expansion of a knowledge base apt to amelioration of the educational problem is preliminarily sketched. The paper is a polemic that--ranging from specialized treatments in the lower roots of a problem attack to broad comments addressing national policy--provides a structure against which to develop useful counterpolemics.

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Many argue--Drucker (1969), for example--that the productivity of labor in education is low and that a problem of first priority is to raise the productivity of educational labor appreciably. This proposition accepted, remarks that follow stem from the thesis that instructional system design (ISD) provides the key to raising educational productivity to levels characteristic of industrial and postindustrial phases of social evolution.[1,2]

The assertion of low productivity does not argue that education has failed to evolve in apt ways along important dimensions. In those areas where the educational viscera pick up the right information, we argue in Part I that the industry is moving forward with the times. Thus, it has been shifting for several decades from a preindustrial concern with craft-emulative skills to knowledge-based skills of the industrial age and from a mute posture regarding social values to a stance more becoming to the postindustrial era. The industry's failures to progress occur primarily where visceral sensitivity must give way to sustained cerebration and explication; it fails most often where such explicating processes as ISD are required.

The assertion of a critical role for instructional system design in securing appreciable improvement in educational productivity is predicated on what could and will be, rather than on an as yet incipient ISD that knows not even its own mind. We argue that ISD, its potential realized for defining and blueprinting effective-efficient instruction, will be propaedeutic to the complex effort required to achieve educational productivity consonant with existing knowledge and human ingenuity. Such a view must remain contentious until the ISD process itself is sufficiently explicated that its implications for structuring instruction and influencing augmentation of the knowledge base on which it must feed can be clearly drawn and so evaluated.

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[1]Signification of the term instructional system design is equivocal. The problem to be addressed is one of explicating and extending the ISD process consonant with making it an effective force in educational reform.

[2]The terms preindustrial, industrial, and postindustrial are used increasingly in economics and allied fields to reflect contrasting sets of conditions pertinent to gauging socioeconomic advance. Herein, such terms will reference primarily to two factors: a) evolution of the knowledge-referencing of skills and b) evolution of social value-referencing of production.

Part I places the instructional system design process in the larger universe to which it belongs and inventories major functions or objectives of the ISD process. Parts II and III illustrate, for a cognitive skills domain, components and structure of the instructional learning situation as suggested by emerging views of ISD process structure. Part IV discusses how ISD might stimulate progressive expansion of a knowledge base apt to ISD exploitation to yield steady gains in educational productivity.

PART I: PLACE AND OBJECTIVES OF INSTRUCTIONAL SYSTEM DESIGN

PRODUCTION AND RELEVANCE AS COMPLEMENTARY ISSUES

American society has entered a postindustrial era wherein the older questions concerning how to secure desired production are increasingly subordinated to questions concerning what production is desired. Thus, a postindustrially oriented citizenry is causing bellwether industries to transition from productivity questions of the industrial era to value questions of the current era. However, even in industrially advanced nations, not all industries have solved their production problems. Thus, the trailing foot of an advancing education is planted in the primeval ooze, rather than in the industrial age that the bellwether industries are now departing. In consequence, however concerned the citizenry is becoming with questions of value, the education industry must continue to regard the older questions concerning productivity as largely unanswered and therefore the legitimate object of appreciable consideration.

Not without reason, a growing number of critics of American education insist that education's principal problem is one of irrelevance--that is, the pursuit of objectives that are no longer apt. While such a view is not unperceptive, it unduly downgrades the productivity problem that is education's legacy in light of a slower evolution. Too often hoisted, the banner of irrelevance will entail an undue risk of throwing baby out with bath water. For relevant or irrelevant, most contemporary educational efforts will prove unacceptably underproductive.

Value questions referencing to the standard products of conventional producers of goods have become relatively emancipated from productivity questions in that most such products reflect their own explicated design-specified functions and are efficiently produced and relatively cheap. Hence, questioning the relevance of customary goods in light of their functions and productive-operative side effects is timely. However, in light of the locus of its trailing foot, not all of the value questions that currently address education will prove aptly timed.

One may reject ping-pong balls or polystyrene cups on grounds that--while efficiently produced and cheap--these products reflect misused or less-than-optimally-used wealth; any such decision reflects a value or relevance judgment. Grounds for rejecting an educational product typically are richly more varied. One such apt and important ground is that instructional objectives, as reflected in instructional system design specifications, may be irrelevant in utilitarian, survival, or recreational senses. A second may be that ISD specifications are obscure; a third that the instructional product fails to steer the student to objectives specified by the ISD; a fourth that efficiency of instruction--its cost in dollars and student time per unit acquisition--is low, whether due to design deficiencies or infidelity of design application; and a fifth that efficiency and effectiveness are indeterminate due to use of an inapt measurement process, whether stemming from design deficiency or infidelity of application. Different grounds for rejection of an educational product call for different postrejection responses.

The serious student of difficulties of education can afford to sacrifice neither the yin of increased relevance nor the yang of improved productivity when seeking to resolve these difficulties. Progress in education will neither be served by allowing questions of relevance to wither on the vine nor by over-simplifying educational woes exclusively as those of misdirection.[3] While, as sketched below, the ISD process will bear centrally on questions concerning how to achieve desired production, inevitably in the exercise of such a process, one will operate on the fringes of and stir up the outer sands of relevance. To do so is inadmissible only when the technical expert enters the value domain without noting that the technical domain has been left behind.[4]

A postindustrial phase of social evolution increasingly subordinates how questions of production to why questions of social value. Preindustrial and industrial phases share how questions as matters of appreciable concern. What distinguishes these earlier phases?

One criterion for classifying an enterprise as industrial is that it systematically exploits an organized knowledge base in support of design-effective and efficiently produced products. If such a base does not exist, is left intuitive, appears as disorganized scraps, or is not systematically exploited, then the enterprise is preindustrial. According to such a criterion, the educational industry is clearly preindustrial, however businesslike its boardroom or awesomely modern its physical plant. For although the industry is moving increasingly toward defining the skills it seeks to instruct in the classroom on organized knowledge bases, it

[3]While educational funds may eventually need to be unblocked consonant with various sorts of reallocation, the proposition that the American education industry is underfunded is beneath contempt.

[4]The technical domain clearly subsumes all treatments addressing educational efficiency. Some facets of educational effectiveness fall into the technical domain while others fall into the value domain. All efforts to match instruction to design specifications address effectiveness in a technical sense. Those that attempt to match instructional objectives, as reflected in design specifications, with social values clearly fall in the value domain. Those that attempt to match instructional objectives with the child's perceived relevance tendencies also probably fall into the value domain. Attempts to engineer the child's perceived relevance tendencies toward consonance with given instructional objectives fall into the technical domain. Particularly for younger children, perceived relevance is a major unresolved problem of education.

exempts the education of its own work force from this thoroughly modern tendency.

The industry tends toward vertical organization in that it creates the work force that it employs. It causes candidates for admission to the work force to apprentice for years to artisanships that share a largely unevaluated lore on schooling the young. One consequence, however unintended, is that the industry's principal organizational accomplishment of this century has been to create the nation's largest single-industry work force. The productivity of this work force considered, in a land that both admires and secures efficiency in superior quantity, the industry manifests the quaint coloration of a labor-intensive enterprise.[5] In face of this situation, although educational objectives invite serious scrutiny and some reorientation, the central problem--as with all preindustrial states and enterprises--is to raise the productivity of labor. This necessitates, as a first step, antecedent efforts that expand, improve the organization of, and systematically exploit a knowledge base that is apt to the instructional process and hence to the education of educators.

While the citizenry can hope to contribute positively to selection of apt educational objectives, its contribution to resolution of the productivity issue necessarily will be largely negative. Its threat to reduce educational funding levels in face of perceived increasing costs unaccompanied by increasing productivity is the primary political force that those who would appreciably elevate productivity can harness.

Some apparently feel that the problem of educational unproductivity would go away if parent and child were allowed to select their own educational objectives and then shop in an open market for educational treatments that secure these objectives for the child. Attractive though this view is, the pull of the present--and perhaps increasingly of the future--would seem to preclude making the fate of the child entirely a function of the wisdom of parent and child in selecting objectives. The pace of change is forcing strategies that minimize skills obsolescence to become quite complex. Detection of such strategies should prove more amenable to responses of corporate magnitude than to those that an individual might offer. Moreover, while proprietary ingenuity might strip away certain

[5]In a land of organized and well-paid craftsmen, the craft-instructed teacher is showing a pronounced tendency to become craft-organized to secure the remunerative advantages of such organization. During the era of the poorly paid teacher, low productivity was less an issue than it will be increasingly as salaries drift ever upward. As some school districts already are finding out--usually for the wrong reasons--bankruptcy of the educational enterprise is a possibility at the local level. For the industry as now constituted, it well may be that "firm" options are classic: improve productivity or go bankrupt.

bureaucratic factors underlying low productivity of the currently constituted industry, the evidence is not compelling that any educational organization can be very productive if forced to draw its labor force at random from the nation's human resources. Any such organization can look good with God-given good teachers. The problem is that there are not enough of them to go around. Hence, the central need of education remains one of creating a radically more productive, machine-augmented labor force.

The history of automation of labor suggests that only the most repetitive and easily comprehended of instructional routines will be automated soon. Even when the more complex facets of teaching are understood, costs of doing so probably will preclude their automation anytime soon. Hence, even then, in appreciable residual form, effective education of the educational work force will remain a problem to be addressed. The revolution that instructional system design, as envisioned here, seeks to advance is one that addresses educational productivity, using treatments that are aimed both at the instructional situation in which the child is ensconsed and at the teacher's college where the story really begins.

THE FUTURE OF INSTRUCTION

A reading of far-out futurists and authoritarian utopians suggests the possibility that education has no future. Most probably it does, and most probably that future lurks under our noses.

People undoubtedly learn things spontaneously--that is, in absence of perceivable systematic guidance. Little people seem to do a good deal of this. At times it appears that spontaneous learning is about the only kind to which the child is susceptible. Is the moral that learning succeeds, while teaching fails? There are noninterventionists who think so. An alternative view is that teaching can succeed but that it has not appreciably done so yet because we do little yet to make instruction efficient or technically effective or to improve its perceived relevance in light of the child's circumscribed experience.

Dimensions of Educational Evolution

If education is going somewhere, it is coming from somewhere. Since the matter seems appreciably misunderstood, where is the departure point that contemporary education affords?

The articulate--who have a tendency to lag well behind practice--in recent years have been advising those who wear shoes that the pace of change now has reached the point wherein we no longer will be able to foresee the ultimate ends of any child's education. To such Rip Van Winkles--a fraternity that has included all analysts of education at one time or another--the reply that educational evolution warrants is "Lo, thus has it been these long many years."

Perhaps for the wrong reasons, educators and their supporters have been proclaiming for decades that education (meaning, we now know, knowledge-based, language-mediated skills) and training (meaning, we now know, those skills that incubate and emerge from lengthy craft apprenticeship given over to rote learning of verbal chanties and motor emulations) are different things, with the former infinitely superior to the latter as a measure of well-used human resources. Such rhetoric may have been premature when first advanced, since the automation of repetitive labor was minor before it became possible for computer designers to exploit transistor technology. However, whether the distinction between education and training arose out of a visceral futurism, conceit, or a perceptive anticipation of technological change, events have at last vindicated it.

The grounds for continuing discontent with today's public schools remain Wagnerian in scope. However, the industry does not err in the direction of asking today's student to depart a preindustrial artisan.[6] The public schools of today are turning out a different breed of cat than they were a generation ago. Today's high school graduate has knowledge-based computer-programming skills where yesterday's graduate had rote-learned bookkeeping skills long since automated in larger organizations. Today's high school graduates are college-bound in proportionately much larger numbers than were yesterday's, with the result that exploitable knowledge systems play a much larger role in the curriculum than formerly. Where motor emulation and the rote learning of verbal routines dominated vocational education a generation ago, technological sophistication of much of today's blue-collar work is necessitating that vocational skills be defined on knowledge systems. Thus, television repair and the trouble-shooting of electronic systems presuppose some degree of orientation to an underlying science and technology.[7] The record is spotty and sullied

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[6]That fate the industry reserves for its teachers. However, B.F. Skinner apparently would settle for the narrowly trained artisan down in the ranks. For Skinner would not trust resourcefulness below the level of the Mr. Clean leadership that represents society's salvation in his view.

[7]Some years ago, the U.S. Army found itself giving expensive electronics training (here we would call it education) to short-enlistment personnel whom industry then lured away at the first opportunity. The Army's solution was to strip away the knowledge system which made its graduates adaptive to new tasks and so attractive to industry. By reducing the exploitability of its training, the Army succeeded in increasing reenlistments among electronics personnel. Few of today's high school students probably would succumb to such a strategy.

with subcultural favoritisms. However, today's education in the public schools is appreciably more predicated than yesterday's on the proposition that we can no longer reasonably foresee the ultimate ends of any child's education.

Craft-skills romanticists continue periodically to mount challenges to the trend toward knowledge-referencing of skills. They argue, correctly, that society cannot be populated entirely by the ethereally erudite. However, excepting for a few craft skills that may survive for another generation (carpentry perhaps), some of the clerical skills (typing possibly), and the popular hobby crafts, narrowly defined skills are not the answer to a need for skills diversity of public schools output. A larger objective of the contemporary public schools is increasingly to replace narrowly skilled hands with skilled minds capable, if need be, of employing the hands in a variety of ways consonant with different conditions of work, many of which cannot be foreseen. Ineffectively perhaps on occasion and inefficiently no doubt always, visceral practice nevertheless is redirecting along suitable lines in consequence of the pace of change and the perishability of circumscribed skills. Help it may need from the technologist, but no warning that redirection is in order. Its antennae are too sensitive to necessitate what essentially are political alarms.[8]

A second dimension of education's attunement to change occurs in the value domain. A scant two decades after Jack Tenney--that bordello piano player turned State Senator--made sex education in California equivalent to card-carrying Communism, education in the public schools has made praiseworthy progress in questions of value. Historically, public education has been abused whenever it attempted to move perceptibly beyond a lowest common denominator of social values, however rational the grounds for doing so. Perhaps the same is true today, in that education is simply following a postindustrial society's tendency to evaluate, modify, and apply the value system to the economic and other systems bearing on "quality of life." Even so, it sometimes seems to outdistance the political leadership in dealing in the classroom with questions of social equality and ecology. Thus, visceral practice once again can be credited with sensing change and accommodating to it.

Instructional Specificity and Educational Breadth

As a simple consequence of education's growing awareness of the perishability of circumscribed skills in today's world, we are moving

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[8]However useful discovery learning may prove as a campaign, strategem, theory, or empirical effort, the call of its proponents in recent years to stamp out circumscribed skills instruction drifted onto the stage for the most part after the visceral practitioner had moved on.

steadily toward that general education that liberal arts professors, burdened with the intolerable spectacle of well-endowed professional schools, yearned and proselyted for a generation ago. What significance does this trend have for the future of instruction, and particularly for an objective of instructional specificity in the public schools?

Addressing this question presupposes some sort of view of intellectual development. Application of library scholarship might reveal an unimpeachable such view. For present preliminary polemic purposes, the following crude model should suffice.

The model's base assumption is that children start out "concrete-oriented." It is assumed that earliest concepts are identified with extremely restricted exemplary domains and that concepts grow more general with the child's accretion of suitable experience. Another assumption is that the conceptual field diverges during the earlier years, with classic convergent organization presupposing a divergent phase. Hence the integration of concepts presupposes prior suitable development and generalization of the individual members of the field of concepts that gets integrated. The individual proceeds from denotative specificity to generalization, with generalization involving induction based on two or more nonidentical specific instances or exemplars of the concept (or field of concepts). When the store of generalized concepts is sufficient, integration becomes possible.

As McLuhan (1964) notes, work during the Gutenberg (postprinting, or preindustrial plus industrial) era became increasingly specialized and, hence, circumscribed. However, the pace of change during the current (or postindustrial) era necessitates despecialization of skills to ensure longer shelf life and, indeed, efficient reeducation when skills flowing from a knowledge base acquired earlier no longer permit one to cope effectively with the situation (whether economic or some other). It follows that during the last century of the earlier era, when universal public education gained hold in industrial nations, education (and training) must have become increasingly specialized over the life of the individual.

