PLANNING AND META PLANNING

1959

D-6555
7/8/59
Planning & Meta-Planning
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Things are in the saddle, and ride men.

— Emerson

* * *

Man has made himself a tool of his tools.

— Thoreau

* * *

History records more frequent and more spectacular instances of the triumph of imbecile institutions over life and culture than of peoples who have by force of instinctive insight saved themselves alive out of a desperately precarious institutional situation, such, for instance, as now faces the people of Christendom.

— Thorstein Veblen

* * *

Like a hypochondriac who is so absorbed in the processes of his own digestion that he goes to his grave before he has begun to live, industrialized communities neglect the very objects for which it is worth while to acquire riches in their feverish preoccupation with the means by which riches can be acquired.

— R. H. Tawney

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THE LAND USE CONTROL CENTER:

A SYSTEMS APPROACH TO THE PLANNER'S TASK

PART I: ANALYSIS

Introduction: The Problem and Its Importance

The planner as a manager of urban resources. This study begins with the premise that it is both fruitful and eminently desirable to explore some of the implications of viewing the city and regional planner as a manager of urban resources. Taking such a view focuses attention upon aspects of the planner's task and role which are often neglected in the more usual discussions centering around the functions of the "master plan", zoning procedures, and so on. For example, we are immediately led to consider problems of an organizational nature; or problems centering around the requirements for successful accomplishment of the planner's task; or problems having to do with measuring the effectiveness of the planner's performance; or problems which are connected with the planner's need for--and dependence upon--all kinds of information. This viewpoint, then, will be implicit throughout the remainder of this study.

An essential preliminary question: why planning? Before we can direct our attention to the specific subject of this paper, however, we must deal with the fundamental question, why planning? This question, in turn, may be interpreted by the two interrelated questions: can we do without planning entirely? and, are there any viable alternatives to planning? If the answers to either or both of these latter questions is yes, then obviously we can have no very compelling answer to the fundamental question. However, we hope to show that neither of these questions can be answered in the affirmative.

The first question--can we do without planning entirely--raises the specter of the "exploding metropolis" and all its attendent ills. The second question--are there any viable alternatives to planning--raises the hoary doctrine of the economist that "in a free market, land will tend to be developed to its highest and best use". Let us look at these questions more closely, then.

The exploding metropolis. To bemoan the fate of our cities and bewail their impact on our countryside has become so fashionable that Fortune magazine has devoted a series of articles to the subject (later turned into a book bearing the ominous title, *The Exploding Metropolis*[1]), while Life magazine printed an ardent plea to "save our countryside" which was based upon these articles. That a problem exists, then, seems to be fairly well recognized; that planning is the answer to this problem is primarily a matter of one's point of view--plus faith. This brings us to the second of our related questions, the economists' assertion that self-interest operating in a free market is an adequate answer to the troubles that beset the city. Since agreement about the existence of a problem is widespread, while agreement that planning is the best answer to the problem is not, we shall turn now to a critical examination of the economists' assertion.

The economists' view. The argument of the economist is still best expressed by Adam Smith himself, who said:

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[1] The Editors of Fortune, *The Exploding Metropolis* (Garden City, New York: Doubleday and Company, Doubleday Anchor Books, 1958).

> Every individual is continually exerting himself to find out the most advantageous employment for whatever capital he can command. It is his own advantage, and not that of the society, which he has in view. But the study of his own advantage naturally, or rather necessarily, leads him to prefer that employment which is most advantageous to the society...
>
> By directing that industry in such a manner as its produce may be of the greatest value, he intends only his own gain; and he is in this, as in many other cases, led by an invisible hand to promote an end which was no part of his intention. Nor is it always the worse for society that it was no part of it. By pursuing his own interest he frequently promotes that of the society more effectually than when he really intends to promote it.[2]

In terms of urban land economics, this has come to take the form of the doctrine that, "in a free market, land tends to be developed to its highest and best use". If these assertions are true, then the planner becomes a stumbling block to the efficient workings of the real estate market, and therefore an obstacle to the beneficient functioning of society. Can these assertions be true? We think not.

We have critically examined the "highest and best use" doctrine elsewhere[3]; here we shall simply summarize that analysis and its conclusions. First, the analysis attempted to operationally define the assertion; that is, to carry out the testing of predictions implicit in the assertion. As a consequence, it was concluded that the assertion is probably meaningless, or if not meaningless, then neither true nor valid. In order to better understand this conclusion, one aspect of the analysis, stemming from an insight provided by game theory,

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[2] Adam Smith, Wealth of Nations (Chicago: Encyclopedia Britannica, 1952), Book IV, Chapter 2, pp. 193-194.

[3] Harry F. W. Perk, "Aristotle, Ptolemy, and Urban Land Economics", unpublished manuscript prepared for Dr. Leo Grebler, UCLA Graduate School of Business Administration, April, 1959.

bears repeating here.

An insight from game theory. Consider the "Prisoner's Dilemma", which may be represented by the following game matrix in normal form:

$$\begin{array}{ccc} & & B \\ & & \begin{array}{cc} b_1 & b_2 \end{array} \\ A & \begin{array}{c} a_1 \\ a_2 \end{array} & \left[\begin{array}{cc} (9,\ 9) & (-10,\ 10) \\ (10,\ -10) & (-9,\ -9) \end{array}\right] \end{array}$$

The rows of the matrix are the first player's strategy choices; the columns are the second player's. The entries are the payoffs to the players respectively (e.g., if player A chooses his a_2 when player B chooses his b_1, then A gets 10 while B "gets" -10). What happens when each—perfectly rational—player seeks to maximize his own gain?

The players might analyze the situation as follows: player A says to himself, "if B chooses his b_1, then I should choose my a_2, since I'll get 10, which is better than the 9 I would get if I chose my a_1; now if B chooses his b_2, then I should still choose my a_2, since a -9 is better than—at least, not as bad as—the -10 I would suffer if I chose my a_1". Thus player A decides to choose his second strategy no matter what player B decides to do. However, by a similar argument, player B views his possible choices and their respective payoffs and also decides that the best he can do for himself is to choose his second strategy, b_2.

But note what happens to these "rational" players each pursuing his own self-interest: their choices, a_2, b_2, intersect with a payoff to each of -9! And yet they could have obtained a mutual payoff of plus 9 if they could have agreed to cooperate by each choosing his first strategy (i.e., a_1, b_1). The fact that there is an incentive for each player to "double-cross" the other in the case of a mutual first choice means that the only stable position is that of the mutual second choices, with its payoff of -9, -9! As Anatol Rapoport was quick to point out, an interesting observation emerges:

> The observation is that "group rationality" is different from "individual rationality", not only in the well-known sense that the welfare of the group may sometimes demand "sacrifices" from the individuals in it, but in a stronger sense that departures from "selfish" decisions on the part of each individual actually result in greater individual rewards for both. This is often realized as part of "social wisdom", but here we have a rigorous, specific demonstration of this principle.[4]

This demonstrates--in a compelling fashion, we believe--that individuals pursuing their own self-interest do not "necessarily" promote society's welfare. Indeed, it leads us to the rather paradoxical thought that altruism can be justified on the basis of "selfish" considerations!

Thus we are led to answer the question posed earlier--are there any viable alternatives to planning--in the negative; at least, if the alternative is the one offered by the economist. And since we had already decided to reject the notion that we can "do without planning entirely" (for perhaps less compelling reasons--but we are willing to make this rejection simply as an article of faith anyway), we are now ready to assert that the answer to the fundamental question--why planning--is: there is no other viable alternative in sight.

After this lengthy preliminary discussion of the importance of considering the subject to be presented in this paper, we are at last ready to state briefly the specific problem to be dealt with hereafter.

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[4] Anatol Rapoport, "Critiques of Game Theory", Behavioral Science, Vol. 4, No. 1 (January, 1959), p. 57.

The problem of control. It is our contention that planning without control is futile, while control without planning is blind. It is our further contention that the current state of the art of city planning suffers more from futility than from blindness. That is, the crucial problem facing the planner is the problem of control: his ability to devise plans is relatively well-developed, but his ability to implement them is woefully lacking. And this lack is due not so much from a resistance to control by the planner on the part of other centers of power (and the general public), but rather to a fundamental inadequacy of the planner's tools and techniques for dealing with his task. The remainder of this paper will be devoted to an exploration of the possibility of achieving this control which is now afforded by: (1), developments in the science of management together with a revolution in information technology; (2), the application of control system analysis to the planner's task; and (3), the synthesis of a tool, technique, and organization designed to provide the planner with an adequate means for control over his task.

Management Science and the Revolution in Information Technology

The meaning of "management science". The last decade or so has witnessed a mushrooming growth of applications of the scientific method of inquiry to the problems of management. These applications are perhaps best exemplified by what has come to be known as "operations research", although this is but one aspect of the application of scientific method to the domain of management. Terms such as "game theory", linear programming, dynamic programming, systems analysis—these and many others could be cited to give some feeling for the multi-faceted activity occurring under the rubric "management science"[5]. For the purposes of this paper we shall understand the term to mean simply the use of scientific method and scientific techniques for the study of problems encountered by management, broadly conceived.

The revolution in information technology. If the growth in the use of scientific method in business and industry has been significant, the rapidity of the development and use of new tools and techniques for dealing with information--symbol manipulation and communication, broadly conceived--has been nothing short of phenomenal. Some feeling for the magnitude and rapidity of this revolution is conveyed by the following facts: the first large-scale electronic computer, the ENIAC, was completed in 1946; the first one to be reproduced commercially, the UNIVAC, was delivered to the Bureau of the Census in 1950; the first of these to be applied to strictly business problems (as contrasted to scientific problems) was installed at the General Electric Company's Louisville, Kentucky, plant in 1954; and yet today there are literally hundreds of electronic computers in use by business, industry, and government. The profound impact these "electronic brains" have on the organizations using them is well recognized by all persons familiar with the computer field[6]. And the best (or worst, depending

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[5] For a closer look at this general subject area, the reader is referred to the following works: C. West Churchman, Russell L. Ackoff, and E. Leonard Arnoff, Introduction to Operations Research (New York: John Wiley and Sons, 1957); Howard S. Levin, Office Work and Automation (New York: John Wiley and Sons, 1956); George Kozmetsky and Paul Kircher, Electronic Computers and Management Control (New York: McGraw-Hill Book Company, 1956); Richard Canning, Electronic Data Processing for Business and Industry (New York: John Wiley and Sons, 1956).

[6] For example, see Levin, op. cit.; also, Canning, op. cit.

on your point of view) is yet to come.

For example, consider the words of Dr. John M. Salzer (Director, Intellectronics Laboratories, Ramo-Wooldridge Division, Thompson Ramo Wooldridge, Inc.) who recently wrote:

> The words computers, electronic brains, automation, synthetic intelligence devices, automatic control, cybernetics, data handling and data processing each suggests a narrow part of the broad field of extending the human intellectual process by machines. None is adequate to describe the whole. None of them conveys the idea of a man-machine partnership in intellectual activities and, moreover, that most major intellectual pursuits in business and government, in peacetime or in wartime, will in the future involve large complexes of human beings and machines working together. The new partnership will do the world's intellectual task, will provide the "nervous system" control of the physical operations of the world.[7]

It was to describe this fandamental and growing concept of extending man's intellect (primarily through information technology, of which electronics is the dominant aspect), that the word "intellectronics" was coined.

But no matter what word one uses, the important point to consider here is that this revolution cannot fail to profoundly effect the planner and his task.

The significance of these events for the planner. The ways in which the planner and his task will be effected by these events are threefold: (1), by the wealth of new insights--about man's place in the organizational environment, the organization's place in the communal environment, and the multiplicity of reciprocal relationships among these factors--which the application of scientific method to

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[7] J. M. Salzer, "Intellectronics--Extension of Man's Intellect Through Electronics", published in a special supplement to the Los Angeles Times marking the opening of the Ramo-Wooldridge Laboratories in Canoga Park, California, December, 1959. More on this general subject may be found in W. Ross Ashby, Design for a Brain (New York: John Wiley and Sons, 1952).

management problems has generated; (2), by the development of spectacular new tools for dealing with the manager's tasks; and (3), by the development of ways to use these new tools for the purpose of experimenting in the domain of management--that is, it is now possible to perform experiments in the field of social science in the same sense in which it has long been possible to perform experiments in the field of physical science[8]. These points will be elaborated throughout the rest of this paper.

The Systems Approach to the Planner's Task

The "systems approach" defined. In its broadest sense, the term "system" can apply to any set of variables whatsoever; their interrelationship is a function of the individual making the selection. When used in the context of management science, however, the term system usually connotes a complex whole of interconnected components, such as a "man-machine system". Thus the "systems approach" is used to emphasize the necessity and utility of dealing with a problem in its broadest context, the entire system, whatever the particular system may be. This concept should be well-suited to the planner, since by nature such a person habitually "sees things whole"--that is, takes the systems approach.

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[8] For a fuller treatment of this point, the interested reader is referred to: R. L. Chapman, J. L. Kennedy, A. Newell, and W. C. Biel, "The Systems Research Laboratory's Air Defense Experiments", *Management Science*, Vol. 5, No. 3 (April, 1959), pp. 250-69; J. L. Kennedy, "A 'Transition-Model' Laboratory for Research on Cultural Change", *Human Organization*, 14, pp. 16-18; W. R. Reitman, "Computers in Behavioral Science", *Behavioral Science*, Vol. 4, No. 4 (October, 1959), pp. 330-35; H. A. Simon and A. Newell, "Heuristic Problem Solving", *Operations Research*, Vol. 6, No. 1 (January-February, 1958), pp. 1-10; A. Newell, J. C. Shaw, and H. A. Simon, "Elements of a Theory of Human Problem Solving", *Psychological Review*, Vol. 65, No. 3 (1958), pp. 151-166.