Consonant with the foregoing crude view of intellectual development, the individual's earliest education--then as now--must have begun on specifics. Perhaps as a base collection of concepts became more general with increasing education during the earlier era, a point was reached relatively early in education wherein two things happened. First, generality of any concept considered to have economic utility was pinched off at what has come to be called the data-language level, consonant with those requirements for an interpreted terminology inherent in a sensible acquisition of the prescriptive verbal routines of specialization.[9] Second, early conceptual divergence of the knowledge base--which was to serve both the general educative needs of the individual and the requirements of specialization--quickly gave way to a convergence or progressive constriction of the base grounded exclusively on the requirements of specialization. Thereafter, prescriptive routines became central, and this was the plane on which most individuals came to know a good deal about damned little. The general education movement in this country could be viewed as a suitable reaction to such a chronology and as an anticipation of a postindustrial future when humanist value judgments would gain prominence and breadth of educational experience would have economic value for all or most individuals.

If general education counters the trend toward increasing specialization, then it must not be true that education at the primary level is most general and at the university level most specialized. For such a view would contradict both the crude model of intellectual development offered above and the requirement that the earlier educational chronology be overturned.

The argument that education is general in the elementary school years is based on its apparent tendency to remove few if any career options from the student's field of choice. However, if we set aside the literacy facet of elementary education, then one can argue just as readily that such education does not place any career options in the student's repertory either.

If the skills taught in the elementary schools all were taken to mastery and if these skills formed a common foundation for most existing and many as yet unimagined roles that adults might play, then all of these skills might prove general in the sense of being least susceptible to economic obsolescence. However, there is more to elementary education than skills taken to mastery. Elementary education addresses at least two sorts of skill: a) a few communication and computation skills--for example, reading as decoding print to speech--which for all practical purposes are taken to terminal mastery levels and b) a large number of other skills or of knowledge systems to which these skills reference, for which instruction does not progress beyond barest beginnings. For skills of the second type, the elementary school graduate can be viewed as having a shallow and nonintegrated understanding of a broad skills domain. Shallowness arises because the child would have only the beginnings of the relevant knowledge systems to work with. Thus, such skills (if any) would be specific in that the underlying acquired knowledge base

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[9] Such a view is unsurprisingly consonant with the terminological tendencies of operant conditioners and with Skinner's view that the dray horses of society ought not be saddled with too many alternatives to the recommended road to social goodness.

precludes significant exploitation to yield the different performances under different conditions that the general education model requires. Such general education as occurs in elementary schools extends only to an important handful of communication and computation skills that flow from knowledge systems that one expects might survive even McLuhanian retribalization. The second component of instruction in elementary schools is consonant with the crude model for intellectual development. There, divergence is in flower and despecialization is only beginning.

Elementary education during the earlier era probably was similar to that for the current era, except that a) the knowledge base as given by science and technology for the most part was less developed, b) the knowledge base was less used in line with educational intent, and c) few skills beyond those of communication and computation were taught in the classroom. Possibly excepting the tendency of the McGuffey series--which was ahead of its time--to base reading on explication of a phonics system, terminal educational objectives of the earlier era reflected even communication and computation skills that were grounded on formulas designed to yield curcumscribed skills. Conversely, educational objectives of the current era apparently are to produce a moderately deep and integrated understanding of a knowledge base whose exploitation will populate a moderately-broad skills domain.

It appears tenable that contemporary and future Leonardos will prove rare. Hence, it continues true during the current era that an individual moving through the educational process will have to choose from among alternative knowledge bases at some point in his education. This sense of specialization cannot be avoided. However, nothing precludes his adding to that base and of integrating the new with the old, whether through age 18, 22, or 70. This is a broadening process that must continually increase the breadth of the skills domain to which the individual has access. From a standpoint of lifetime educational objectives, early narrowness of the knowledge base acquired is only a temporary manifestation of intellectual development. Later specialization is merely a matter of convenience, subject to correction by continuing education.

Brzezinski (1970) believes that the pace of knowledge accretion, supercession, and organization during the postindustrial era will necessitate lifetime instruction. In his view, education "through the age of 18" can be relatively stable, with higher education--restructured as systematic continuing education--serving to bring the individual up to date periodically as the skills that are consonant with earlier education become outdated. He also believes, consonant with the crude model of intellectual development, that continuing education--by making pertinent experience a true function of age--will result in more effective intellectual integration, more widely dispersed in the national work force and perhaps in more profound degree than at present.

In the political sense of reading the times and accommodating to them, educators are making progress in matters of instructional relevance.

As a first line of defense against obsolescence of skills in light of the pace of change in the scientific and technological knowledge base underlying economic activity, the industry also appears to be progressing, although assistance from the scientific and educational R&D communities will be required on a continuing basis to determine or predict which elements of the base will prove most resistant to change and so most germane to treatment in the public schools.

Increasingly during the later public school years, the student will encounter elements of the knowledge base that are in a dynamic state of change. The predictable eventual obsolescence of these elements--together with obsolescence of some earlier mispredicted to be stable--can be overcome through periodic continuing education. Continuing education can also be used to better exploit experience in the service of an objective to optimize intellectual integration.

All in all, then, education and instruction have futures, although they need to overcome the historic problem of educational underproductivity by upgrading efficiency and technical effectiveness and to reorganize "higher education" to accommodate pace of change in the knowledge base underlying economic (and other) activity. Whether the "firms" now accountable for educational output will continue to hold their places in the industry or give way to successor firms that are more productive perhaps is immaterial.

THE CONTINGENT STATUS OF MANAGED PRODUCTIVITY

Many Americans cherish the view that an intolerable situation can always be overcome by superior management. Perhaps this is so. If it is so, then what sort of response characteristics of the manager make it so?

It appears tenable that, on maturity of the instructional system design enterprise, the structure of management of the instructional routine or larger endeavor will be appreciably specified by an instructional system design or a complex of such designs, suitably yoked together. However, since ISD is yet in infancy, management of instructional routines necessarily is appreciably or totally independent of explicit constraints flowing from a design for instructional systems. This leads to a situation that some will welcome and others deplore--management accountability. In light of educational underproductivity, what is a manager to do?

Burger (1971) has added his voice to those of other prominent individuals who note that adjudication with justice in the larger American courthouses in recent years has suffered because of the creeping pace of the judicial process. Burger recommends that legal and administrative functions be clearly separated in major federal courthouses, with the latter handled by administrator-managers having responsibilities on the plane of those for hospital administrators.

Although there are those who remain unconvinced that the law has reached that ideal state wherein no unjust judicial design can be plucked from it, the argument that more just adjudication depends on improved management of the constitutional-statuatory design of the legal process lends weight to the view that the process itself is acceptably designed--that is, merely inefficient in execution. Thus, if eighteenth century English law made indebtedness a felony and executive speed a design specification for justice, then the judicial process that did not fling the debtor into prison quickly would in practice necessarily have been judged inefficient. In such a situation, the manager must be accountable and has the option of performing either efficiently or slothfully.

In education (if not in law), the design of the process itself is the first problem. We could hope that better management would be the key to more efficient education--whether in consequence of on-the-job training, the tenets of management science, or both--only if the educational process were acceptably designed. After reviewing the dismal record of consistent failure of "management treatments" to accomplish anything tangible in the educational setting, Stephens (1967) concludes that such treatments are losers. Perhaps they are only losers when viewed as propaedeutic to the process of upgrading educational output. For the disease runs deeper. The key to improved output per unit cost, we argue, must be improved conceptualization and management of efforts underlying production of instructional systems having specified desired output characteristics. To have much positive effect, superior management must be an overlay on design-referenced superior treatments of educational processes.[10]

On scrutiny, it appears tenable that today's inspired instructional manager--whether an administrator or teacher--will be found to be operating, however intuitively, more at the level of an instructional system designer than that of a customary manager. For, in face of a dearth of pertinent instructional system design specifications, the practice of management techniques alone will not suffice. The inspired instructional manager should prove to be more a technical innovator in ISD and related domains than a decision-maker who chooses between proposed alternative courses of action addressing return-insensitive questions of efficiency. Until ISD efforts mature--and so specify the objectives of management--our best hope for upgrading educational output in consequence of

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[10]When an industry is appreciably inefficient, its efficiency can sometimes be improved by the exercise of subtractive arithmetic. By cutting out some of the deadwood, one can cut costs without extensively depressing an already low output. While return might not improve and perhaps might decline slightly, the exercise of subtractive arithmetic should yield improved cost-return. The foregoing view of positive effects of superior management contemplates the <u>joint</u> improvement of return and cost-return.

instructional management effort is an assumption, however informally, of ISD functions by instructional management personnel. It is argued, then, that the response characteristics that make it true that superior management can somewhat ameliorate an intolerable educational situation are those referencing to ISD functions.

ISD FUNCTIONS AND THE PULL OF DESTINATION

An Inventory of Functions

Conway (1968) characterizes the system design process as "that kind of intellectual activity which creates a useful whole from [the system's] diverse parts." Such systems are designs for "machines" that produce products. What system characteristics are admissible depend, first of all, on design specifications for the product. These relate to its physical characteristics, its functions, and often its production-unit cost. Design specifications for customary goods, while occasionally sticky, conceivably typically are at least an order of magnitude less difficult to explicate than those for an instructional product in the era of skills despecification.

Conway tends to rule out design efficiency as a function or objective of the system design process. By this, he apparently means what we will call practical efficiency. For one may distinguish between theoretical and practical efficiency and, beyond this, between system and process theoretical efficiency and between system and process practical efficiency. System theoretical efficiency refers to the probable cost of making use of a given effective system design in light of the knowledge base on which it is predicated. Such a base is consonant with production of alternative effective designs. The system design that is developed should be theoretically efficient in that it avoids obvious Rube Goldberg characteristics. Parallel statements apply to process theoretical efficiency, which refers to the probable cost, in light of an apt knowledge base, of the system design activity itself. Conway is concerned with process theoretical efficiency.

A system or process design having practical efficiency typically can be secured only at great cost, either in systematically extending a general knowledge base or in mickey-mousing beyond the knowledge base. In consequence, practical efficiency must lie beyond the system design activity that produces a theoretically efficient design or a system design process activity that produces a theoretically efficient process. That is not to say that a theoretically efficient ISD will not be propaedeutic to and control the effort to secure in practice that level of efficiency that the ISD promises in theory. Such an ISD should control the development of the instructional system that it specifies.[11] Moreover, it should have a beneficial focusing effect on all short-term efforts to extend the knowledge base in apt ways, a matter to which we will return.

The foregoing comments suggest that the following objectives are in the purview of system design and system design process activities: a) specifying output (or Rome) precisely, particularly with respect to product functions, b) consonant with existing knowledge, producing an effective design (an instructional path that theoretically will get to Rome), c) consonant with existing knowledge, producing a theoretically efficient design (an instructional path, with pedagogical overlay, that will get to Rome by the theoretically shortest or least costly route), and d) consonant with existing knowledge, creating a system design process that is theoretically effective and efficient.[12]

All of these objectives have implications for focusing all shorter-term efforts that seek to extend the knowledge base for ISD--and attendant educational productivity--in apt ways. The third and fourth objectives also have implications for development of specified products, whether the product is an instructional system or an organizational form within which ISD will be accomplished.

Most remarks of this paper bearing on the cited objectives <u>address</u> the first three--those referring to design. However, most such remarks themselves <u>classify</u> under the fourth objective--that for process. Only process effectiveness will be of appreciable concern here. Process efficiency in the instructional system design setting will merit serious consideration only after an effective ISD process has been identified.

<u>Culture and Destination</u>

The first instruction of a good recipe for preparing possum is to obtain a possum. In the current era, the possum of destination defined

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[11]Few have attempted clearly to distinguish between instructional system design and instructional system development activities. While there may be agreement that ISD is "rationally" prior to development, the development-oriented have tended to make ISD an ill-defined component of development (cf., Schutz, 1970). Perhaps the issue will become increasingly irrelevant with increasing maturity of ISD. Optimally, all developments of instructional systems should flow from explicated designs.

[12]Much lurks behind these summary descriptive phrases. Thus, a concern with an efficient pedagogy--without which there could be little in the way of an efficient design--takes one into formulation of "instructional learning theories" and adduction of taxonomic systems addressing skills, educational media, and other facets of the instructional situation. While the existing knowledge base will prove helpful to attaining such subobjectives, inevitably one will be required to forge on ahead, whether merely in a contentious sense or with empirical follow-through.

on culture is going to be harder to catch than formerly. Consider conceptual skills.

In the culture of the American child of the early industrial era, one could foresee the child's destination better than one can do so today, because the pace of change then was more leisurely and the utility of specialization more compelling. The data-language view of required common core conceptual development for most purposes placed destination very nearly under the nose of "curriculum engineers" of the day. In consequence, it was less risky then than it is today to isolate the "more fundamental" conceptual skills of early education.

Earlier we contended that contemporary education during the elementary years does not seek to take many complex skills to a mastery level, but rather to have the child acquire those portions of the knowledge base that will both not be quickly superseded and can be used to build on. Such elements of the knowledge base can be characterized as more fundamental conceptual skills. One cannot define more fundamental skills without placing some constraints on the domain of all possible destinations. Thus, the fundamental skills for the preindustrial Kipsigis child of Kenya, the early industrial child of Southern Italy, and the post-industrial American child will be the same only if there is agreement that these children will reach adulthood under the condition of a common culture and, hence, a common range of potential destinations. The concept of fundamental skills, then, must be defined on culture, social evolution, or the scientific and technological knowledge base that is apt to a society.

The American instructional system designer no doubt will make the right choice between cultures and, hence, apt knowledge bases--at least in the crude sense of the alternatives sketched above. It appears compelling that he should avoid too narrow a strategy for isolating the skills that he will take as fundamental. Thus, an uncritical or partisan acceptance of the proposition that mathematics or scientific method exhaust the clues to the postindustrial destinational domain in particular should be resisted.[13] Given the contemporary knowledge base and an

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[13]Consider "modern mathematics" from a destinational standpoint. Does the society that modern mathematics contemplates compel belief, or is it one conceived by a proficient mathematician who would levy instruction on society's children out of pride in discipline. Parents and wits have been known to voice the suspicion that, whatever its contribution to mathematical sophistication of the citizenry, modern mathematics slights computational efficiency. Perhaps it is both correct that tomorrow's adult will be armed with a minicomputer and so able to dispense with efficient computation and that such an adult will not be able to function without mathematical sophistication. In posing such questions--referenced not just to modern mathematics but all of its modern sisters--education would do well not to let the discipline-oriented and their partisans have the last say. For a license to steal strains disinterested integrity.

understanding of areas of greatest turmoil referencing to that base, such a choice offered in the absence of a cogent defense probably should be taken as indicative of either parochial conceit or a slothful unwillingness to labor.

Fortunately in light of the pace of change, there is reason to believe that all sorts of fundamental skills inventories addressing postindustrial destinations will prove apt. That is, there may be many alternative effective routes to effectively functioning adulthood in the postindustrial society, just as there are alternative routes to any Rome. The term fundamental, then, while indicating more than an arbitrary departure point, will not signal exclusiveness. There need not be--and probably is not--any one grand design that alone is congruent with the existing knowledge base. That the convergence-oriented appear to teach, for in their domain one individual's tree-diagrammatic terminal nodes will be more intermediate in the tree of another.

Even when instruction becomes appreciably more efficient, communication and computation skills instruction and recreational and other hobby activities will take up much of the child's time in elementary school. While entry into the rest of knowledge base domain will be made during elementary school years, the brunt of instruction addressing the domain will fall to later public school years. If we place fundamental skills instruction in those portions of the elementary school years unclaimed by the skills and activities cited immediately above, then the extent of the fundamental skills domain by definition will be quite finite. Any sober effort to chart an intelligent course into the larger domain should turn out useful, even though one cannot with great confidence foretell what tomorrow's effectively functioning adult in postindustrial society will look like.

PART II: ORIENTATION TO INSTRUCTED LEARNING

A SKETCH OF COGNITIVE SKILLS ACQUISITION

A general instructed-learning view presumably would differ in certain respects from a view that applies more narrowly. The former probably would be more difficult to express. Hence, for illustrative purposes, a narrower domain--that for cognitive skills--will be sketched. The sketch offered takes the views of Olson (1970) as a point of departure, although occasional liberties are taken with these views. A more detailed commentary on Olson's findings and views is presented elsewhere (Follettie, 1972).

Some antecedents of Olson's views on cognitive learning are the Gestalt psychology of the 1930s, the "needs influence perception" psychology of Postman, Bruner, and others, views of the cultural relativists (e.g., Whorf, 1956), and the view that much of technology extends not only to man's senses but also his nervous system, with implications for "civil defense against media fallout" (McLuhan, 1964). Olson differs from many perceptionists in tying a learning process to enactive behavior--the performatory act--and from most who are interested in the learning process in viewing instructional factors as having a role to play in theoretical accounts.[14]

Olson extensively studied acquisition of skill in constructing diagonal patterns, usually by placing five checkers in appropriate recesses of a five by five matrix of recesses. His and other findings and conjectures then were used to devise "some aspects of a theory of cognitive development." While Olson does not use the terminology of instructional system design, much of what he has to say classifies under that heading.

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[14]Olson believes that a theory of instruction is needed to tie psychological theories of learning to the larger instructional situation of education. Yet, most learning studies--even those dictated by theory--employ instructional routines, however weak, addressing effectiveness and efficiency. The problem that current learning theories pose for the educator--if not for the theorist--is that they repress consideration of troublesome antecedent conditions underlying findings to be accounted for. The pretheoretical Aufgabe and Einstellung studies were empirically conscious of such conditions. However, there has been little theoretical follow-through. The straightforward course would be to settle for a single theory--an instructional learning theory--that embraces all of the important conditions of instructed learning. While necessarily shallow at the outset, such a theory would encompass the major known significant components of instructed learning situations and, hence, would not sacrifice education for constrained depth.

In Olson's view, S (a learner, whatever the occasion or auspices of learning) employs his perceptual system to form schemas that guide his performatory acts. The information that S obtains from a perceptual universe depends on organismic factors and his prior experience with the cultural media.[15] S uses the prior effects of culture-- experienced but not necessarily understood, to borrow from McLuhan--to construct a schema that reflects his theory of how some facet of the universe is put together. Experience reflected as schema constrains S's perceptual options--that is, tends to determine what information he will pick up. Apparently, S will modify a given schema when the performatory act that the schema controls does not secure a desired objective--that is, when the act is unsuccessful, signifying that it does not reflect criterion performance. Apparently also, the experience that is critical to schema modification is S's perception of failure, where criterion performance (or act acceptability) may, but need not, depend on instructive transmission. Failure detection results in schema modification. The modified schema then causes new information to be picked up and the consequent execution of a modified performatory act to occur. The modified act will be terminal if it secures the objective. If not, then schema modification will continue until an act that does secure the objective--a criterion performance act--occurs (depending on the worth of the objective and whether S is "encouraged" to go on trying).

Olson views cognition as evolving in such a manner that the more primitive Gestalt cues--edgedness, proximity, orientation--are perceived early in the life of S and the more specific cues provided by culture only later.[16]

Olson apparently shares McLuhan's view (1964, p. 305) that education should come to be "recognized as civil defense against media fallout." That is, Olson seeks favorably to influence the child's education by having the educational process reveal to the child how the universe he perceives is invented or shaped by men and expressed by cultural media that are extensions of men.

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[15] Olson's views on media tend to resonate with those of McLuhan (1964). McLuhan viewed media as communication and other cultural devices in private hands. Educational media contrast with such media in that the instructional system designer can specify form and function consonant with technology and a conceptual skill to be mastered. The concepts of medium and nested media are sufficiently useful that their origins in McLuhan's work will be explored in Part III.

[16] Conceivably, such a developmental dimension could usefully be viewed as an orthogonal extension of a two-dimensional skills taxonomy having typology and enactivity as its dimensions.

TAXONOMIC CONSIDERATIONS

Skills Taxonomy

The term cognitive skill tends to excite more heat than light. We follow Olson's lead: to cognize is to perceive.

Taxonomic systems tend to be useful for two reasons: a) they differentiate "types" and b) they orient the classifier or user of the system to an overall domain of interest. A first--or vertical or typological--dimension of the typical skills taxonomy orders categories of skill on a rank scale. The basis of record for ranking may be some such factor as phylogeny, ontogeny, or effortfulness. Perhaps it is only coincidental that such rankings for skills tend to reflect the level of regard that educated individuals feel for the different categories. The vertical series of a gross skills taxonomy--acceptable for present polemic purposes--ascends as follows: discrimination skills, associative skills, concept-rule skills, large-bore system skills. Discovery skills run off the top of the chart.

Herein, every skill is viewed as containing two components--cognitive and psychomotor. Conceivably at every vertical level, at least one skill could be detected or defined that features an appreciable cognitive component. A second--or horizontal or enactive--dimension of the gross taxonomy to be employed will differentiate skills on the basis of cognitive-psychomotor emphasis. The cognitive pole of such a dimension will reflect an acquisition requirement referencing primarily to skill structure as this is revealed by E (experimenter or educator) to S (a learner, whatever the occasion or auspices of learning). The psychomotor pole will reflect a requirement referencing primarily to disposition of S's musculature (particularly that musculature that is employed post-perceptually). Pole-to-pole proportionality of cognitive-psychomotor learning requirements is assumed to have continuous-variate characteristics; a leftmost skill would be predominantly cognitive; a rightmost, predominantly psychomotor.

It is not compelling that cells of the rectangular matrix implied by the two-dimensional skills taxonomy should all be filled. However, we assume that all cells are fillable, but with highest "cell frequencies" falling around a left-oriented diagonal and with any line that is orthogonal to and originating on the diagonal moving through progressively lower cell frequencies. That is, cognitive-psychomotor stress will appreciably interact with typology, yet not so highly as to preclude the discovery of skills having a high cognitive loading but classifying at the lower end of the typological scale or vice versa. The skills taxonomic views underlying formulations to be presented, then, are approximately conventional.

Cognitive-Psychomotor Emphasis

A skill is primarily cognitive if acquisition is primarily a matter of schema revision following failure to achieve criterion performance. However, if we distinguish between cognitive and psychomotor components of acquisition--and hence between performatory acts indicative of cognitive and psychomotor skill--then a schema will control either act. Perhaps the two acts are merely products of analysis of an integrated act, so that a single schema will suffice to control both. Even so, it appears useful to distinguish between facets of the schema controlling the different components of the integrated act. Hence, a skill will be considered primarily cognitive if acquisition is primarily a matter of revising the schema's cognitive facet and primarily psychomotor if acquisition is primarily a matter of bringing the musculature under better control consonant with an adequate existing cognitive facet of the schema.

To say that every skill has cognitive and psychomotor components is to say that every skill has cognitive and psychomotor structure. Whatever the magnitude of a skill's psychomotor component, it is assumed that S's psychomotor performance will be conditional on his perception of cognitive structure for the skill. Consider the cognitive structure of pursuit rotor skill. A target of given size, revolving at given rpm about a given radius, is to be tracked using a tracking device that precludes riding the target, with the object of staying on target throughout a specified period. If S's schema for cognitive structure is defective, then he should not acquire the psychomotor skill that is conditional on the apt schema for the skill's cognitive structure.

Really precise views of the psychomotor structure of any skill remain to be unravelled by the psychophysiologists. A skill's cognitive structure, into which is built a summary review of what is required--e.g., on target always--sets the condition for skills having an appreciable psychomotor component. Gross advice on psychomotor structure can always be formulated; such advice provides a basis that is more systematic than trial-and-error for forming a psychomotor schema conditional on the cognitive schema. Particularly in professional sports, there is a strong emphasis on explicating acceptable and unacceptable psychomotor performance for training purposes. However, educational practice outside the athletic domain and perhaps the typing classroom suggests that much of the record concerning just what the muscles are to do to achieve desired performance is left unstructured. Whether such practice is due to ignorance, lack of ingenuity, a dearth of resources, or a feeling that such information is trivial is unknown.[17]

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[17]Could we manage to make professional football gate receipts a function of penmanship, then professional football players well might write like girls out of Eastern finishing schools. (How do such girls acquire their stylized penmanship?) The public schools appear typically to have given up on the pursuit of efficient psychomotor performance on evidence of failure of

E does not typically evaluate cognitive skill when a pursuit rotor task is to be mastered. Perhaps this is because such tasks typically in the past have employed adult Ss, for whom the cognitive component of the skill probably can be taken to be trivial. Yet for a child, it is conceivable that there is a point in development wherein it is true both that S could acquire pursuit rotor skill and could do so only if E first expended some effort on transmitting information concerning cognitive structure of the skill. For younger Ss, it appears possible to vary cognitive-psychomotor stress while holding one side of the ratio more or less constant.[18]

There is a tendency in the literature to ennoble cognition as a uniquely human process and even as one whose locus is the higher reaches of the typological dimension of a skills taxonomy. The foregoing remarks should clarify that the term is not so used here. Whether planaria are capable of cognitive learning we neither know nor care. However, perhaps all of the vertebrate learning literature not specifically dealing with complex psychomotor activities appreciably or primarily addresses cognitive learning. Hence, Spencian T-maze studies using rats who earlier learned to locomote and grasp are as cognitive as Tolmanian studies using multiple-T-mazes or Bournian concept-learning studies whose Ss are human. Progress will not be served by confusing a pervasive cognitive process or domain with a narrower higher-conceptual one. However useful, the cognitive revolution was primarily rhetorical, which is perhaps the reason it was so bloodless.

Typological Subsumption

If, for a skill classified at any level of the typological dimension of a skills taxonomy, one explicates the cognitive structure of that skill,

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wooden and pedestrian attempts to improve it. While the domain of such "craft skills" properly is a shrinking one in the public schools, those skills that remain probably warrant more analytic treatment. Whether Skinnerian training techniques are the answer to the problem is unknown; however, Skinnerian determination to prevail in such situations probably is in order.

[18]Diagonal construction as a continuous end-to-end act provides an example of the possibility for varying cognitive-psychomotor stress almost at will. The psychomotor requirement can be minimized when rendered as the drawing of a ruled line through the outline of a square or rectangle. A toy now off the market, wherein one hand controls horizontal movement of a marker and the other hand vertical movement, can be used to maximize the psychomotor requirement while causing the child to acquire a diagonal construction capability. The cognitive requirement--to form the concept of diagonality appropriate to production of a continuous, directional exemplar--appears similar for the two situations.

then that structure may be summarized using a proficiency hierarchy grounded on given entry skills. It appears so that the cognitive performatory acts implied at lower levels of the typological dimension--e.g., discrimination, association--will appear at various points in a proficiency hierarchy summarizing the cognitive structure of any skill classifying at a higher level. Thus, when S learns a multiattribute concept, it may be required that he differentiate (discriminate) relevant attributes and relations between attributes. A further requirement may be that these attributes and relations between attributes be named (associatively paired with lexical items). Hence, an interest in higher-level skills does not imply that the lower-level skills have been left behind, but rather that one has entered a region of greater typological heterogeneity.

CONCEPTUAL SYSTEMS

Conceptual systems, as Olson notes, are products of culture. Men invent them. If such a system is found useful to economic or social commerce of the day, then it will be enshrined in a recorded or other form that maintains it. For those who follow, such systems are a key to the wisdoms of past generations and to their naivete. Such systems learned, the individual is armed with blueprints for perceiving the universe that he alone might not invent if he lived to the age of Methuselah. However, these systems constrain the individual to perceive the universe in ways that will be found naive a generation hence, if not sooner. Man's dilemma is that his progress will be hampered if he allows the Tiber wolf to rear his child and hampered also if he allows the culture to fit its particular spectacles to the child. Hampered more, one imagines, in the former case, since nature is such an opaque instructor. An apparently apt concession to the tunnel-viewing perils of taking one's cues from culture is to advise the educator to enter into the child's schematic store the general rule that today's utility may prove unutilitarian tomorrow, so that all schemas should remain tentative and subject to revision. Indeed purchase, but caveat emptor.

Culture's conceptual systems come large, if not unbounded. The conceptual systems that one will take as isomorphic with skills structures of educational interest are cut out of larger systems. At minimum, the conceptual systems of education may range from single-attribute concepts--e.g., blueness--to appreciable portions of such systems as mechanics and the English language.

A concept encompassing two or more attributes will be formally defined only if the relations holding between attributes are specified. This is done by specifying one or a related series of rules. Society seldom is interested in having an individual learn such rules per se. Neither society nor the individual often would find such learning useful. The typical terminal instructional purpose referencing to such rules is that they be generalized--that is, applied as intended throughout a specified domain of rule applicability. To learn a rule as a linguistic expression is to learn it associatively without leaving the linguistic domain. To learn one or a few of its interpretations by relating it to one or a few of its exemplars in a signification domain of interest may necessitate both discrimination learning and cross-domain association (of linguistic terms with exemplars of significates.) Learning the rule's interpretation throughout a specified signification domain, where instruction features only a few exemplars of the rule, necessitates that the rule be generalized. These different skills requirements imply different performatory acts, each of which will be apt at some point during negotiation of a proficiency hierarchy culminating in terminal--or apex--skill.[19]

PROFICIENCY HIERARCHIES

Rigorous explication of proficiency hierarchies will not be attempted here. However, the plane diagonality concept studied by Olson can be used to provide orientation to the domain of the proficiency hierarchy concept.

Culture provides a conceptual system for Euclidean space. Let us say that on this system culture has defined a conceptual system for Euclidean geometry. This system defines a conceptual system for diagonality, a special case of which is plane diagonality.[20] One manifestation of plane diagonality is potential to a square matrix of recesses--Olson's square (Chinese) checkerboard--or dots. Such a matrix permits E to exemplarize plane diagonality in various ways or to require S to perform in various ways to demonstrate that the concept is grasped under conditions imposed by the square matrix and performatory act specification. Such exemplarizations or acts potentially portray constructive plane diagonality in one of four ways: a) continuously and somewhat instantaneously as a unitary response--e.g., by rod placement, b) continuously by ruler placement but with an additional progressive requirement that S then draw a line from corner to corner, c) sequentially by successively placing checkers in recesses (Olson's principal performatory act) or by successively pointing to recesses or dots, d) successively but nonsequentially by placing checkers in recesses or pointing to recesses or dots. Below this level, depending on the child's entry skills, one may define discriminatory and associative performatory acts that are en route to one or all of the diagonal performatory acts that are potential to the entire range of media that the concept of plane diagonality implicates.

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[19]The pyramidal article of faith evident in the typical usage of the proficiency hierarchy concept must be that the instruction of interest is convergent in form. We return to this issue in the next section.

[20]That plane diagonality is a special case can be verified by looking up the definition of diagonal in an unabridged Webster's dictionary.

Each performatory act, over the range from the discrimination and labelling of attributes through generalization of the plane diagonality rule or rule set, reflects a skill having cognitive structure. A proficiency hierarchy incorporates the set of such skills that are both necessary and sufficient to its own terminal (apex) performatory act. These skills are semiordered over instructional time on a basis that often is called logical but better might be called effective-efficient. The apex of the proficiency hierarchy for plane diagonality is set by culture using Euclidean geometry as its agent. Whether the apex should be reached and, if so, when in the life of the child, are determined by maturational factors and educational policy based on social values. How far down the typological dimension of a skills taxonomy one will reach when identifying those skills that are necessary and sufficient prerequisites to acquisition of the apex skill will depend on what entry skills can be assumed.

Learning theory, conventionally interpreted, appears primarily concerned with efficiency issues. Proficiency hierarchies primarily serve effectiveness technology. Perhaps for this reason, work on proficiency hierarchization--e.g., Gagne (1970)--heretofore has not been considered to be in the mainstream of learning-theoretic effort. The result is a tendency to delineate theoretical formulations in ways that preclude exploitation in the instructional setting, since a useful theory in such settings typically will be integrative across "kinds" of learning, arranged in a temporally referenced pattern.

As one attempts to design instruction spanning from a one-medium act that references to a constrained view of a concept (e.g., Olson's square matrix-referenced diagonal construction act) to multimedia acts that reference to a more abstract view of the concept, it is demonstrable that the designer can expect to encounter other concepts than those which appear to belong to a one-concept proficiency hierarchy of somewhat pyramidal form. Consider the situation where the apex of the hierarchy reflects a generalized level of proficiency regarding plane diagonality. Down from this apex in the body of the skill structure let the Olson constructed diagonal skill or act reside. This act requires that a diagonal be progressively constructed using a fully ordered series of $\underline{N}$ moves. Inherent in this act is a component that refers to a second concept, that of number sequence.