The nature of the planner's task. If one takes the systems approach to the planner's task itself, one is led to ask somewhat different questions than would otherwise by the case. For example, what are the bounds of the system with which the planner deals? What are its components, and how are they connected? Is the system open or closed? Is there feedback among the components, and if so, what kind—that is, positive or negative? We have dealt with the beginnings of such an inquiry at some length elsewhere[9]; suffice it to say here that the city planner's task--the primary function which the city planner exists to fulfill--is essentially one of controlling the use of land (broadly, space) within his area of responsibility, the purpose being to ensure a more efficient and effective utilization of this fundamental resource so as to promote the greater well-being of the community. To better understand the planner's task one must look more closely at the nature of the system with which he deals.

The "metropolitan community" viewed as a system. A city the size of Los Angeles dominates its surrounding territory; within this territory are other communities of varying sizes; all these, together with the hinterland which supports them and which they serve, make up what has been called the "metropolitan community"[10]. It is this

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[9] Harry F. W. Perk, "A Conceptual Model of the Planning Activity", unpublished manuscript prepared for Dr. James Gillies, UCLA Graduate School of Business Administration, June, 1958.

[10] For a fuller treatment of this concept, see R. D. McKenzie, The Metropolitan Community (New York: McGraw-Hill, 1933), and Don J. Bogue, The Structure of the Metropolitan Community (Ann Arbor: University of Michigan Press, 1950).

complex ecological system that constitutes the raw material which the city planner hopefully attempts to fashion into a system which more closely approaches a suitable base for the activities of men. For this purpose the planner has available certain tools and techniques, to which we shall now briefly turn our attention.

Some current planning tools and techniques. The planner trys to control his exceedingly refractory raw material by such instruments as are exemplified by zoning ordinances, various police powers, eminent domain, and so on; some of the techniques employed are those of land use surveys, statistical analyses, population forecasts, various development plans, and above all, the "master plan". There is considerable evidence available to support the contention that none of the currently available tools or techniques are adequate for the task, however[11]. Indeed, the very concept of a "master plan" is suspect: given the extreme rate of technological change which characterizes our culture, it may well be either impossible or undesirable (or both) to attempt to set future goals on the basis of currently available knowledge and techniques[12]. Even if this were not so, it is very doubtful that the master plan concept is able to "make a difference" in the context of this rapid and accelerating rate of change. Besides, there simply are not enough planners to go around: if the well-being

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[11] See, for example, Harry F. R. Perk, "Are Master Plans Really Necessary?", The RAND Corporation, Santa Monica, May 13, 1958.

[12] For a discussion which gets down to fundamentals--which asks some of the right questions--see Percival Goodman and Paul Goodman, Communitas, Means of Livelihood and Ways of Life (Chicago: University of Chicago Press, 1947).

of a community depends upon having a master plan, and having a master plan depends upon having planners, then at least *some* (the majority, most likely) communities are in for a very rough time. What then might be needed to enable the planner to more effectively deal with his task?

The ideal regulatory mechanism. From the point of view of establishing the most effective system for accomplishing the planner's task, an ideal would be *self-regulation*: that is, a system which acts of its own accord to correct for disturbances within it. Consider the statement of L. R. Dice in this regard:

> A good regulatory mechanism must be automatic in its action, prompt in its response, uniformly dependable in its application, not easily subject to change according to legislative or bureaucratic whims, smooth and effective in operation by increasing or decreasing its control in proportion to the need for it, and economical in that it should itself consume as little as possible of the resources of the ecosystem.[13]

We shall devote Part II of this paper to a discussion of what such an ideal control system might be like. First, let us summarize the discussion up to this point.

Summary of Part I

We have seen that the fundamental opposition between the planner and the classical economist can be resolved in favor of the planner; there is every reason to believe that the *laissez-faire* concept is both empirically false and logically invalid, which leaves the field open to other possibilities, of which the concept of planning is the most promising. Considering then, the planner as a manager of urban

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[13] Lee R. Dice, *Man's Nature and Nature's Man* (Ann Arbor: University of Michigan Press, 1955).

resources, we have seen that both new scientific insights and revolutionary new tools are available to assist the planner in accomplishing his task. Finally, by taking the systems approach to the planner's task, we have begun to recognize some of the requirements for an ideal regulatory system to ensure effective task accomplishment. With this background we are now ready to consider the synthesis of such a system.

PART II: SYNTHESIS

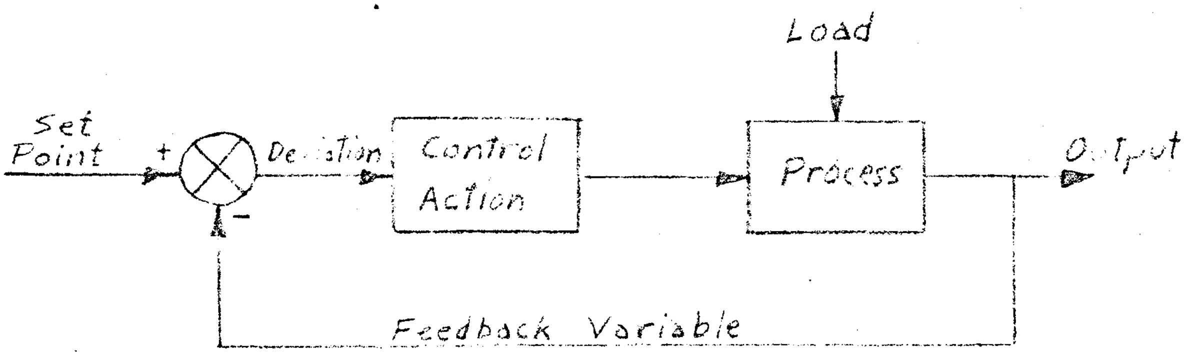
The LUCC: Conceptualization

Existing precedents. Are there any precedents for a "Land Use Control Center" (which we shall abbreviate to "LUCC" for the sake of convenience)? Yes, there currently exist at least two systems of comparable complexity and with even more demanding time and reliability constraints; furthermore, another such system is currently being intensively investigated by means of simulation. The systems referred to are: (1), the Continental Air Defense Command's system of Air Defense Direction Centers ("ADDC's"), a network of manually operated radar direction centers: (2), the SAGE system (Semi-Automatic Ground Environment), also an air defense system, but one in which specially designed large-scale electronic computers play a very prominent role; and (3), the Air Force logistics system, currently being studied in the RAND Corporation's Logistics Systems Laboratory. In order to make the later discussion of the LUCC system more readily understood, let us look more closely at one of these existing systems.