That one may always take such second concepts as entry skills is beside the point. For the point is that any two exemplars of a general concept advance the view that the concept has unique characteristics or attributes only if these exemplars differ from each other with regard to irrelevant attributes. These irrelevant attributes are only irrelevant to the general concept of interest; they exemplarize other general concepts. Particularly where concept learning is defined on construction acts, multiconcept instruction becomes inevitable as one reaches up for generality. In a technical sense, then, the converging pyramidal proficiency hierarchy becomes an oversimplification.

If it is tenable that the pyramidal proficiency hierarchy whose apex in some sense constrains subordinate structure is a useful conceptual device, it is also a fact that unfolding instruction has a tendency to be flitting back and forth among a rather large set of such hierarchies. While proficiency hierarchy structure and its larger pyramidal implications at face value tend to portray concept learning as convergent, neither practice nor rational analysis reveals how this could be so. Methuselah, efficiently instructed, conceivably would have reached a point wherein his concept-learning chart would reveal appreciably more convergence than divergence, for intellectual integration seems a convergent process. However, for younger children, such charts, if we could draw them aptly, probably would reflect a strong tendency toward divergence.

Assuming that the conventional proficiency hierarchy has many of the characteristics of a suitable building block, the time has probably arrived when one must forge beyond this level of analysis to reveal the larger structure in which such building blocks are embedded. The form of such a structure should be a joint function of an instructionally interpreted conceptual domain and pedagogical considerations underlying efficient instruction. Such a view implies that one impose structure on the "fundamental skills" domain, and that this be done on grounds of instructional efficiency. For that is the full significance of rejecting the practice of calling skill structures "logically organized." No doubt a logic--bearing on instructional effectiveness--must be considered. However, the exercise of such a logic is insufficient to implicate an efficient structure, because the logic fails to preclude generating a large field of structures, some of which do not bend to the processing tendencies of the learner nearly so well as others.

PART III: ANALYSIS OF THE INSTRUCTIONAL SITUATION

Education appears almost as inevitable as death and taxes; formal education is almost as negatively received in many quarters. The past suggests--although the future may be a different matter--that formal education will occur whether or not efficient and even, too often, whether or not effective. The past also suggests that education will modify in face of discontent and, in consequence, will demonstrate that it continues to be possible to discover new avenues to ineffectiveness and inefficiency. He who said that the more things change, the more they remain the same might well have been looking at education at the time. The industry shows a positive passion for change; yet one is reminded of Gilbert's modern major general, a prideful dilettante who was forced to admit at last that his grasp of science and technology "has only been brought down to the beginning of the century."

We used to blame lepers for their leprosy. Perhaps we are doing the same thing when we ask educational practitioners to unravel problems of great pith and moment. Albeit some educators tend to treat the industry's pathology as their own proprietary preserve, it is time for reasonable men to admit that the patient can hardly be physician to his own malady. One can pull a sliver from one's finger, but not pluck a tumor from one's brain. Who will form and lead the surgical team?

While the instructional system designer may aspire to those roles, one must admit that his credentials as yet are insufficient. Armed only with educational theories that tend to sustain no life but their own, a few emerging instructional design tools, and a midwiver's guide to pedagogical practice, the contemporary practitioner of ISD looks more the weekend warrior than a modern-day St. George. What armamentarium can the system designer bring to bear?

One weapon that should not be overlooked is the preceptive guaging of one's own ignorance. While the positive effects of such effort will not be immediate, one can aspire to the mobilization of apt activities only if one first identifies a problem requiring resolution. Thus, an awareness that an existing tool--proficiency hierarchization--is insufficiently powerful serves to mark the need for work that reveals those operating characteristics of human processing equipment that formulation of conceptual system structures should reflect.

Another approach to perceived ignorance--one that is simply more systematic than the flagging of isolated problems--is to structure a broader domain using whatever tools one perceives as useful. This approach to structuring ISD is employed in sections that follow. Such an approach may be taken as a polemic in one of two senses. The first is that of a contentious offering--subject to modification, refinement, or countercontention on the part of others interested in advancing ISD. The second is that of a pronouncement to be ingested and acted upon by the faithful. Authors may be pardoned for visceral tendencies to aspire to acceptance of and adherence to their polemic. However, ISD will grow more apt only to the extent that interested individuals treat such polemics as a challenge to do better. One can only insist that the instructional situation, being complex, must be structured as a precondition to effective engineering. A faulty structure can be corrected, whereas little can be done with the bits and pieces of ISD lore that currently masquerade as structure.

The instructional system structure to be presented will take instructional medium, instructional milieu, and performance factors as major components of the instructional situation.[21] The instructional situation to which Olson's diagonal construction tasks reference will serve as an illustrative framework for describing these components. The relation of transfer and generalization concepts to media will be treated briefly. Finally, McLuhan's view that media nest will be modified and extended consonant with exploitation in the instructional situation.

INSTRUCTIONAL MEDIA

Some always will admire anyone who can see to China on a clear day. Thus, one finds an occasional schoolteacher or assistant professor in a School of Education warmly championing McLuhan's (1964) views on media. However, most men of reputation for perspicuity have managed to refrain from discussing McLuhan except during the cocktail hour. For unrestrained rhetoric is not much admired in such circles except when it is one's own. Fortunately, Olson was not repelled by McLuhanian rhetoric--perhaps because Torontoans who do not hang together surely will hang separately. Olson's positive contribution--which his own rhetoric sometimes obscures--is to begin the McLuhanian medium on a transformational journey into education. We attempt below to block off some of the cul-de-sacs that this journey must avoid to ensure that the traveller will reach a state of instructional mediumship.

We begin by noting that <u>medium</u> here will be specified by the instructional system designer based on the instructional objectives he addresses and potentialities of technology. While the mass media and audiovisual aids of contemporary education illustrate some of the capabilities of the technology for devising media, the instructional medium will not simply be a television set or network or an audiovisual aid. Rather, it will be a "device" to which a specified performatory act of instruction references. As such it will be one of the interdependent elements of a designed instructional system. Hence, it will have system-defined functions, rather than the functions that it could have in a free market or in the hands of an entrepreneur.

21Depending on the skill to be taught, medium and milieu components of the instructional situation can be interpreted as singular or plural.

To illustrate, Olson's square checkerboard does not preclude hatcheting. S may deface the board, kick it, throw the checkers at it, or pile checkers in a column in one of its recesses or elsewhere. However, the board was designed in contemplation of a specified performatory act and is used by Olson to secure that act in consequence of the prior transmission of instructions that suitably specify the required act. The medium per se is incongruent with a variety of acts--e.g., typing, weaving, reading. However, its exact instructional role depends upon the instructional design that is imposed upon the board or other medium, rather than on the medium itself, which invites a broader range of acts than instruction normally will contemplate.

A later view will modify and extend McLuhan's view that media nest. According to this view, media that nest in other media are "devices" only in the sense that conceptual systems, or exemplars thereof, are devices.[22] Present remarks reference to a simpler model wherein the medium is a physical device. Olson's square checkerboard exemplarizes this narrower sense of the term.

Informational Components of the Medium

A useful instructional medium should permit both criterion performance and noncriterion performance. Olson's square checkerboard meets this test. On it, one can either construct a diagonal pattern--Olson's typical criterion act--or one of a variety of other patterns.

Every exemplarization of any concept is bound to contain features or attributes that do not belong to that concept unless the "concept" is the label for an identity set. Most useful concepts have a membership of exemplars no two of which are identities, although both exemplarize the concept. In such cases, every member of the set has an informational component that reflects attributes of the concept and an informational component that reflects attributes of one or more other concepts. Thus, the diagonal patterns of Olson's square checkerboard share some of the characteristics of diagonal patterns ruled through hollow squares or rectangles, diagonals formed by placing a rod across the outline of a square or rectangle, etc. But these patterns also differ in certain senses not critical to the diagonality concept. These differences reflect attributes of concepts other than that of plane diagonality.

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[22]According to the view presented in a later section, when suitably referenced to its conceptual system by performance specifications, the medium becomes an exemplarization of the conceptual system. Hence, every medium implies a conceptual system; where performance is specified, the unit of instructional system construction is the medium-concept pair.

If one wishes to evaluate S for acquisition of a given concept without switching media--that is, if one wishes to evaluate S for transfer of concept acquisition as opposed to generalization of concept acquisition--then the medium used must exemplarize the concept in alternative ways. Olson's square checkerboard also meets this test with respect to diagonal construction. The board permits construction of two different diagonal patterns--one left-oriented, the other right-oriented. Acquisition can reference to one of these patterns, transfer evaluation to the other. Like the intermedia exemplars, these alternative patterns differ with regard to irrelevant information. However, in the transfer situation there is a systematic shift along a single irrelevant dimension--that of orientation in the case of the checkerboard. Intermedia shifts are more profound and not necessarily so systematic.

Physical Components of the Medium

If the medium is a unique component of the instructional situation, then it needs to be differentiated from other components of the situation. Given an instructional interest in the concept of plane diagonality, then Olson's square checkerboard may be viewed as belonging to a larger set of media that, taken together, permit specification of a range of performatory acts indicative of S's skill regarding the concept (and, incidentally, alternative concepts such as exterior row or column, interior row or column, and certain nonlinear concepts). The central analytic characteristic of Olson's medium is that it consists of two parts--a board showing a range of markable alternatives and a set of markers.[23]

Both Olson's and McLuhan's usage of such phrases as "the medium in which one is working" reflect that one plays or works a medium. In consequence, we adopt the view that all media have handles. The set of markers for Olson's medium constitutes its handle. In the broader sense of media to be treated in a later section, the concept of handle will be extended to attentional handles.

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[23]Those fiercely committed to expository closure will wish to study the following description of an Olson like checkerboard in some detail. The board is an 8-by-8 inch square having 25 circular recesses arranged in a five rows-by-five columns-matrix. Each recess is 1 inch in diameter and three-sixteenths of an inch deep, with one-half inch intervening between any edge of the board and the nearest point bounding any exterior recess and with one-half inch intervening between boundaries of any two adjacent recesses falling on any line that is parallel to an edge. The nonrecessed surface of the board is a middle gray and the recesses white. The set of markers is five checkers, each seven-eighths of an inch in diameter and nine-sixteenths of an inch thick, colored red. Checkers fit readily into and are easily removable from recesses. Arrangement of board and checkers with respect to each other is described in a later subsection.

Arrangement of Physical Components on a Larger Ground

If the nonrecess portion of the Olson board is ground to any figure composed by entering checkers into recesses, then there must be a larger ground--or superground--on which board and checker components of the medium distribute prior to act performance. Thus, board and checkers invite or require distribution over the superground.[24]

Whether the superground should be classed as part of the medium or as part of the milieu will depend on the extent to which one believes that a medium can be specified independently of its superground. Where designer joins handle to the device to be manipulated, perhaps superground need not be considered as a component of the medium. However, when the physical relation of handle to device is left unspecified, then to a degree the medium becomes an abstraction whose exemplars will vary in distribution over superground. For a television set, controls can be placed on the set, across the room using a remote control device, or at headquarters (as in Orwell's 1984). Distribution over superground requires specification only when failure to specify permits the exercise of unacceptable act specification options.

INSTRUCTIONAL MILIEU

Olson follows the dominant practice of educational and behavior-science research in saying little about the milieu. One may put one of two evaluations on such silence: a) that the conditions of work are unimportant--at least during instruction--or b) that they are important, understood, and inevitably optimized in the empirical situation addressing instructional effects. It is probable that some conditions of work are important and others not so important and that the effects of some conditions of work are understood and exploited in the experimental situation and others not. Both in the instructional situation and in those knowledge-soliciting situations bearing on the instructional situation, it appears tenable that more explicit and systematic attention might with profit be extended to milieu effects.

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[24]Once more we provide the tantalizing detail, based on an Olson-like situation. The board is recessed into a large table of rectangular shape so that the board's nonrecessed surface is flush with the top of the table. The table is black. One edge of the board is parallel to and 3 inches from the viewing edge of the table. The checkers are placed in a recessed saucer in the table--to left or right depending on handedness of S. The saucer center is 6 inches outward from the edge of the board and 7 inches inward from the viewing edge of the table and its diameter is four inches.

Undoubtedly, there are some who will argue that the classroom or other instructional scene is bedlam and, therefore, that a busy street corner is as good a place to do educational research and as good a characterization of the milieu as instructional systems design should reflect. Such an argument could prove like accepting the malaria victim's malaria and seeking to intervene with effect only in matters of diet.

It is the posture of poor relations in a rich family to accept any facet of the educational milieu as not reengineerable if it should turn out that costs are bearable in light of probable return. Were those who control retooling of the educational facility to evince an arbitrary hostility to the notion that today's housing for instruction may be defective, then at least one should evaluate at what cost in instructional efficiency such intransigence is purchased.

In some instances, one can overcome or minimize undesirable features of the milieu that are too costly to suppress through modifications bearing more centrally on the problem. As a weak illustration, one might overcome marginal lighting deficiencies in an instructional situation of the Olson type by using day-glow paints to mark recesses and checkers of the medium. That is, one can sometimes counteract a known deficiency in the milieu, relatively expensive to correct, through the relatively cheap reengineering of a medium.

One is struck with the kaleidoscopic color and multitude of forms typically to be found in contemporary classrooms--particularly those used for earlier elementary instruction. At this level, the blah milieu is definitely not preferred, even though intuition suggests that such "pinballing" of the milieu--while perhaps generally stimulating--might detract from instruction addressing particular skills--e.g., square checkerboard-referenced diagonality. One can probably find proponents of all sorts of view on such matters. One such view might be consonant with the contemporary classroom more or less as is--that is, that the general milieu should both be rich in sources of stimulation and the place where all instruction occurs. Alternate to this view is one that all specific instruction should occur in blah boxes painted a neutral gray. Shades of intermediate viewpoint no doubt occur. Perhaps in this 112th year since the birth of John Dewey someone will step forward and tell us how the matter should be resolved.

Consonant with resolving the milieu question, one should not lose sight of the sometimes positive effects of practicing placebo medicine and otherwise securing Hawthorne effects. To those who say that one should beware of Hawthorne effects, perhaps the proper advice is just the opposite. If one can obtain a Hawthorne effect cheaply while knowing that that is what one has, then one should accept it with gratitude.

Foregoing comments address those components that classify as inanimate transmitters of the milieu. These fall in the purview of engineering psychology. Many such factors have been studied in industrial situations (cf., Wulfeck & Zeitlin, 1966, particularly with respect to environment). Some such factors have been studied nearer to the instructional situation (cf., Tinker, 1959). Alternative to these components are those that classify as animate transmitters of the milieu--e.g., those dealing with personal characteristics of E and distributional characteristics of peers of S. The optimization of E as an emanator of personal characteristics falls to cosmetology, headshrinking, and charm schoolmastery, rather than to human engineering as typically constituted. Presence and distribution of peers of S, where the performatory act requires individual rather than team responding, probably falls to social psychology.

Milieu, or environmental, factors underlying acquisition and performance conditions hardly have gone without study. Either we have failed to exploit the resulting knowledge base to yield an instructional situation that is more attuned to efficiency optimization of learning, the base is inadequate, or no problem exists with respect to milieu. One humbly doubts the last of these possibilities. The truth probably lies somewhere between the first and second.

PERFORMANCE FACTORS

A case might be made for the proposition that a more conventional treatment of the factors herein classed under the rubrics of medium and milieu might be based on "psychological" interpretations of system design (cf., Gagne, 1966). It would be more difficult to defend conventional views on performance components of system design (cf., the Glaser & Klaus chapter in Gagne, 1966). Such views are based on the wrong measurement rationale and, if one excepts certain ritual mumblings concerning "behavior" and "task analysis", live a life of their own; they are neighbors to the system perhaps--as one chapter of an edited work is the neighbor to another--but under no compulsion to resonate to the same and only musical score.

Incarcerated in the milieu and physically oriented to the medium, S desirably will perform--that is, in the illustrative case provided by Olson, place markers in certain of the alternative recesses of the board. He can be expected to do this under one of two goads: a) if effectively instructed or directed to do so or b) spontaneously, based on prior experience or a stir-crazy boredom. Thus, performatory acts occurring under instructed conditions do not necessarily signify that the instruction is effective (a matter that has been observed in print by many a teacher of PS 154). Spontaneity may be a first line of defense in face of ineffective instruction. Remarks that follow assume that performatory acts are instructed. Rather than giving a special place in the formulation to motivational factors, we will be content here to take the view that instruction either will be effective or less so, depending on instructional system characteristics.