The ADDC. The Air Defense Command has the responsibility of protecting this country from enemy air attack. For this purpose it has established a system of Air Defense Direction Centers, staffed by thirty to forty Air Force officers and men who operate the radar scopes and related equipment provided for the accomplishment of their task. This task--the defense of their area of responsibility from enemy air attack--has essentially three components: (1), the initial detection and tracking of all air traffic in their area; (2), the identification of each aircraft within this air traffic so as to ensure no hostile aircraft are present; and (3), the taking of action in the event that an "unknown" is discovered to be hostile. These three components are usually known as "surveillance", "movements identification", and "control", respectively. To better understand the functions of these components, let us examine an ADDC in operation.

Radar is the means of initial detection of the air traffic: the electronic pulses bouncing back from the aircraft appear as "blips" on the ADDC's radar scopes, thus permitting the continuous tracking of all aircraft visible to the radar. These tracks are plotted on a central display board at the front of the direction center; this visual analogue of the air traffic situation is then used for purposes of comparing the tracks as detected with the expected flight paths as submitted to the ADDC by the Federal Aeronautics Authority, which in turn had obtained them from the "flight plans" which are required to be submitted to the FAA. Any discrepancy between the existing and the expected tracks serves to initiate control action: fighter aircraft are sent out to visually identify the aircraft which is unknown; in real life the consequence of these inspections has been the detection of aircraft which are off their flight plan, or whose flight plan has been filed late and is thus not available in the ADDC to permit identification within the center itself[14]. Fortunately, no aircraft has yet been identified as "hostile" except in training exercises.

A control system analysis. It can be seen from the preceding that the ADDC is an instance of what is variously called a "closed loop control system", "feedback system", or "servosystem". This may be illustrated by the following ultrasimplified diagram:



Interpreting this diagram in terms of the ADDC, the "process" being controlled is the air traffic situation; the "load" is the fluctuating air traffic, including possibly hostile planes; the "set point" represents the "no hostiles allowed" condition, as determined by the flight plans filed with the FAA and in turn submitted to the ADDC; the "feedback variable" is the radar input to the ADDC, while the "deviation" (or "error") is the difference between the tracks as plotted from the radar input and the flight plans; and finally, the "control action" is just that--the sending out of fighter aircraft to take action against

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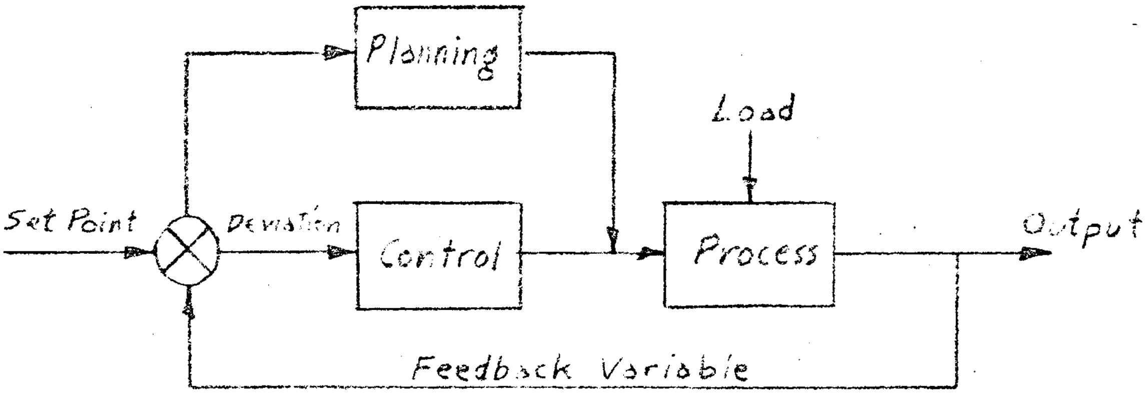
[14] For a more detailed discussion of these--and related--systems see R. L. Chapman and others, op. cit.; D. G. Malcolm, "Real-Time Management Control in a Large Scale Man-Machine System", the System Development Corporation, SP-90 (1959); A. J. Rowe, "A Research Approach in Management Controls", System Development Corporation, SP-194 (1959); W. W. Haythorn, "Simulation in RAND's Logistics Systems Laboratory", Report of System Simulation Symposium, co-sponsored by the AIIE, TIMS, and ORSA (Baltimore: Waverly Press, 1958), pp. 77-82.

any hostile aircraft which may be discovered.

To give some idea of the generality of this descriptive model, consider another system: the oft-used example of the thermostat which regulates room temperature. In this case, the set point is the temperature setting of the thermostat, the process being controlled is the room temperature, the difference between the measured room temperature and the setting of the thermostat--the deviation--is the means by which control action is initiated to cause the furnace to decrease (or increase) its output, depending upon whether the load--the outside temperature--has risen or fallen. Such systems as these are considered "on-line" (or "in-line") control systems operating in "real time"--a very useful heuristic, as we shall see.

A descriptive model of the LUCC. Let us now interpret this generalized model in terms of the system with which we are primarily concerned. The process to be controlled is that of the use of land; the set point is the statement of community land use objectives (perhaps as embodied in the master plan); the deviation between the stated objectives and the land use situation as measured initiates control action to bring the existing and desired state of affairs into conformity; and of course, the load on the system consists of all independently arising factors causing a change in the land use situation (such as population changes, new industries, and so on).

It will be seen from this interpretation that what is usually thought of as "planning"--as distinct from "control"--is most fruitfully viewed as a second-order feedback level, as shown in the following ultrasimplified diagram:



In this case, the community objectives together with data about the existing state of the process to be controlled are fed into the planning element, which then acts upon this information so as to affect the nature of the control action itself, which in turn affects the ongoing process. It would be possible to carry this model one step further, and view the establishing of the community objectives themselves as a third-order feedback level. Broadly speaking, this third-order feedback level would be the largely political process by which the community comes to formulate objectives in the first place. However, for the purposes of this study, it will not be necessary to go beyond the planning and control levels.

<u>A predictive model for the LUCS</u>. By virtue of having adopted the servosystem concept as the basis for our descriptive model, we thus have all of the well-developed theory of servomechanisms and automatic process control at our disposal. An extensive literature (see the Bibliography) exists to assist us in analyzing our land use control system, and predicting the behavior of the system under transient and steady-state operating conditions. It is beyond the scope of this paper to go into a detailed analysis of the many elements involved in the control system contemplated here in order to estab-

lish a workable predictive model, however.

There is another sense in which we may think of predictive models, though, which should be mentioned here. One of the chief advantages of the LUCC system would be its ability to simulate the effects of given changes (or proposed changes) in the land use situation so as to be able to predict their impact through time. Since the computer would enable this simulation to occur at a greatly speeded-up time scale (very much faster than real time, like observing the movement of a glacier by means of time-lapse photography), with suitable predictive models upon which to base such simulation the LUCC's would be able to provide the planner with vastly superior date than anything he currently has available upon which to base his recommendations[15].

The decision model for the LUCC. The planning and control system set forth here obviously involves the making of decisions; what are the criteria for making such decisions? That is, in the operation of the control actions of such a system, or in the transformation of the community objectives into specific operational plans by the planning element of the system, what is the nature of the criteria which are to be used to select one alternative planning or control action from another? To be concrete, and perhaps more lucid: suppose, for the purpose of a necessary control action, a choice exists between using the power of eminent domain or paying a seemingly exhorbitant

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[15] For an extended treatment of this point, see Stanford L. Optner and Associates, "On the Feasibility of Electronic Data Processing in City Planning", Report to the Department of City Planning, City of Los Angeles (Los Angeles: Stanford L. Optner and Associates, January, 1959).

price in order to obtain a piece of land needed by the city; what enables the planning and control system to choose between these two alternatives?

The answers to questions such as those posed in the preceding paragraph are highly dependent upon the predictive model, and thus cannot at this time be definitively answered for the system under study here. However, certain general considerations pertaining to all such systems may be mentioned. For example, the problem of the stability of the system is a crucial one. Stability is in turn highly dependent upon such factors as time lags, phase relationships, and the gain in the system. That is, whether the control system will suffer from "hunting" (the inability to "zero in" on the desired control value), or be subject to oscillations of ever-increasing magnitude--and so on--is largely a matter of the time lags, the amplification (gain), or the phase relationships in the system's feedback. Another aspect of importance is the behavior of the system under transient conditions (can it handle temporary overloads, for example). Also, the response rate is of critical importance: will it be rapid enough to correct an incipient disturbance before the disturbance has reached dangerous proportions? And is the system sufficiently flexible to handle changing load and operational conditions now and in the foreseeable future?

This gives some indication of the nature of the criteria which must be taken into account in operating as complex a system as that being considered here. These criteria enter into the problem of system design, to which we shall now turn.

The LUCC: System Design

An overall view of the system. Before taking up specific aspects of the system design problem, it would be well to take a look at the system in its entirety, as it might exist five years after first being established, say.

First, the system must be coextensive with the metropolitan community (which includes the hinterland, recall): second, there must be a sufficient number of individual centers (LUCC's) in the system to ensure adequate coverage of this area; third, the location of individual centers must not be a matter of arbitrary political decision, but rather a function of the logic of the system itself. These three "design principles" imply a fourth: the system must be flexible; that is, as the metropolitan community changes (as regards size, internal population distribution, changing nature of land use, and so on) so must the planning and control system.

Briefly, then, we would envision a planning and control system consisting of a number of linked land use control centers covering the entire metropolitan community, with each particular center receiving its planning objectives from the local area it serves and over which it exercises land use control (of course, there would be extensive coordination of these objectives among all centers). For a metropolitan community the size of Los Angeles and its environs, the number of LUCC's might range between 10 and 20, depending upon such factors as the characteristics of the available computers which would be required, the expected system load, the yet to be determined optimum ratio of task events per center, and so on.

The system design matrix. To better enable us to grasp the many factors of the system design problem, consider the matrix shown in Figure 1. While it is beyond the scope of this study to fill in the boxes of this matrix with all the information needed to permit the design of our system, it should serve to give some idea of the full extent of the design problem, and perhaps a better understanding of the many interrelated factors which must be taken into account.

The LUCC: Cost-Benefit Analysis

The selection of appropriate criteria. As soon as one uses the term "cost" the whole field of economics opens up before us. However, we are going to insist upon an even broader interpretation of the term for the purpose of evaluating the LUCC; for as one might well say to the economist, "There are more things in heaven and earth, Horatio, than are dreamt of in your philosophy"[16]. The current inability to precisely measure certain admittedly important aspects of the problem (such as ramifications in the social and political realms) should not be allowed to prevent us from making some--albeit tentative and imprecise--allowance for non-pecuniary factors. Having pronounced this caveat, let us now look at some of the probable costs involved in our system.

Probable costs. The system costs may be roughly divided into at least these five categories: (1), cost of system design; (2), cost of system installation; (3), cost of system operation; (4), obsoles-

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[16] With all due apologies to William Shakespeare (the quotation, of course, is from Hamlet, Act I, Scene V).

Problem Aspect Problem Component		Hardware	Techniques	People	Organization	Environment	
Purposes and Objectives							System Constraints
Data Collection							
Data Processing	Physical						
	Analytical						
Data Utilization	Interpret and Evaluate						
	Present and Disseminate						
Implementation							
		System Constraints					Measures of System Effectiveness

FIGURE 1. System Design Matrix

cence costs; (5), non-pecuniary costs. Since we do not have all the necessary information upon which to base accurate estimates of these costs (the system does not yet exist, nor has it here been specified sufficiently precisely for such costing purposes), the best that we can do at this point is to give order of magnitude estimates. As a basis for such estimates we will consider a fully-implemented system as it might be designed for installation in the Los Angeles metropolitan community.

<u>Category 1.</u> The cost of system design would very likely fall in the low megabuck range (i.e., 2-5 million dollars, say). This would be an essentially non-recurring cost, of course, and would include all aspects of the system design from initial survey of the system information requirements, through specification of the requisite hardware, operating techniques, staffing requirements, organizational support, and linkages with other existing systems, to the specification of appropriate sites for the LUCC's themselves. This estimate of cost is based on the conviction that the existing state of the art of information handling technology is adequate for the task--that is, no "breakthroughs" are required.

<u>Category 2.</u> The cost of installation would include all necessary hardware (i.e., the computers and associated facilities), the plant and equipment to house this, the communication linkages between the centers and other related organizations, and the essential initial training of operating personnel. If the computers are rented rather than purchased, then as an unadorned but educated guess, we would put the cost per center in the 2-5 megabuck range, which puts the system

cost in the range from a low of 20 million dollars to a high of 100 million dollars (the range depends also on whether 10 or 20 centers are needed, of course). The initial cost would be correspondingly higher if the computers were purchased rather than rented. Category 2 costs are also essentially non-recurring.

<u>Category 3</u>. The cost of operation is made up predominantly of the cost of running the computers (rental or amortization costs, maintenance costs, etc.) together with the relatively high labor costs involved (nearly all personnel would be highly trained in relatively scarce skills, and therefore expensive to employ and retain). A plausible figure for the staff salary fees per center per year might be 200 kilobucks; this would give a system operating salary cost of 2-4 megabucks per year. A plausible figure for computer operation would be ½-1 megabuck per center per year, or a system cost of from 5-20 megabucks. Thus the overall yearly system operating costs would be on the order of 10-20 million dollars.

<u>Category 4</u>. Obsolescence costs are of at least two kinds: the costs associated with replacing equipment and facilities of the system itself as these become obsolete; and the costs associated with the effect the system will have on obsoleting much of the existing "machinery" and skills of government now devoted to the same ends. It is very difficult to assess these costs, even on an order of magnitude basis. However, it is likely that the second of these two kinds of obsolescence costs will outweigh the first. We shall have occasion to return to this point in a later connection.