Rather than giving a special place to an incremental view of acquisition, we will be content to take the view that if the performatory act is suitably defined, then one can get along nicely with the two-state--skilled, unskilled--notion of acquisition (or performance) and thereby transform the issue into a straightforward one bearing on instructional efficiency of alternative instructional treatments yielding skilled performance.

Performance factors are discussed under three headings: act specification, entry skills, and criterion specification. Under the first of these headings is specified skill structure and conditions of performance underlying the performatory act. Under the second is inventoried those skills on which a proficiency hierarchy culminating on the Olsonian terminal skill is grounded. Under the third is discussed what criterion of act-execution the instructional system will find acceptable.

Olson does not explicitly distinguish between act structure and criteria of act acceptability. Although education shows a similar tendency--a consequence of which is to treat criteria as free variables--intuition suggests that any social mandate that may formerly have existed for this practice will increasingly be withdrawn as we move into the postindustrial era.

Act Specification

Man-machine views of system design treat the machine as having certain functions. A combination of idiot-proofing and training assures that the individual will operate the machine to ensure that only certain of these functions will be realized. This is not so different from what we have in mind, except that the functions that are uppermost in the present views are those of reflecting conceptual system structures. The nested-media "machine", to which we will come in a later section, perhaps is only a special, or somewhat more complex, case of gadgetry, like a computer.

Noted earlier, the medium closes out some options concerning a conceptual system domain but, in absence of act specification, fails to yield a precise view of the structure of an exemplar of a conceptual system of interest. Assuming the one-medium, one-conceptual-system situation, then act specification in general tells S how to grab the handle to work the medium.

Act specification can take a variety of forms. One form used by Olson was to make a five-checker pattern on his (or E's) board, which was identical to S's board and placed atop it, to withdraw E's board after giving S an opportunity to study the pattern, and then to require pattern construction by S from memory on S's board. Here we make do with one board. E first makes a five-checker pattern on the board, then tells S to study the pattern for a moment since S will have to copy it from memory, then returns the checkers to the saucer, and finally--immediately or with short delay--directs S to copy the pattern.

While act specification is conditional on the medium--a matrix and a number of markers--the medium itself is insufficient to implicate the act that will be specified. As the foregoing illustration indicates, the act specification routine has three effects: a) It isolates the pattern that will organize S's schema. b) It defines the information that S must obtain to execute the act successfully. c) It describes the conditions under which the information will be obtained and used.

Pattern. The pattern formed from N checkers--in Olson's studies one of at most 12 five-checker linear patterns--exemplarizes a concept. This exemplar will condition, although not define, the informational requirement.

Informational requirement. Olson demonstrates that different sorts of performatory acts predicated on searching a common pattern in the context of a common medium require different information. A recognition act requires less information than a construction act. Hence, the cognitive schema that yields acceptable recognition or gross discrimination of a diagonal pattern must be refined before it will yield acceptable construction of a diagonal pattern. The informational requirement apparently is a function of at least two factors: a) size of the contrast set (number of alternative acts that are entertainable) and b) a summary measure of how much the alternatives depart from pattern.

Conditions of performance. E has a wide range of options concerning how to proceed after medium, pattern, and informational requirements are specified. The pattern can be presented on S's board or on a board to left or right, above or below S's board. S can be directed to look at the pattern briefly or for longer. E either can direct S's attention to certain features (attributes) of the pattern or fail to do so. Production can be required to begin immediately after the pattern is removed or following delay. Certain of these decisions are pedagogical in that they are consequential to efficiency of act acquisition. Others are substantive in that they are consequential to effectiveness of act acquisition. Conditions of performance, then, encompass pedagogical and substantive procedures. When applied in verbal form, pedagogical procedures are instructions that address efficiency. Substantive procedures promote effectiveness by calling attention to the cognitive structure of a pattern exemplarizing a concept--e.g., straight line, corner to opposite corner, for the diagonal concept.[25]

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[25]Olson's most instructionless procedure reduced conditions of performance to directing S to look at or to study a pattern briefly consonant with later production. That minimum value of pedagogical treatment typically characterizes even operant conditioning studies using infrahuman Ss; it takes the form of a shaping routine antedating

Entry Skills

Substantive instruction explicates the cognitive structure of a pattern exemplarizing a given concept. Such instruction references to a proficiency hierarchy whose set of skills outline structure for the concept, conditional on a medium or set of media. The proficiency hierarchy ends at a selected performatory act that is placed at the apex of the hierarchy. Where does it begin?

Explication of a proficiency hierarchy theoretically reaches down into the void of an infinite regress (which some skills analysts seem determined to overcome). One way to avoid unbounded explication is to ground the proficiency hierarchy on some view of the entry skills of S. S does not necessarily possess these skills. However, whether he does can be evaluated. If they are not there, then E can place them in S on the basis of informal training. The training must be informal because the entry skills cutoff for the proficiency hierarchy precludes skills analysis and explication below the entry skills level. In the studies reported by Olson, some entry skills are made explicit, evaluated, and, if necessary, informally trained. Others are only implied.

The pattern construction act presumes certain motor skills; its verbal instructions assume an entry ability to decode to meaning the language used to describe conditions of performance to S. These motor and comprehension entry skill requirements Olson evaluated and, if necessary, informally trained. In certain studies, he also required that certain five-checker linear patterns be constructable on entry--e.g., an interior row pattern--but not other patterns, particularly the diagonal pattern.

Those entry skills that Olson's work tend to imply rather than to explicate might be called "informational load-processing skills." By his own account, Olson attended to such skills when designing medium, pattern, and procedure.[26] However, the fact that they are entry skills to Olson's acquisition tasks seems worthy of comment, particularly since the concept of plane diagonality does not require some of these skills, either on entry or terminally. Thus, while the notion of a contrasting

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the first bar-pressing response. Most, if not all, learning studies employing vertebrate Ss feature at least such a minimum value of instruction. Modern learning theory simply rises above its pervasive but complex empirical details.

[26]The term procedure incorporates performance specification and pedagogical overlays on performance specification. The term continues useful as a subsuming device, but is retirable in the uncritical, catchall sense in which it is often employed.

set of patterns appears applicable to any view of the diagonal construction performatory act, neither the contrasting set inherent in a response-sequencing requirement nor the delay inherent in a successive checker-placement requirement seems other than a pure function of the specified act.

Skill in handling the pattern contrast set. One of Olson's objectives is to teach diagnoal construction to younger Ss who can copy certain patterns involving exploitation of the primitive cues of edgedness, proximity, and orientation, but not other patterns, particularly a diagonal, which cannot be constructed simply by making use of the primitive cues. Had Olson found that younger Ss could not copy any linear pattern on the board, then he might well have concluded that some detail of the medium was faulty. A possibility is that he might then have designed the board as a four-by-four or three-by-three matrix or shortened the pattern without shrinking the matrix--e.g., to four or three checkers. His own account makes clear that the choices of a five-by-five matrix and a five-checker pattern were not arbitrary, but rather were referenced to a population of Ss.

Shrinking the matrix--which necessitates shortening the linear pattern--results in shrinking the contrast set of alternative patterns. Expanding the matrix and pattern length has the opposite effect. Intuition suggests that a 21-by-21 matrix would yield good edge pattern production by a younger S required to place 21 checkers, displacement of pattern for most interior rows and columns, and failure on diagonal patterns. On the other hand, a three-by-three matrix well might yield good production for all three-checker linear patterns, the diagonals included. Reduction in pattern length while holding matrix size constant again reduces the pattern contrast set--that is, the set of all possible patterns, not just the linear ones. That too should make the task easier.

Decisions on matrix size and pattern length set requirements for amount of information S will have to deal with. If the intuitive notions on outcome expressed above are correct, then a given child will or will not be prediagonal depending on pattern contrast set characteristics when a nonunitary construction act is required. For certain of Olson's studies, then, it is tenable that entry skill is defined on matrix size and pattern length characteristics inherent in or referencing to the medium. Olson says much of this; what he does not say is that membership in the diagonal culture will, for a given S, be conditional on how many alternative patterns the construction act features. That given, then level of diagonal construction skill becomes a function of pattern contrast set characteristics. Skilled in constructing a diagonal on a three-by-three matrix, S conceivably will require additional training before he will prove skilled when the medium features a four-by-four matrix and a four-checker response.

Skill in handling the sequential contrast set. Olson apparently typically allowed as correct either of two sequences for forming a five-checker linear pattern: a) beginning at End_1 and progressing to End_2 or b) vice versa. Requiring one of these sequences--as opposed to one of the other 118 that can be used to form a given five-checker pattern--introduces a second or sequential contrast set.

It appears tenable that the concepts exemplarized by a top edge, interior row, or diagonal pattern will not usually be interpreted as order-constrained. However, E is entirely privileged to impose such a constraint if it appears to serve a useful pedagogical purpose or if E wishes to define an order-constrained diagonal concept. In either case, accepting the option amends the terminal diagonal construction skill and hence entails amending the proficiency hierarchy to reflect an en route or entry skill for space-time sequencing. S either will bring this skill to the training situation or the skill will need be taught him. For younger Ss, it appears tenable that such skill will be present or absent depending on pattern length.

Delay-handling skill. Prior to learning a pattern-exemplarized concept, when asked to construct a pattern using N elements placed one at a time, S must carry portions of the pattern in memory until the final element is placed. Thus, when an act entails making a progression of responses over time, then delay between pattern presentation and performance in some sense must occur, even though onset of performance may immediately follow withdrawal of pattern. The same sort of reasoning applies to the pattern-perceiving activity. If much information must be extracted--as opposed to one glanceful--then delay is operating even though the delay interval is zero. Pattern contrast set characteristics define degree of effective delay. For a given S, such delay will increase with increasing information-handling requirements. If performance is a function of delay, then the medium and pattern that minimize delay might classify S as a diagonal child, whereas greater delay might classify him as prediagonal.

Only the successive-construction type of performatory act requires diagonal skill to be conditional on more than infinitesimal delay. If performance is a function of delay, then S either must possess the requisite delay-handling skill on entry or gain such skill thereafter.

Criterion Specification

The medium, act, and entailed entry skills specified, the extent of S's skill--skilled or unskilled--depends on what form E's specification of criterion skill takes. As Olson's work demonstrates, a description of a performatory act referenced to a medium alone will not define required criterion skill. Joint specification of medium and act condition criterion performance. However, this alone is insufficient to fully implicate criterion skill.

Olson employs a variety of criterion skill specifications. On one occasion, he requires that a pattern be copied entirely without displacement of any checker; on another, displacement of one checker might be allowed. In some instances, accuracy is defined on one attempt to construct the pattern; in others, the act is judged accurate if copied on one of two attempts. In some studies, part credit is given when certain but not all features of the pattern are copied; in others, part credit is not given. In some cases, the performatory act is considered acquired after one number of correct attempts; in others, after a different number. It follows that specification of medium and performatory act yet leaves criterion--or acceptability--characteristics of performance free to vary.

It appears generally true in all settings that criterion specification options will remain after medium and performatory act are specified. Misinformation concerning instructional effects probably arises more due to failure to report criterion skill settings precisely than to any other single factor. Olson does a fairly creditable job of describing the different criterion skill settings used in the various studies of his research program (although not the rationale--if there is one--underlying study-to-study variations of setting). The educational research literature does not always go even this far.

SKETCH OF THE ISD PROCESS

Conceptual System Isolation and Proficiency Hierarchy Design

A first task of the instructional system designer (hereafter denoted E) is to isolate all or a portion of a culture-revealed conceptual system whose cognitive structure warrants instructional treatment because it yields ways of perceiving the universe and consequent performatory acts having social utility. Such a system might be denoted an instructional conceptual system, to distinguish it both from the broader conceptual system in which it resides and other conceptual systems at E's disposal.

E then preliminarily designs a proficiency hierarchy expressing the cognitive structure of the instructional conceptual system. This device and other conceptual systems that are at E's disposal then are put to use to achieve several objectives culminating in production of a proficiency hierarchy in "final" form.

Ensuing Activities

Media specification. One objective implied by exploitation of the proficiency hierarchy is to design one or more media to which the performatory acts entailed by the hierarchy will reference.

Milieu specification. A second objective referencing to the hierarchical design is to engineer one or a set of milieus consonant with engineering psychology findings and the resources at hand.

Act specification. A third objective is to specify--for each performatory act reflected in the proficiency hierarchy--the form, information-handling requirements, and applicable instructional treatments that the hierarchy conditions. At this point one can get deeply involved in pedagogy aimed at efficiency optimization. Thus, one may require that responses of discrete diagonal construction occur in a specified sequence on evidence or supposition that a sequential requirement enhances concept acquisition. While pedagogical treatments will reference to the proficiency hierarchy in preliminary form, they will be defined on characteristics of S and the milieu that E can afford. Such treatments discovered, it becomes necessary to amend the hierarchical design to a "final" form that reflects purely pedagogical considerations for the first time.

Entry skills specification. A fourth objective is to specify instructional points of departure, or entry skills, that bound explication of the proficiency hierarchy consonant with probable or assumed characteristics of an entry S.

Criterion specification. A fifth objective is to specify one or more criterion settings for each performatory act of interest. The current tendency is to assign criterion, or acceptability, settings that are convenient to E (or the educator). During the industrial era one could have turned to the market for clues to a nonarbitrary basis for setting criterion values for many of the performatory acts instructed. In light of the pace of change during the postindustrial era, such an approach is much less tenable now than formerly. In consequence, a problem for instructional system design in the current era is to find an appropriate nonarbitrary basis for defining acceptability levels for key performatory acts, so that such a rationale can be made a basis for criterion specification.

TRANSFER AND GENERALIZATION

Systems are called conceptual that can be represented or exemplarized in alternative ways. If it is possible to usefully portray a given conceptual system using a single generic proficiency hierarchy, then it should also be possible to identify two or more component hierarchies in the generic hierarchy, each of which references to its own unique medium or field of media. (Such subordinate hierarchies would share some skill or act nodes and have others not in common.)

The terms transfer and higher-order generalization are distinguished on the basis of media referents and, hence, relative levels of generalization. Transfer reflects first-order generalization, an intramedium phenomenon appropriate to an earlier phase of concept learning. Higher-order generalization reflects an intermedia phenomenon appropriate to later phases of concept learning.

Transfer Phase of Concept Learning

Consider the conceptual system for plane diagonality, narrowly referenced to a five-by-five checkerboard medium, with the required performatory act successive placement of five checkers to correspond to a previously modelled diagonal pattern. Transfer to the opposite diagonal is obtained in consequence of a change in act specification--e.g., showing S the opposite diagonal pattern, instructing him to copy it, and perhaps providing supplemental instruction addressing value of the diagonal-orientation feature (left or right). Medium and criterion normally are the same for transfer training-testing as for original training-testing.

Learning-to-learn effects ruled out, then if appreciable training underlies original learning and little training underlies transfer, there must be a communality between the two exemplarizations of diagonality inherent in the medium such that each pattern, independently, exemplarizes the communality. If there were no communality, then there should be no instructional savings during transfer training. This communality across exemplars exemplarizes the concept.

Whatever, the attributes employed by a given culture to define a given concept, these attributes must inhere in all exemplars of the concept. However, a corollary convention is that different exemplars having nothing not in common belong to an identity set, rather than to a concept.

If the left-oriented diagonal is learned in consequence of given instructional outlay and then the right-oriented diagonal is learned in consequence of nil instructional outlay, then either a) the medium does reflect the concept, which has been learned at a transfer level or b) the medium reflects only an identify set of exemplars, whose members have been learned. For this reason, evidence of transfer, while encouraging, should not be taken as clearly signalling that the journey toward suitable concept generalization has begun.

Higher-Order Concept Generalization

Media are like exemplars formed on media, in that they are representations or exemplars of a conceptual system, having elements of communality and elements of uniqueness in relation to other media reflecting the conceptual system. If we change the medium in some sense--e.g., through matrix expansion or by replacing its discrete pattern representation through use of a medium featuring a continuous pattern that invites or requires a unitary construction act--then performance referencing to the changed medium will have to overcome a "more artful camouflaging" of the concept than performance referencing to the opposite diagonal of the original medium. The convention is warranted (and apparently in force) that a test referencing to a switched medium that is more than a component of the original medium is a test for higher-than-first-order-generalization (typically simply called generalization). The instructionally interpreted conceptual system should indicate what tests for higher-order generalization are appropriate.[27]

A well-engineered instructional system will define both transfer and higher-order generalization levels of concept formation on the system. Perhaps only when S reaches the more abstract levels of a concept as "simple" as plane diagonality will it become compelling for E self-consciously to reference instruction to a conceptual system. At a transfer level, the conceptual system for plane diagonality may prove as trivially worthy of attention as is the conceptual system for pursuit rotor acts when adult Ss are used.

BROADER MEDIA

Foregoing sections of Part III treat media singly as system component devices. In the instructional system sketched earlier, the concept of medium was used in a restricted sense to refer exclusively to Olson's square checkerboard. In a later subsection the illustrative instructional system of Part III will be reexamined. In consequence, the square checkerboard will become just one of three media operating in the situation. This medium will refer to and exemplarize a "nonlinguistic" conceptual system. A second medium--nearer to McLuhan's principal usage--will be a communicator or delivery mechanism. A third will be a message, or exemplarization of a linguistic conceptual system that is loaded into and transmitted by the communicator to facilitate acquisition of the criterion performatory act referenced to the square checkerboard.

Prior to treating the instructional system in terms of different media referring to different conceptual systems, we consider some antecedent views of McLuhan and certain characteristics of organizations that operate at or near the forward edges of their knowledge base. McLuhan's pertinent views are sketched because they have influenced the

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[27]An alternative to switching the medium is to switch the criterion specifications by making them progressively more stringent. It does not appear useful to classify criterion-switching treatments under the generalization heading since, in that case, the concept of interest itself may be viewed as undergoing progressive modification.

wider view of media to be presented. The "forward organization" is described sufficiently to indicate the legitimacy of regarding organizations as design-sensitive media.

Some Views of McLuhan

McLuhan (1964) focused on the role of media (or technology) on the course of social evolution. He saw the electronic media in time reversing the tendency toward ever-increasing specialization and compartmentalization of human effort, with society becoming more flexibly organized and with individuals progressing from narrow (and increasingly automatable) functions to more general roles involving the handling of large amounts of information. McLuhan peered into the future and found it at his doorstep in the sense that he believed that contemporary technology preempts the future.[28]

McLuhan shares with contemporary economists--and with educators, particularly the proponents of discovery, eolithy, and serendipity doctrines--the view that the training of specialized skills no longer can be taken as a major characteristic of education in the American postindustrial society. Whether McLuhan was a cause or a component of the tide of consensus now prevailing with regard to this point of view is unimportant here. Most now would agree with McLuhan's view that American society is moving toward a reversal of the increasingly differentiated and inelastic social organization that treats such organization as a tree-diagrammatic structure whose roots undergo division without end. Although his avowed interest in education apparently did not extend beyond "immunizing" S to those persuasive effects of the media that would not normally be perceived, McLuhan discerned a discontinuity between a terminal-state industrial age and a rapidly succeeding postindustrial age wherein the electronic media would play

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[28]Contemporary technology less preempts the future than places certain constraints upon it. For if current technological trends are not overturned, then technology will remove only some, rather than all, options regarding social actions and individual roles that might otherwise be available. In the same sense, Olson's checkerboard does not preempt the performatory act, but only somewhat constrains its domain.

a central role. The implications of this view for education beyond immunization to the media McLuhan left to others.[29]

McLuhan's views on media--which presently we will translate as a mixed bag of conceptual systems and their exemplarizations--appear exploitable for purposes of arming the instructional system designer bent on guiding the educational phase of the transition journey between two ages. A succinct index to these views (p. 52) is: "Except for light, all other media come in pairs, with one acting as the 'content' of the other, obscuring the operation of both." However, more may be involved than "pairs," as is inferable from the following comment(p. 8):

> the "content" of any medium is always another medium. The content of writing is speech, just as the written word is the content of print, and print is the content of the telegraph. If it is asked, "What is the content of speech?" it is necessary to say, "It is an actual process of thought, which is in itself nonverbal...." The "message" of any medium or technology is the change in scale or pace or pattern that it introduces into human affairs.

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[29]Education as the agent of government has a role to play in ensuring that society will survive its transitional journey from the earlier to the now-dawning age. Drucker's (1969) chapter on the knowledge economy suggests that half of all jobs in the American economy soon will fall into the knowledge sectors, which are the postindustrial or growth sectors. Could we rely exclusively on "normal attrition" in the older sectors featuring repetitive labor--which reflect the dead, as yet unburied--then the transition from specialized skills to those based on exploitable knowledge systems would pose no problems for society. The pace of change suggests that normal attrition may not be the answer, particularly since the transition problem is complicated by presence of a sizable racial-ethnic minority component whose membership heretofore has been denied equal economic and associated opportunities. As opportunity shrinks in older sectors of the economy, some current jobholders in these sectors who are not yet to the end of their working lives will be rendered unemployable. These will be added to the already unemployable. As unemployability mounts, the alternatives short of societal disruption are a) retraining programs that prepare these individuals for entry into growth sectors of the economy or b) welfare-type policies that increasingly broaden the burdens placed on a shrinking work force. Drucker (1969, p. 300) believes that "we must be able to insure...an unskilled worker that, when his present job becomes obsolete, society will help him to find another job, to acquire the necessary knowledge and skills for it, and to move to it." No doubt, Drucker would also apply this view to the already unemployable. However, the prognosis must be guarded that adults not heretofore experienced in exploiting science and technology bases (or in acquiring

Semanticists probably would find fault with the foregoing citation, particularly on attempting to identify the referents of the different "media" to which McLuhan refers. Such individuals probably would miss what is of value in the unrestrained rhetorician who seeks to sell a vision. For if such sketches are exploitable they surely will capture someone's fancy and thus receive the tidier and more mundane taxonomic treatment that they warrant. A seeming implication of the foregoing view--one we will draw ahead of semantic tidying--is that if the content of any medium is always another medium, then the content of a second medium--being itself a medium--must be a third medium. That is, the view suggests a progression or chain of media, one nested in the next, potentially stretching out to some threshold of resolution (like the old-time illustration on the Nabisco Shredded Wheat box). We return to this implication of McLuhan's view in a later subsection.

Organizational Structures as Media

Conway (1968) shows that structure of the system design organization will affect characteristics of the design that the organization produces. Students of the system design process agree that organizational structure will affect output in various ways. Consonant with such views, it appears reasonable that all organizations whose outputs are complex man-machine system designs addressing significant educational, political, economic, social, or military problems should be viewed as media. Such media are invented to serve two purposes: organizational control and problem amelioration. Whether control in practice is subordinate to problem amelioration when the problem lurks on man's knowledge frontiers is a matter of contention. However, inevitably control is legitimized as subordinate to problem amelioration. Such organizations are multichannel transceivers designed to favor certain types and locuses of communication.

Children--classroom-organized and otherwise--share with organizational personnel (and with more broadly organized citizens operating in larger societal organizations) the possibility that they will experience a tyranny of control whenever conditions do not favor straightforward evaluation of organizational output. The classic situation wherein control gets the better of output occurs when an organization has

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such bases) can be moved into the knowledge sectors in appreciable numbers. Yet the alternatives are sufficiently repelling that attempts to suitably retrain (or rather reeducate) such individuals should be given increasing consideration and support in the years immediately ahead. For the retribalized society of navel contemplators envisioned by McLuhan, if entertainable, lies well beyond the horizon we must reach if the journey--wherever it is going--is to continue.

little competition that could provide alternative performance underlying relative evaluation. The more immediate threat to output functions--particularly when the organization is operating at or near knowledge frontiers--is that evaluation of output necessarily will be predicated on use of ambiguous criteria or criteria not yet perceived to be inapt. Another factor standing in the way of making control subordinate to output is the tendency for ambitious output designs to require time to evaluate; evaluation of necessity then will be infrequently culminated and can be made less frequent still by appeals to "prohibitive" costs of evaluation. Such threats to evaluation face the organizational medium with a grave risk of capture by control advocates and subsequent modification of organizational design to favor greater control at the expense of output functions.

McLuhan expressed two sorts of concern regarding the communication media. The first was to identify characteristics of any medium that cause an intended transmission to be modified. While not entirely compelling, his characterization of television as a cool medium and radio as a hot one illustrates his first concern. The thesis is that some media feature high image resolution--hence, are hot--while others degrade resolution--hence, are cool--and that receptivity in a given culture or subculture is a function of resolution characteristics of the medium. His second concern relates to how media executives can exploit such characteristics of media to serve their own ends--that is, to control an audience. Similar concerns apply to the organizational media, except that such media address both internal and external audiences and afford greater opportunities for redesign consonant with control.[30]

Whether the organization designer seeks to perpetuate an organization by controlling it sufficiently either to permit uncontended claims of progress effectively to substitute for output or to insure that such progress will actually be made, the form that the organizational design takes will be a function of the designer's (or executive's) theory concerning characteristics of a suitable organization. Such a theory can be called a conceptual system. The design, if consonant with the

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[30]Some argue--cf., Galbraith, 1964; Drucker, 1969--that the technostructure or portion of the work force that exploits knowledge systems must be served and that this works against central control, since the technostructure of any postindustrial organization houses an appreciable portion of its work force. Where outputs can be evaluated straightforwardly, it appears tenable that the technostructure will be sufficiently armed to act as a counterweight to central control in any tyrannical sense. However, where outputs cannot be evaluated straightforwardly, it becomes difficult to pierce the logic of technostructure hegemony.

conceptual system--which an effective design will be--and the organizational medium that results from faithful application of the design then will exemplarize the conceptual system.[31] The conceptual system or theory underlying design and medium typically will be sufficiently general that other exemplars of it could be deduced and constructed. Where this is so, the system designer is privileged to deduce and compare alternative exemplarizations that are consonant with his base (whether contentious or verified), somewhat in the manner that the circuit designer mickey-mouses beyond his base in electronic theory.

This subsection sketches the ambivalent posture--of warm regard alternating with open hostility--that knowledge-based organizations addressing problems of great moment lying at or near the frontiers of knowledge warrant from system designers and the larger society. It also conveys the useful implication that the concept of medium need not be a narrowly constrained one having applicability to such mere devices as unstructured potter's clay, an Olson checkerboard, or that recently discovered marvel of the technology of the 1930s, television.[32]

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[31]Unlike the design for a television set or network--but perhaps not unlike that for a television organization--the organizational design faces a continuing threat of misapplication based on inexactitude of personnel science and technology. A well-executed organizational design will specify personnel functions. Only if actual personnel match these design specifications will the medium represent a faithful application of the design. The same considerations apply with regard to instructional system designs. Here, too, faithful design application presumes that system personnel specifications are met. The romantic view of some instructional system designers that personnel can be designed out of the system constitutes an understandable wish-fulfillment tendency in face of the difficulty of implementing man-machine designs with men in them. That is why instructional system design in time must permeate the curricular reaches of the teacher's college.

[32]A medium (or medium-concept pair) not typically in the purview of the classroom is the human as personality. S often learns the nature of real-live people at the source, for there are any number of individuals with whom he must find accommodation. Such learning typically is the product of unguided OJT. All individuals exemplarize the human reactor (a conceptual system), but do so while showing unique tendencies reflecting the personality or personal signature of the individual. The effect of any such individual is to modify certain of S's schemas or to cause them to become personally referenced. Individuals as media, perhaps even more so than organizations as media, warrant comprehensive study and consequent instructional treatments that provide "civil defense against media fallout."

Medium-Concept Pairs in Instructional Systems

The public relations breed has carried forward from antiquity the proposition that "Its not what you say, but how you say it." A serious treatment of McLuhan's view that "The medium is the message" requires an admission that McLuhan did not mean simply to elevate a public relations principle to lettered respectability. Rather, he apparently intended to assert that the electronic media are more than simple additions to an already large inventory of media. Instead, in his view, they are multipliers of the scale of communication sufficiently profound to impose a new era--that of an imploding universe or globe--on mankind, a view shared by others--cf., Brzezinski (1970). While the view appears to fit the facts, it is for the most part irrelevant here. For present purposes, the rhetoric is more attractive than its author's intent.

The proposition that "The medium is the message" appears to have both figurative and literal senses. We wish to transform the proposition into one that is entirely literal. A first step toward such "rehabilitation" is to substitute the indefinite for the definite article. This yields the proposition that "A medium is a message." A second step is to substitute query for declarative form, thus inviting analysis. The result is "What medium is what message?"

The message concept is a technical one in communication theory. Consonant with polemic privilege, we avoid any constraints on use of the concept that might emanate from that discipline through use of the convention that a message is an exemplar of some conceptual system. A medium is a message because every medium references to some conceptual system and is an exemplar of that system. Thus, "A medium is a message" will be taken as equivalent to "A medium is an exemplar."

The media that most concerned McLuhan are those that interface with S--the so-called delivery systems or communicating machines. Any such medium herein is denoted $Medium_1$. One example of $Medium_1$ is a radio. A second is the "voice box" or transmission system and the auditory or reception system of a baboon or human--the transceiver mechanism apart from the options that may be available to a user who applies the mechanism during communication. When later, we speak of E as $Medium_1$, the intent is to refer just to the transceiver component of E.

Radios, transceivers, televisions, telegraphs, telephones, newspapers, and books all reference to their own particular conceptual systems. Both mechanical and human transceivers obey certain physical laws--whether the same ones is not important here. Such a system of laws is denoted here a conceptual system. Any $Medium_1$ exemplarizes such a system, denoted Conceptual $System_1$. To the extent that $Medium_1$ is taken as given and not central to an educational objective, its special characteristics affecting transmission risk being overlooked--McLuhan's central theme.

What goes into a $Medium_1$ machine will not be what comes out of it. The system designer whose communication model takes this into account then has the choice between compensating for this fact by operating on machine input or shopping for or devising a different $Medium_1$ (or some combination of the two).

What comes out of $Medium_1$, particularly in educational settings, is not necessarily what S receives. Fidelity of reception can be optimized in two ways. One road to improved fidelity involves S's manipulation of handles on $Medium_1$. As with television controls, suitable manipulation to improve fidelity presupposes prior acquisition of act specifications referencing to such handles. Alternatively or complementarily, one may manipulate handles on S. This presumes that the nature of these handles is understood, so that the instructional system designer can grab S (by reaching through $Medium_1$) consonant with pertinent information on species and culture characteristics and perhaps regarding the prior experience of S. Both the scientific base for isolating handles on S and the implications of this base for real-time evaluation of S and contingent instructional responses presently are sketchy. Such matters resolved, then the system designer would ensure that input into $Medium_1$ contains those elements that marshall S's attention.

Depending on its characteristics, much or all of the rest of the instructional system will go into, be carried by, or act as the content of $Medium_1$. Conceptual $System_1$, which $Medium_1$ exemplarizes, lies outside this system, although the system design might find it necessary to refer to the system when settling upon $Medium_1$ as the particular exemplarization to be employed.[33]

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[33]McLuhan treats television as a cool medium owing to its relatively poor image resolution in the commercial setting and radio as a hot medium due to its high resolution character. However, the conceptual system underlying radios surely suggests how one could lower its signal fidelity to ensure the telephonic level that McLuhan calls cool. It is probably also true that technology provides the basis for increasing scan line density of television tubes and associated actions that would bring image resolution more in line with the film level that McLuhan calls hot, particularly in the context of closed-circuit educational television. Hence, hot electronic media can be cooled and, perhaps somewhat less easily, cool ones can be heated up. If such compensations for undesirable characteristics of a shelf-item $Medium_1$ are desired, then Conceptual $System_1$ becomes of interest.

Medium$_1$ at best is only the most proximal element of the instructional system. The instructional system will feature one or more medium-concept pairs a consideration of which may underlie selection of Medium$_1$. One such pair is illustrated by Olson's square checkerboard referenced to the plane diagonality concept--Medium$_2$ referenced to Conceptual System$_2$.[34] Another is a performance specification conditional on Medium$_2$ and referenced to a language system--Medium$_3$ referenced to Conceptual System$_3$.