<u>Category 5</u>. The most difficult "costs" to assess are those of

a non-pecuniary nature, of course. They are also likely to be the most important, however. In this category are such factors as: the disruption of existing inter--and intra--governmental relationships which is certain to occur; the obsoleting of much of the existing governmental "machinery", as was mentioned earlier: the potentially drastic impact the system could have in the realm of "private enterprise" activities, such as the purchase and sale of real estate, for example; the threat of over-organization which, it must be admitted, exists by virtue of the highly effective nature of control provided by such a system; and so on. Indeed, perhaps the most significant of these non-pecuniary costs is the possibility of man becoming a slave to these machines (as happened in the case of the automobile, for example), as Norbert Weiner--one of the founders of cybernetics and a pioneer in the development of information technology--has recently warned. But before we become so depressed we abandon the very idea of creating such a system, let us look at some of the benefits which might accrue from its existence.

Probable benefits. The preceding cost assessment looks so staggering as to seriously raise the question whether the probable--or even possible--benefits could ever outweigh such costs. Despite the admittedly foreboding nature of that assessment, we are nevertheless convinced that our planning and control system *can* be justified; indeed, that we cannot afford to do without it. The expected benefits may be separated into the two broad categories of non-pecuniary and pecuniary benefits. Let us start with the former of these.

Non-pecuniary benefits. What is it worth to save our cities from going bankrupt? To re-fashion the "exploding metropolis"? To prevent the desecration and wastage of our countryside? To give man the possibility of gaining some control over his self-made environment--even, over his destiny? We are convinced that our planning and control system would make possible all of these benefits; but we know of no way to measure their "worth". Incidentally, assessing the worth of such benefits as implied above is directly analogous to the situation facing the ADDC: what is the worth of defending this country from enemy air attack?

Pecuniary benefits. If the costs were difficult to determine, the pecuniary benefits are well-nigh incalculable: we are unable at this time to attach even a "ballpark" figure to them. For one thing, the benefits must be assessed in a different way than the costs: by trying to determine what the cost would be of not having such-and-such a capability, we get some idea of the worth of having the capability. For another thing, the benefits cannot be adequately established by simply estimating the savings to be realized by the replacement of existing facilities and individuals: experience has shown that computer system installations can almost never be justified on the basis of such savings as, for example, the salaries of the clerks likely to be replaced.

Evaluation. What then can we say of the ratio of benefits to costs? Would we be justified in building such a system as that discussed in these pages? Since our previous analysis has given us only part of the needed information--the denominator, but not the numerator, of the benefit-cost ratio--we must fall back upon our informed judgement and educated intuition. Our intuition tells us that some such system as described here is sure to come about, if for no other reason than that man has now created the capability for it while the opportunity--nay, necessity--pounds loudly at his door. Our judgement tells us that the benefits do in fact greatly outweigh the not inconsiderable costs, even if we cannot yet attach a number to this ratio.

On the posit that the system is justifiable, we shall now turn to the matter of implementation.

The LUCC: Implementation

Even if we could convince the most hardened skeptic that the benefits of our system would, in fact, greatly exceed the costs involved, the absolute magnitude of those costs are so great that it is patently obvious that no such system would be provided to meet the needs of the planner alone. Has this all been just an idle dream, then? We think not. But then how is the planner to get his control system?

Strategy. "If you can't beat 'em, join 'em". Uppermost in our mind at all times must be a recognition of what it is we are really trying to do by creating this planning and control system: certainly, it cannot be an end in itself. What we are really trying to do is bring about the possibility of enlightened self-regulation in the domain of the metropolitan community ecosystem. There is no doubt a degree of self-regulation in the system now, but it is due to the blind and blundering forces of man-in-nature. For example, the congestion in the central city acts to stimulate the flight to the suburbs which in turn reduces the congestion somewhat (at least, changes its nature); the pollution of the air serves to make the area less attractive to newcomers, who then settle elsewhere, and so on. Given sufficient time for the working out of such forces as these, the metropolitan community would reach a level of steady-state equilibrium. But what kind of an equilibrium would this be? It would be of the same disagreeable sort as that which the world-wide population explosion--if left unchecked--will bring about: war, disease, and famine will serve to inhibit unlimited growth. This is rather like waiting for the "equilibrium" which is established when cancer kills its host. Surely man can do better than this.

Keeping in mind that we hope to achieve intelligent self-regulation by means of our system, consider the following: first, the planner's decisions are but one (relatively minor) aspect of the vast network of interrelated decisions which constitute the basis for self-regulation; second, the planner both seeks information from, and provides information to, other decision-makers in this network; and third, the information needed by all members of this communication network is both exceedingly valuable and not easy to come by. Would it not be possible to take advantage of this situation--the mutual dependence upon information by the various members of the communication network--in order to bring our system into existence? Let us explain what we mean more fully.

It has been estimated that the number of over-lapping districts, areas, service boundaries, zones, political jurisdictions, and so on, if fully enumerated, would exceed one hundred[17]. Thus any given location in the community might be categorized in a considerable number

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[17] Stanford Optner, <u>op. cit.</u>, p. [illegible].

of ways: by its street address, postal zone, school district, census tract, Department of Water and Power meter book area, police reporting district, and so on. Suppose a given piece of now vacant land were to be developed with an apartment building: imagine the number of organizations which would have a need to know of this, all the way from the Building Department which must issue a permit to the telephone company which will have to install the telephones for the future tenants. If all of these sundry organizations could obtain the information they needed from one place, this should permit substantial economies to be developed in their operations by virtue of the improved coordination, scheduling, and so on, made possible thereby. Therefore, ready access to such information should be worth something to them.

Again, consider the industrialist who wishes to locate a suitable site for a new factory, say; the search for such a site can become very expensive and time-consuming. Would it not be worth something to this industrialist to have access to information which would enable him to know of <u>all</u> possible sites which meet his criteria? Or consider the realtor who is trying to provide such information to a client; if he can show his client several suitable sites, the probability of his making a sale is greatly enhanced. Or again, consider the market researcher who is trying to obtain accurate data on the number of households in a given area, together with information about various of their characteristics, and so on: the more easily such information is obtainable, the better he is able to serve his client. But we need not belabor the point.

It should be apparent from the foregoing what our implementation strategy should be: we should expand our concept of a land use control center (for the exclusive use of the planner) to that of a "general purpose information center"--the "GPIC". Thus the planner would be but one of the many users of such a center, just as he is now but one of the many users of the services of the telephone system, say. And just as in the case of the telephone system, he would pay a fee to utilize the services of the GPIC--along with the host of other users, thus making the charge to him sufficiently small to justify his using the service.

We can now see that the cost of our system is not such an insurmountable obstacle after all (imagine the difficulty which Alexander Graham Bell's contemporaries might have had in visualizing the current telephone system in its entirety, and the capital investment which that system represents). By splitting the amount among a number of cooperating groups, no one group need suffer an impossible burden. Indeed, we can even conceive of the services of our GPIC being available--at a suitable fee--to the ordinary citizen wishing the kind of information it would provide.

Another aspect of the problem of self-regulation serves to enhance the desirability of the GPIC concept to the planner, quite apart from whether or not it represents the only way in which the planner is likely to get the system. This aspect is exemplified by the importance of _timing_ (recall the earlier discussion of time lags). If the planner is to achieve effective control he must be able to influence decisions regarding the use of land _before_ these decisions become irrevocable. What better way to do this than by being part of an information system which provides various users of the land with the information upon which their decisions are based? That is, when the industrialist seeks to find a suitable site for his factory, the GPIC would provide the means whereby the planner could influence his choice <u>before</u> he has committed himself. This would obviously be preferable to having the industrialist later try to get a zone variance on a piece of property which he should not have chosen in the first place. Many of the planner's headaches are a consequence of some individual having taken an action only to discover when it has become too late that a different action would have been much better for everyone. Ignorance is <u>not</u> bliss.

Two additional strategical considerations are worth pointing out, before we turn to the matter of tactics. First, it may well be possible that the GPIC concept could be developed to encompass the function of a "land use exchange" (like a stock exchange), which would greatly facilitate area development and urban renewal while at the same time raising the realtor's status to something like that of a stock broker, all of which should make support for the system more likely to be forthcoming. It is beyond the scope of this study to consider this point in detail, however. Second, the GPIC concept could be used to further the cause of metropolitan integration: the logic of system design would decree the location of specific GPIC's, rather than arbitrary political decision, and thus the planner could exercise his control without the usual frustration encountered due to the nature of political decisions as dictated by political boundaries. Local autonomy would still be served, of course--since the local community would be the source of the community objectives upon which the planner bases his control action--but the all-encompassing nature of the system would permit a degree of coordination in planning which is beyond the contemporary planner's fondest dreams.

But let us now turn to the problem of tactics.

Tactics. In order to speak meaningfully of the various possible courses of action that might be followed to implement our system, one needs to know much more of the details of the system. Thus perhaps the immediate tactic to be considered is one having to do with furthering the system design itself. As was indicated in the section on the cost of system design, this is no small problem. On the other hand, if such a system as we have been considering were to be created for the ten or twenty largest metropolitan communities in the United States, this would represent a potential computer market on the order of 1 to 2 billion dollars--which ought to offer some incentive to the computer manufacturers to underwrite a substantial part of the system design costs themselves.

But before any computer manufacturer is going to invest expensive time and talent for such a purpose, the cities will have to indicate they are interested in having such a system. So the first order of business will be to convince the city fathers that they have a problem, and that it demands this--or some similar--system for its solution. We hope that this paper will serve this end in some small way.

Summary of Part II

The purpose of this part of our paper was synthesis; we began with a consideration of the overall concept of a land use control system.

We showed that precedents for such a system already exist, together with means for their experimental manipulation; we also pointed out the utility of the extensive body of control system theory for the purpose of system design. After setting forth some "principles" of system design, we displayed a "system design matrix" which could serve as a framework for gathering the specific, detailed information required for actual design of the system. A consideration of some of the probable costs and benefits attached to such a system left us with the conviction that the benefits outweigh the costs—even though we could not attach numerical estimates to the benefits. Finally, a look at the problem of implementation indicated that a suitable transformation of the LUPC system concept into the GPIC system concept should greatly enhance the probability that an effective implementation strategy could be devised, together with the necessary tactics to ensure the success of the implementation strategy.

PART III: PROGNOSIS

Critique

Throughout the analysis and synthesis of our planning and control system we were guided by the question, "what is the nature of the system which would best deal with the planner's task?", rather than the question more frequently posed, "what can be done to make the existing system more effective?". This difference in approach has both advantages and drawbacks; the advantages we believe are apparent in the preceding parts to this paper; here we shall consider some of the drawbacks.

Perhaps the most obvious drawback of our chosen approach is that it necessitates dealing with a hypothetical system: without much more time and greater resources than were available to us for this study, such an effort is likely to remain somewhat unconvincing.

Another drawback is that even if our analysis of the need for--and the technical feasibility of--the system is convincing, the problem of cost is likely to appear to be insurmountable (especially in view of the fact that our discussion of the probable benefits could not succeed in attaching dollar amounts to these benefits so as to enable a direct comparison with the costs); although our discussion of implementation may have served to mitigate this somewhat.

Perhaps another difficulty lies in the nature of the chosen problem-area itself: there is apparently no literature directly relevant to this particular problem to provide the background necessary to make our approach and our solution seem both reasonable and plausible[18].

Despite these (and other) drawbacks, we should like to emphasize that it is more important to seek an answer to the right question--even if the search is unsuccessful--than to obtain an answer to the wrong question. In any event, the system considered here is no panacea, nor is it a substitute for a community's knowing where it wants to go in the first place.

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[18] However, the Stanford Optner report mentioned earlier (see footnote 15), although addressing itself to a different question, contains many useful insights together with material relevant to the system design aspect of the problem. Also, the literature pertaining to the military systems discussed is very likely to be useful in this regard (see footnote 14). Management theory has borrowed extensively from developments within the military domain in the past, and there is no reason to believe this will cease to be true in the future.

Prognosis

If one is to take seriously the currently favorable outlook for meaningful disarmament negotiations, then the question immediately arises: what would be the impact of disarmament on our economy? Indeed, Gerard Piel, publisher of the Scientific American magazine, recently gave a lecture on the subject, "Will the Boom in Science Survive Disarmament?"[19] And the major point he was making in this address was that the United States had better find a substitute for the 40-odd billion dollars a year being spent on non-consumer goods (armaments and such), or our economy will suffer a drastic decline with the advent of disarmament (if it comes).

It is just such a consideration as this that gives us reason to hope that the cost of our planning and control system may turn out to be one of its chief advantages, rather than the serious drawback it might appear to be at first sight. For what better way could we employ money released from armament spending than in creating this much needed aid to our floundering cities? Much the same talents as are now utilized by the "defense" industry could be utilized in creating the system of GPIC's, which is another important factor in its favor (especially in Los Angeles, which is heavily dependent upon advanced weapon system research, design, development, and production).

Coupling the above thought with the previously mentioned possibility of making the system a multi-purpose one (i.e., deliberately creating a

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[19] This lecture was sponsored by the Los Angeles Chapter of the Federation of American Scientists, and took place on October 19, 1959, in Los Angeles.

capability for dealing with questions of importance to businessmen) gives rise to yet another thought: perhaps the local business interests would view the establishment of this system as a positive good from the point of view of their own economic well-being. If properly presented, we are sure this way of viewing the system could come to predominate.