Let Medium$_1$ be E as transceiver. While E's transmission characteristic will be the only one discussed here, his ability to receive transmissions--particularly queries--from S is a desirable one in many instructional situations. Silence on the reception component of the transceiver only reflects a desire to hold down expository complexity.[35]

Let instructional intent be to teach one or more performatory acts referencing to the conceptual system for plane diagonality. Medium$_1$ is used to communicate to S a suitably-encoded message--Medium$_3$--that specifies the performance that S is to acquire with respect to Medium$_2$. Medium$_3$ is an exemplar of an appropriate system for encoding messages--e.g., spoken English, denoted Conceptual System$_3$. However, Medium$_3$ cannot be just any message that could be formed on Conceptual System$_3$, but rather must specify performance that is conditional upon an educational objective referencing to Medium$_2$. Hence, Medium$_3$ is subset rather than message notation, signifying the subset of exemplars of Conceptual System$_3$, each of whose members is conditional upon educational intent regarding Medium$_2$ (and Conceptual System$_2$).

As the Performance Factors section of Part III indicates, desired performance is described when a variety of act and criterion specification parameters are given values. The particular set of values selected defines a performance requirement that any member of the subset Medium$_3$ will describe. The ith member of the subset, denoted Medium$_{3i}$, is an exemplar of Conceptual System$_3$ conditional on instructional intent regarding Medium$_2$ (and Conceptual System$_2$).

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[34]Medium$_2$ need not appear as a physical object falling outside Medium$_1$. Where Medium$_1$ is a CRT that is markable using a light pencil, a Medium$_2$ of the square checkerboard type can be represented on Medium$_1$. Whether Medium$_2$--itself a transceiver in that it "presents" and "receives" information--exists apart from Medium$_1$ or is represented on Medium$_1$ depends on Medium$_1$ characteristics.

[35]Conceptual systems of instruction are portions of larger systems. An exemplar of any such system fails to exhaust the domain of exemplars. Hence, the possibilities for generalizing a given restricted instructional system are great. To handle instructional system generalization (or transfer) would require that one employ a complex system of system-term subscription. Use of such a system of notation would not serve present expository purposes and so is avoided.

Setting aside transfer and generalization considerations, acquisition of the cognitive structure of an act of interest necessitates that _S_'s schema reflect or incorporate $Medium_{3i}$. When this condition is met, then the instructional effect Act_{2i} will be obtained. Assuming here that Act_{2i} reflects criterion performance--which it will if the psychomotor requirement is trivial or adequately treated by $Medium_{3i}$--then the preconditions to appearance of such performance are that $Medium_{3i}$ be communicated over $Medium_1$ and that $Medium_{3i}$ tie $Medium_2$ to the instructional system. One may build into $Medium_{3i}$ the whole of the relevant pedagogy or may define a Conceptual $System_4$, a pedagogy, whose exemplar $Medium_{4i}$ is conditional on instructional intent; $Medium_{3i}$ then will be conditional on $Medium_{4i}$. Similarly, the system designer's compensations for undesirable effects of $Medium_1$ can be viewed as a medium-concept pair whose exemplar is conditional on $Medium_1$; $Medium_{3i}$ then will be conditional on the compensatory exemplar.

McLuhan, and Olson to a lesser extent, tends to label as media entities that might better be regarded as either conceptual systems or medium-concept pairs. Particularly in education, where one is interested in increasing the breadth of concepts originally defined on narrow domains, the concept of the medium-concept pair should prove useful to construction of effective instructional systems.

PART IV: AFFECTING THE KNOWLEDGE BASE FOR ISD

Much wistful ink has been devoted to securing an apt scientific and technical knowledge base for education. Organizational crusades to establish educational and training technologies are not infrequent. In recent years--as the flow of Federal funds to educational R&D has increased--the problem of an inadequate base has pierced to the very desks of the entrepreneurs of the liberal arts. And yet as NASA reaches for the stars, educators continue merely to reach for a larger share of the GNP.

Educational disaster now is a possibility because the industry's chronic underproductivity at last is producing a revenue crisis. In face of an emerging revenue ceiling, the industry is gripped by a cost-push inflation resulting from increasing costs of unproductive labor. However, the times require more than that the industry live within finite but considerable means. The dynamics of postindustrial existence will require that it do so while progressively broadening the individual's knowledge base. The only solution apparent is to raise the productivity of labor.

Some believe--cf., Goodlad & Klein (1970)--that a first increment to increasing educational productivity can be obtained with little augmentation of the knowledge base. That is, some of the needed educational innovations are shelf items which, although seldom requisitioned in the past, have been around for a long while. The implication is that securing a first increment to progress is primarily a matter of political action. Thus, one might argue that many already know how to devise more apt ways to calibrate instruction to the child's prior achievements and to evaluate instructional effects. Doing the first would constrain instruction neither to speak up to nor down to the child and so cease to waste much of his time. Doing the second would transfer the burden of accountability from child to instructor and would banish the illogical practice of grading the child for prior achievements or rate of acquisition; in consequence, every child would take from the instructional situation concrete evidence of accomplishment, whereas now many take from the situation a sense of failure that is warranted although misplaced.

There is something to be said for the view that implementation of such innovative ideas on a national scale would yield a first increment to improved productivity. Perhaps elementary-level education could be thoroughly redesigned and redeveloped consonant with existing innovative ideas for something like $25 million, which would purchase 1,000 professional man years of labor with suitable support. In 1969, there were approximately 24 million children in the kindergarten through sixth grades (Barr & Foster, 1970, Table 6). If the redesigned K-6 instruction could be placed in the nation's classrooms at a cost of $50 per child or $1,500 per classroom--a one-time cost--then implementation would cost approximately $1.2 billion. Costs of such a "first-round" program would be justified primarily by consequent appreciable improvement in return; some portion of these costs might be recaptured in time through a shift in the instructional man-machine mix in consequence of redesign.

Some such work now is in progress in educational R&D laboratories, although such work is fragmented across diverse objectives and marching to different tunes regarding perceived instructional system design tools. The political mandate underlying the required nationally oriented, coordinated effort that such a program implies has not yet taken unambiguous, compelling form. While some of the work goes beyond a first round, due to fragmentation it sums to less than a first-round program.

A first-round program should avoid dealing with problems falling beyond current knowledge horizons. It should not seek extensively to develop the machine-delivery systems that current technology suggests it could if enough time and energy were given to the problem in light of developments to date in other fields--for that would belong to a second round. Much of the apt scope-constraining framework could be anticipated and reflected in program objectives. Other constraints would only be identified by vigilant managers in the course of program execution. Suitably constrained, the K-6 instructional program might be redesigned in two or three years.

One valuable side effect of such a program would be identification of areas of ignorance, domains of the knowledge base requiring priority expansion to serve the needs of a "second-round" program and other domains apparently falling so far beyond the existing knowledge base as to justify consideration only in a long-term framework. It appears tenable that the first-round program would confirm undue ignorance concerning handles on S and allied facets of an efficient pedagogy, on the properly-nonautomatable functions of teachers in our time, and on the form of knowledge-system acquisition that is most compatible with human information processing capabilities. Granting that an effective first-round program can be executed whenever the political mandate for it emerges, such a program itself would reveal reaches of ignorance that must be overcome if education is to be as productive as postindustrial life will require. The time has come to systematically operate on the defective knowledge base from which the instructional system designer must draw.

Taking the scientific and technical community as currently organized, it appears much more possible appreciably to influence expansion of the knowledge base when the requirement is clearly drawn and rather modest than when it is broader or more general. Another way to put this is that one can hope appreciably to influence shorter-term requirements for rather-specific information but must be content only to offer advice concerning more general longer-term requirements. Below we examine strategems appropriate to the two timeframes.[36]

AFFECTING THE BASE IN THE SHORT TERM

Explicating the ISD Process

An important component of the knowledge base underlying the design of instructional systems whose implementation will ensure advances in educational productivity is information concerning the ISD process itself. Facets of the process are beginning to receive the attention they warrant--cf., Hively, Patterson, & Page (1968), Kriewall (1969), and Besel (1971), who deal with the vexing problem of creating an apt rationale for instructional evaluation, and Gagne (1970), who deals with skill structures (or proficiency hierarchies). Responses to the overall process-structuring problem are beginning to appear--cf., Schutz (1970), whose orientation to instructional development functions as fundamental to design-development efforts simply signals current immaturity of the design rationale. This paper also is a contribution to the process-structuring literature. All in all, the conclusion appears warranted that an earlier faddist importation of the system design concept into the educational setting is giving way to efforts to accomplish the difficult task of adapting, modifying, and extending the concept to fit the special requirements of the industry.

Perhaps the quickest route to ISD process maturity is through application of a strategem that is entirely administrative in character. Some must be made responsible for maturing process explication. One approach to securing such accountability would be to define ISD process explication as an occupational specialty, to give it staffing levels appropriate to the industry and the work anticipated, and then to secure those whose interest and qualifications are consonant with the expectation of short-term delivery. For such work at present is staffed more like philosophy of science is staffed than as is appropriate to enterprises charged with exploiting technology.

Unworkable Empirical Strategies

A prime requirement underlying improved efficiency of the ISD process is that the quest for apt information be structured sufficiently to check drifts into esoterica and unrealistic attempts to stretch a shrinking

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36For present purposes, short-term addresses first- and second-round programs and extends from the present to 5 or 10 years hence. Long-term lies beyond.

future. Perhaps it requires no defense that unguided efforts to expand the knowledge base, whether theoretical or atheoretical, will typically not pay off in the short term. If that is so, then it becomes necessary to contend with the question concerning the form of useful guidance. Before responding positively to the question, let us consider an illustrative information-collection strategy that apparently is defective.

An atheoretical, but systematic, information-gathering strategy based on representative design considerations has occasionally been recommended since Brunswik (1956) introduced the concept of representative design. However, while variants of a representative design-based information-gathering strategy have been aimed education's way (cf., Siegel & Siegel, 1967)--and even on occasion applied (cf., Light & Smith, 1970)--such an approach does not appear to have caught on. Such schemes, as currently conceived, seem too costly in relation to the potential return--too much inclined to pursue the uncritical "comprehensiveness" that Braybrooke & Lindblom (1963) suggest must defeat policy realignments in the short term. Of course, this does not argue that the concept of representative design itself is faulty, but only that useful ways to exploit it in the educational setting have not yet been devised.

Many of the distinctions drawn in Part III address the question of how reasonably to characterize educational situations. It appears beyond questioning that findings having short-term utility are going to have to characterize educational situations in useful ways. However, the economics of empiricism necessitates that those factors taken to be representative of educational situates and transactions therein be selected with some care. For the unchecked allegation of factors or boundary conditions of potential significance is a costly and largely counterproductive game that can quickly degenerate into one's own private formalism. On the one hand, the empiricist will weary soon of controlling or investigating factors that turn out to carry no weight. On the other, a gaudy taxonomization implies an overall experimental design that all the earth's resources could not fill. Hence, the system designer who represents the educational situation at a level of detail that considerably outstrips his data base will influence short-term empirical activity no more profoundly than the alternative devastating laissez faire climate that now prevails.

The fanciful pursuit of an ultimate idealism that leaves the educational situation behind will not be productive in the short term (if ever). Neither will an unbridled search for fine distinctions at a time when it is not certain that all of the gross ones are worth considering. A moderate representation of educational milieu and objectives, partially grounded in existing knowledge, seems a proper constraining framework for securing apt short-term increments to the knowledge base. For many reasons, the classroom cannot often be used as a laboratory. Where this is so, the laboratory situation should be such as to assure that the journey of findings across the gap will be a modest one. One way to ensure this is by having the laboratory highlight the more germane characteristics of educational situations.[37]

System Designer as a Guiding Force

Let us assume that the instructional system designer, suitably armed with ISD process-structuring information, is required to design instruction that causes S to acquire some concept. Given this charge, the system designer typically will face a variety of problems stemming from an inadequate knowledge base, e.g., a) breadth of the concept's generalization domain is unspecified, posing problems for instructional path formulation and for evaluation of instructional effectiveness; b) the progression of component skills underlying formation of the criterion concept is not obvious, hindering formulation of an effective instructional path; c) forms and magnitudes of exemplarization underlying acquisition of component conceptual skills and fineness of component skills specification underlying acquisition of the criterion concept are unevaluated, hindering formulation of a theoretically-efficient pedagogical treatment as an overlay on the instructional path.

Required to design instruction that causes children to acquire the concept, different designers today would specify, unravel, and refine such problems as are inventoried above somewhat differently. However, it appears tenable that their different views on the matter would overlay a larger, shared problem structure than would be the case for those simply charged with increasing knowledge concerning concept formation. Heterogeneity of viewpoint in the latter group well might be of service to longer-term augmentation of the knowledge base. For shorter term purposes, designer views based on shared reality probably should prevail as a guiding force.

While a designer view of problem structure should be consonant with existing apt information, typically it will forge beyond existing knowledge because that will be insufficient. Hence, the designer view of problem structure will tend to be theoretical or contentious. The work of the system designer, then, may be viewed first of all as the production of a system of contentions referencing to one or more educational objectives. While he may have to act on these contentions ahead of the searches that they invite, the system of contentions itself remains available for exploitation as guidance to those charged with providing short-term increments to the knowledge base. Such contentions need not prove correct in the short term. It will prove sufficient if they do no more than stimulate the quest for apt knowledge by inventorying problems to be overcome. Thus, an important function of the instructional system designer could be to stimulate production of relevant information.

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[37] An earlier paper--Follettie (1970)--attempted to deal with this problem more definitively. Such efforts tend to have a high rate of perishability.

The Alternative to Designer Stimulation of the Base

It is generally assumed that the social-behavior sciences should be a prime source of information relevant to the design or effective-efficient instructional systems. Yet the fit is poor between the information that such sciences provide and the information that instructional system designers require. Large segments of "the literature" reveal--as Simon (1970) has characterized the matter--many interesting findings in search of a problem. Education is largely orphaned from the contemporary social-behavior sciences--except perhaps at grant-giving time--because its problems are not theirs. For their problems address the ages, whereas education is more mortally constrained.

Yet Price & Bass (1969) view unrestrained cooperative action as the answer to the problem of underproduction of apt information. In their view, the way to stimulate production of apt information is by encouraging development of an interactive servomechanistic process involving scientists and technologists. It appears tenable that such a process will prove apt to longer-term stimulation. However, when referenced to short-term educational needs, the process--if operative--has been unproductive. Perhaps augmentation of the knowledge base in the short term will continue to falter until given a more pointed directional character. That is, in the short term, perhaps there is no alternative to instructional system designer stimulation of base expansion.

Mechanics of Designer Stimulation of the Base

The system envisioned by Price & Bass creates difficult work for those who, without portfolio, must mediate between such poorly organized communities as education and science. While their system appears apt when the time frame is long-term, its probable short-term efficiency is low. Hence, such gatekeepers we would thank and excuse from the role of stimulating exploitable knowledge in the short term.

A more artless approach to short-term stimulation of an apt knowledge base might be called friendly persuasion or free enterprise (depending on one's point of view). This scheme would be economic democracy in action, in that it would scarcely inquire into mere raiments of the knowledge-generating entrepreneur. The coercive practice of contracting (almost) exclusively with academic and allied craft unions would be abandoned, thus freeing the membership from those stark moral crises that "work having applications" sometimes precipitate.

The burden of securing an apt knowledge base for education in the short term would be thrown to the instructional system designer--or to a guild or association that reflects the integrated requirements of the ISD membership. While such an approach might prove novel to education and to the educational component of government, that essentially is how Department of Defense lets the research component of its technical R&D.

Most attempts to contract research fail because the contractee has most of the money and therefore buys most of the brains, leaving the contractor neither physically nor intellectually in a position to monitor the research well. One imagines that contractors would get much more for their money if ten cents of every contract dollar were allotted to the contractor for purposes of monitoring the contract. Any contractor operating within the scheme sketched above would need have the wherewithall to do the monitoring job. Otherwise, the positive effects of capitalizing on the ISD membership's problem-apprehending expertise would be erased by the license to steal that a poorly monitored contract represents.

LONGER-TERM ADVICE

The Price & Bass gatekeeper possibly is the only long-term agent who could be enlisted for accommodating educators and scientists to each other. Yet in any age only a few men will appear who have a good grasp of the situation on both sides of the fence. The stimulation group should be augmented through the breeding of such men. That is, a knowledge base should be constructed that could be used either to advise aspirants to gatekeepership or, more directly, to advise all scientists and educators whose cooperative efforts would serve the longer-term needs of education. This section deals with the "advice to scientists" portion of such a guide. Contents are preliminary and tone prepublic relations.

The General Theory Hang-Up

Whether due to a postindustrial spirit or less-exquisite motivations, the academic community is awakening to the longer-term knowledge needs of education. Bruner's (1964) distinction between learning and instructional systems is illustrative of the trend. In an ISD process context, Bruner's distinction simply differentiates the pedagogical component of a design activity from the rest of the activity. However, in an academic or scientific context, the distinction probably is meant to differentiate between pure theory and applicatory extensions.

The academic's historical orientation has been to the pure or general theory. Today, we know that the concept of general theory is relative to the times. A century ago, Newtonian physics was considered a general theory of physics. However, in the intervening years, Newtonian physics has drifted progressively away from a position at the pinnacle of physical organization; it remains sound in its domain, but increasingly special in the sense that either its own domain has shrunk or the universe to which it belongs has expanded. Today it is considered ironic that those who rejected Ptolemaic astronomy as transparent human conceit should have been willing to enshrine Newtonian physics as propaedeutic to all else. In fields whose leading minds have known the embarrassment of being publicly exposed as provincial, there is a commendable tendency to treat the concept of general theory as one that is relative to man's experiences to date. Would that the lesson were more widely learned.

We distinguish today between a subsuming Newtonian physics and its special branches--e.g., aerodynamics. Perhaps one day it will be found useful to distinguish between a more general pedagogical theory and its special branches. Meanwhile, the problem inherent in educators taking their cues concerning pedagogical theory from credentialled learning theorists hangs on a predisposition among such theorists to enshrine the concept of general theory during their quests for theory. The principle lesson that a history of physics seems to have revealed to these grail-searchers is that Galileo "idealized" space for theoretical purposes.

The self-consciously named "empirical laws" of the past--e.g., the Fechner-Weber Law, Ricco's Law, Bunson-Roscoe Law--have not proved to be the components of broader theoretical formulations that many once hoped that such laws would be. It is not compelling that the alternative is to attempt to invent an ultimate generality that forges relentlessly beyond the limits of all experience to date. The concern of psychophysics with an "ideal situation" led to findings which have been carefully surveyed and summarized many times by industrial scientists committed to devising man-machine systems consonant with man's sensory and allied capabilities. Such findings have been found largely useless, due to overidealization of the experimental situation.

Alas, the wrong lessons were drawn from the Galilean experience. For Galileo's ideal space was more a theoretical outcome than an empirical realization. In his day, it was much less possible to rig the empirical situation to defy earthly nature. It is one thing to postulate an ideal state through induction based on findings and another to postulate it based on a rich inner life. Too many of the idealizations of contemporary learning theory seem the products of the latter inspirational routine.

More general theories of pedagogy, while desirable, probably will prove more difficult to devise than more special theories. When obtained, they probably will not prove immediately useful because they first will have to be related to the various applicatory domains by means of special elaborations. The potential advantage to education of an orientation to special-theory production is that special theories probably will arrive sooner and prove less difficult to exploit than more general theories. What is needed are instructional learning theories--or pedagogical theories--reflecting the play of factors that are central to instruction.

Toward Instructional Learning Theories

Those outside the behaviorist camp (e.g., Kohler, Leeper) found most learning theories formulated during the 1930's and 1940's (e.g., those of Hull and Skinner) too mechanistic and narrow when judged against social utility. Many who have since entered the learning-theoretic domain (Bush & Mosteller (1955), Bush & Estes (1959), Atkinson, Bower, & Crothers (1965)) have considered earlier theories too broad to invite systematization and testing consonant with the resources at hand and hence have formulated "miniature" theories or models which sharply curtail theoretical scope in the service of increased predictive precision and power. Both the earlier and later quarrels with learning theories of the 1930's and 1940's had substantive content--cf., Leeper (1944), Estes et al., (1954). However, in retrospect, it appears that the major quarrel of all critics with these theories was primarily pragmatic, referencing to theoretical scope. Earlier critics were concerned with obtaining sufficiently broad scope to warrant an aspiration favorably to affect learning efficiency through theory application to learning situations of social concern. Later critics were concerned with making psychology scientifically respectable in absence of the sort of resource levels available to the hard sciences. Our quarrel with all learning theories down to the present also is primarily pragmatic, as apparently is Olson's.

Olson (1970) exemplarizes a principle of theoretical orientation that probably must characterize any theory that favorably affects education--that of wedding perception and the performatory act. While his view that instructional theories should bridge from extant general learning theories to the classroom may miss the mark, suitably reinterpreted as a pragmatic call for formulations whose scopes are consonant with instructional exploitation, the view appears compelling.

In a sense, Olson's work might be interpreted as groping for the answer to the pragmatic question concerning what scope a learning theory must have before it can aspire to favorably affect the engineering of instruction. Many will choose to stand aside from such a prescription on grounds that, if one cannot have breadth and power together, then power is preferable. Hopefully, some will rise to the challenge, because current experience warrants the view that formulations lacking breadth will not prove apt to the educational enterprise.[38]

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[38]Breadth-power combinations that are intermediate to the extremes of a comprehensive instructional learning theory and a sharply constrained theory have appeared. One that veers toward the comprehensive pole is provided by Quillian (1969). One that is nearer to the restricted pole is reflected in any of the models presented by Groen & Atkinson (1966).

Heretofore, learning theory has addressed measurement-evaluation theory only to the extent that pragmatic objectives have necessitated. Thus, with noteworthy exceptions--e.g., the Cletus Burke-Don Lewis call, during a Midwestern Psychological Association meeting in the late 1950's, to renounce the tyrannical doctrine that the null hypothesis must never be accepted--those identified with learning theory largely have been content to allow the rationale of measurement to be devised by others--e.g., the psychometricians. Measurement threads the fabric of the instructional learning theory that education requires. It is not the psychometrician's fault that the measurement rationale formerly and currently employed by educators and empiricists alike is inapt to assessing the child's progress through instruction. The fault is widespread enough to be shared. The prime culprits appear to be the theorists who have been content to be users rather than formulators of measurement rationales appropriate to learning situations and educators who have bent to the law of least effort. Measurement rationale must be consonant with the work to be done by measurement, rather than the other way around. Whatever its other characteristics, a measurement act must tell us something about the individual child that has teaching-referenced management implications. Measurement should help us to get everyone into the postindustrial era, rather than sitting in judgment concerning who should make the trip.

NOTE ON METHODOLOGY

A number of archaic methodological practices characterize social-behavior science research in all settings. A good place to initiate reform might be in the domain of dependent variable conceptualization. Such notions as error distributions should give way to cost distributions--e.g., in instructional time--when the research classifies as instructional (or of the movement type) as opposed to stative (or of the static type). One reason why educational research teaches us so little is that the investigator asks so little of himself in a teaching capacity. Not lost on Olson, what is truly interesting is why children fail to reach criterion and how they can be brought to criterion. Rather a bore is the fact that one innocuous five-minute instructional treatment is even less statistically promising than a second, itself more usually than not no proper object of enthusiasm.

Olson touches on some of the issues underlying identification of more apt methodologies--e.g., let the child in on the game, at whatever orientative instructional cost is entailed (cf. also Dulany, 1968). A more comprehensive treatment--although one that is perhaps unduly concerned with the applicability of Heisenberg's principle to the molar behavior domain--is provided by Lachenmeyer (1970). Lachenmeyer makes the point--in greater detail and more constructively than Olson--that it is time we stopped pursuing trivia as the price of conforming to parochial views concerning what the empirical game is about.

A research-reform structure is emerging. Hopefully, it will be elaborated and put into use. However, the present pace of change in social-behavior research practices is slow. Perhaps investigators will continue almost immunized to change until learning theories that are more apt to instructional objectives are forthcoming and graduate schools sanctify the new ways consonant with these theories.

CONCLUDING NOTE

In consequence of initial education periodically updated through continuing education, half of the work force soon will classify as post-industrial. The employability of many in the remaining half will be threatened by inability to rise above stereotyped performances appropriate only to an earlier era. Education's political challenge is to raise its productivity; its economic challenge is to raise work force employability by increasing the proportion able to adapt performance to changing markets, products, and industrial processes.

A core education that seeks to graduate only those who are post-industrially employable will not treat such an objective as isomorphic with turning out scientists and mathematical sophisticates. The principal characteristics of a core education addressing future employability will be that it convey the notion of knowledge system qua system, that it place at minimum a modest base of such systems in the individual, and that it exemplarize application (or exploitation) of such systems under representative conditions.

During the early industrial era, education could afford not to delve deeply into economic life excepting in the case of a handful of professions. For most, the educational objectives were to graduate individuals meeting minimal literacy and computational standards consonant with citizenship and to arm these individuals with a common, uncomplex "data-language" on which a variety of specialized industrial training programs--typically of the apprenticeship type--could be predicated. The individual then could expect to spend a lifetime operating a piece of equipment--lathe or soldering iron, pick or plow--under conditions wherein equipment, process, and associated performance would remain relatively constant over a working lifetime.

The "citizenship plus data-language skills" model of education now is gone with the wind. It is a fitting object only for nostalgia for simpler times when educational designs bore the artless stamp of antiquity and the earth stood still or inched along. The essence of the successor model is that it must provide the individual with a good chance for reaching adulthood able to function effectively in economic and other spheres, even though the shape of tomorrow is increasingly obscure. The proposition probably finds consensus that the best hedge against such uncertainty is to optimize the options that today's child brings to tomorrow's world. How to proceed beyond generic unanimity on optimization of options is in appreciable dispute.

I believe that two laissez faire schools of thought on the matter usefully illustrate how not to proceed. The first might be called an unrestricted laissez faire doctrine. This free-market approach--while perhaps appropriate as a counter-action to rigidities of educational bureaucracy--burdens the parent with strategic choices that he typically is underqualified to make and ignores the fact that these choices must be restricted to a set of educational designs all of which themselves may be defective or predicated on irrelevant objectives. The notion of elective subjects possibly is viable at even the lowest reaches of education, for it responds both to the individual as a unique entity and to the vexing problem of elevating the younger child's perception of educational relevance. However, in face of the increasing difficulty of defining educational strategies that optimize options, the role of individual choice in defining educational paths to effective adulthood must be regarded as supplemental, rather than central.

The second such view is that the opacity of tomorrow necessitates that core education be defined on the highest reaches of abstraction of the culture's knowledge base. This view might be called a restricted laissez faire doctrine. It restricts the individual's accountability for educational path selection by providing a departure point. However, the restriction is not great because he is required to negotiate an excessive chasm falling between an all-embracing general theory or knowledge system and the probable realities of germane facets of tomorrow. Magnitude of the required leap to adult roles considered, this educational doctrine, although perhaps closing out no options, appreciably develops no options either. While the view of "everyone a math-science-logic sophisticate" might one day become appropriate to education, it appears not attuned to the tomorrow that education must address today.

Casual study of any committed visceral advocate of the view that one must keep one's options open will reveal the view to be hopelessly abstract in lay hands. Armed with Knowledge System X, one has many deducible performance options in the domain of X. One's options can be expanded either by expanding the possible applications of X that have utility or by expanding the knowledge system domain--e.g., to include Knowledge System Y. The views that options may be defined on unspecified domains and that one can afford to define them exclusive of the probable conditions under which they will be exercised are erroneous. One cannot meaningfully provide the individual with options without providing him with specified knowledge system schemas. Moreover, any attempt to provide him with all possible options is both educational and economic nonsense. The options that an instructional system designer builds into instruction will only be a specifiable subset of all possible options.

Defensible views concerning the sorts of options that contemporary education should seek to place in the individual will stem from models of tomorrow. Construction of such models falls outside the competence of the system designer. His role is to understand such models and, in consequence, to identify uncertainties that the models project (and perhaps the more incredible model features, which also might be interpreted as uncertainties). Thus, designs for postindustrial education will be predicated on future-referenced economic and allied planning. One could wish that such planning was more advanced.

Against a current tendency for subcultural differences to be defined on racial, ethnic, and other demographic and social factors, one perceives a counter-tendency for the older regional cultures to give way to a national culture. Those who design education increasingly will consider a national culture on which tomorrow's economy will be defined. Under what auspices will such work be done?

The coercive-control implications of an education defined at the highest level of government thus far--properly--has dissuaded society from an exclusive statutory centralization of the educational process in this country. The current situation featuring a plurality of policy bodies presiding over the nation's education need not stand in the way of a nationally oriented set of educational designs if only a basis can be provided for securing a more-rationale climate surrounding deliberations of such bodies. No doubt, the industry's leading "firms"--the State Departments of Education and U.S. Office of Education--on occasion perform with less than optimal rationality and, concerning a few issues, chronically so. Whether one will be rational if informed cannot be said with assurance. Ignorant, one really has no viable options to performing irrationally, whatever the intent. Hence, there is a basis for believing that rationality of the educational response at policy levels will improve as policy-level options become more clearly drawn and anchored--a task whose execution should fall appreciably to practitioners of an instructional system design technology. Given the knowledge base underlying rational policymaking, the plurality of policy bodies might not stand in the way of national designs for education. The tenability of this proposition is supported by current policy practices, since there is much already that is common to education across the nations fifteen to twenty thousand school districts. A uniform core education based on persuasion on evidence appears not precluded by the properly defensive posture of competing firms in the industry. When these firms tap a common technology--as do General Motors, Ford, Chrysler, and American Motors--then we can expect to see the different designs for education having much in common while not foreclosing on variant facets that serve either the local situation or the superior vision of certain of the firms.

Whatever base system designers might agree to exploit, the base will not rule out alternative educational designs. Prudence probably compels that more promising design alternatives be pursued in parallel--whether to completion or to some earlier point wherein one of the alternatives shows itself clearly superior. Thus, we need not close out on a "one true level of abstraction" falling between repetitive rote skills and ultimate abstractions of the current knowledge base. Nor need we close out on clearly alternative pedagogies that are consonant with the base, nor on certain other alternatives referencing to individual differences or functions of the postindustrial teacher. Industry wide, perhaps we could afford to pursue something on the order of 2^3 or 2^4 such alternative educational design strategies addressing what earlier was called a second-round timeframe. (A first-round effort would purge education of some of its counterproductive traditionalisms.)

That the instructional system designer should be familiar with current curricular practices and recent curricular trends in the schools seems reasonable. While the schools are inefficient and often technically ineffective, they tend to reflect a political astuteness regarding winds of change that the articulate and analytic perceive only after undue lag. The schools tend to reflect the society's perceptions of relevance. Much of the change in the schools in recent years has been a response to changed perceptions of relevance originating outside the schools. It is defensible that the schools have been at best half-fast in responding to the postindustrial challenge. However, in light of their tendencies to knowledge-system reference instruction and to encourage the child to judge the culture in broader terms than economic profit and loss, the notion that the schools have been standing still is one that only a demagogue could feign to entertain seriously.

Practitioners of the instructional system design technology--whether in a contractual or more direct relationship--will be subordinate to policy bodies that are de jure accountable for appreciably improving productivity of the education industry while increasing the "half-life" of individual employability. Operating within such a system, the practitioner will design educational systems that are consonant with informed views of the structure of tomorrow. He will need resist the view that core education can only be made consonant with needs of the postindustrial society through acquiescence to one or another form of laissez-faire doctrine. He should be willing to entertain a limited number of alternative approaches that are consonant with the existing knowledge base. The exhortatory spirit of this paper notwithstanding, desirably he would avoid narrow doctrinal views not based on evidence.

While de jure accountability always resides with an executive or policymaker, de facto accountability inevitably gravitates to a subordinate level, where men may be discharged or organizations disbanded for failing to meet the executive's need to be de jure accountable. De facto accountability for educational design will not be lightly surrendered to the instructional system designer whose technology is preliminarily sketched in the body of this paper. This is only proper, since the technology is far from sufficiently structured and validated to warrant the exercise of such responsibility. The immediate problem, then, is to secure the necessary support for those who will bring the technology to levels of fruition that are consonant with first- and second-round efforts. For only then will it become possible to describe instructional system design technology essentially noncontentiously on evidence. The positive task of building the technology now warrants serious systematic consideration.

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