One final point: as the population of our country grows, the problem of getting the individual citizen to feel that his voice really counts in the democratic political process becomes ever more difficult. It is our belief that our planning and control system would have a beneficial impact even here: by making possible effective planning and control one makes possible effective political control--the third-level feedback process in which we are all able to take part. And thus our concept of democracy as a form of _self_-control would achieve full realization.

Conclusion

What then can we say in conclusion? First, we will make the flat assertion that today's planning tools are never going to be able to do the job that needs doing; second, a reasonable man may reasonably conclude that the planner's favorite concept--the "master plan"--may well be already obsolete (if not, indeed, entirely a mistake); third, without effective control--now sadly lacking--there can be no effective planning, and without effective planning we are in danger of losing some of our most cherished values. This leads us to believe that a new approach to the whole problem-area confronting the planner is badly needed; if not along the lines taken in this paper, then at least along lines which recognize the various revolutions going on: in management tools and techniques, in technology, in knowledge, in cultural values, in people.

It was in the hope that we could make some small contribution to the effort to keep abreast of at least one aspect of these revolutions that this paper was written.

REFERENCE MATRIX*

Area of Interest / Ref. No.	Analysis						Synthesis				Prognosis	
	The Problem	Mgmt. Science	Info. Tech.	Systems Approach	Planner's Task	Metro. Community	Control System Concept	System Design	Cost-Benefit Analysis	Implementation	Critique	Prognosis
1		x	x	x			x	x			x	x
2	x		x	x			x	x				x
3	x	x	x	x			x	x			x	x
4	x	x									x	x
5	x			x			x					x
6	x			x		x						
7			x	x			x	x	x	x	x	
8	x				x							x
9	x										x	x
10		x	x	x			x	x	x	x	x	x
11		x	x	x			x	x		x		x
12		x									x	
13	x	x	x	x			x		x			
14				x		x						x
15				x			x	x	x	x		
16	x				x	x					x	x
17	x	x									x	x
18	x				x	x					x	x
19	x				x	x						x
20	x				x	x					x	x
21			x	x			x	x	x	x		x
22	x			x	x	x						
23		x	x	x						x		x
24	x				x	x					x	
25		x	x	x						x		
26		x										
27		x	x	x			x	x	x	x		
28		x	x	x			x					
29	x	x			x						x	
30	x	x								x		
31		x	x	x				x				x
32	x	x									x	
33	x				x	x						
34	x			x	x	x						
35			x				x	x	x	x		
36		x		x	x					x	x	x
37	x	x	x	x	x	x		x	x	x		
38	x				x	x						
39	x			x	x		x					
40	x			x	x						x	x
41	x										x	
42		x		x		x					x	
43	x	x										
44	x	x									x	
45		x	x	x						x		x
46			x						x	x		x
47	x	x		x								x
48	x				x	x						
49		x	x									x
50			x	x			x	x	x	x		
51	x	x									x	
52	x	x			x					x	x	x
53	x				x	x					x	x
54	x	x									x	
55		x	x	x								x
56				x			x	x	x	x		
57	x	x		x			x					
58					x	x						
59	x											x
60	x	x								x	x	

* The intersection of row (reference number) and column (area of interest) marked by an "x" indicates that the reference is relevant to the topic.

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We are at ... a point

A Construction Strategy for an Environmental Education Integrative Model.

Systems Language
NFP

1) Select a candidate integrative net, such as axiomatic language.

2) Collect system core themes 3(a) and ~~classify~~ identify them according as to whether they belong in ~~propositional~~ elements (nouns) or ~~combinatorial categories~~ relational rules (verbs) or combinations (sentence).

3) Select an initial set of systems propositions for the generating set.
Semantic. identify all of the nouns, Dictionary

4) Collect ecological, economic, energetics, nutrition, ekistics,... core themes. designated here as theorems

homeostasis - feedback

5) Translate all theorems into a common systems terminology. [This translation is in itself a major integrative process]

translation rule to relational rules

6) Trace between the systems generating set (3) and the theorems (5) as is possible.

7) When tracing is not possible, heuristically add new propositions to the generating set. Again attempt the trace.

8) Iterate step (7) until each of the theorems in (5) can be traced to the restructured generating base.

9) Translate the final systems language into the various user languages.

10) Trace from specific case studies to key theorems or to the generating set as required by the situation.

The term 'trace' is used instead of the more formal derive or prove, until formal inferential steps can be developed in systems language.

SUMMARY REMARKS

Traditional and Current American Education is designed (unconsciously) from the I-It level to bend all participants into Thinking/Sensation Types

The New Perceptive is

1) values clarification must address the level of consciousness of the values dictating the polarizations in behavior

2) values clarification must be available without intervention of expert or specialist

3) techniques developed for measurement of values during I-It consciousness can be adopted to methods of values clarification on I-Thou levels if educational awareness changes level

Integrative Models

must be: Anticipative -- OSIM (Outer Static Integrative Model)
Inferential -- ODIM (Outer Developmental Integrative Model)
Predictive -- ODIM (Outer Developmental Integrative Model)
Economical -- OSM (Outer Static Model)
(economy providing)
Transforming -- IDIM (inner developmental integrative model)
Descriptive -- OSM (Outer Static Model)

There is no such thing as an ISM (inner static model)

Basic test of an Integrative model: you get more out than you put in

The Integrative Threads (IDIM's) of Value Clarification

1) The I, I-Not I, I-It, I-Thou, I = I Levels
    in value and morality
    in freedom
    in consciousness

2) The 5 World Views
    charts, worldview profiles

3) The 4 psychological types
    Myers-Briggs Indicators, Wilson Social Types

Integration is achieved through perceiving all 5 world views or all 4 types in a self-referential manner. Integration is achieving a new level in the I-Not I helix.

TRANSFORMATION IN EDUCATIONAL ARRANGEMENTS

Old style	New Style
ask me what you want to know or need	internalize developmental guidance
transfer of information	ability to organize information fields
separate work/study	integrate work/study
low prioirity on personal experience/ listen-learn	high priority on personal experience learn by doing
separate learning/social action	alternate between learning/social action
protect,certify insights and skills	mutual pooling of insights and skills
role communication	interpersonal communication at new depth
allignment with consciousness level of existing system	allignment with higher levels of consciousness

DRAFT

WORKING PAPER ON INTEGRATIVE MODELS

WILSON

Introduction

Both the Environmental Education Act and the primary recommendation of the Arizona report stress the necessity for the construction of an integrative model for environmental education. In the wording of the Arizona Report, the primary recommendation is "To develop core themes and a conceptual structure in environmental education that synthesizes and integrates pertinent subject matter across and between a variety of traditional disciplines". (1.18) The report does not characterize an integrative model specifically but does give examples of what it regards as the primary core themes or unifying threads with which such a model is to be built. Five core themes or key concepts are suggested: Environmental unity; General Systems Approach; Energy Flow; Economics; and Human Settlements or Ekistics. (1.8) The report suggests further that these primary themes may be divided into secondary or sub-themes such as, pollution, land use, population patterns, etc.

From these recommendations and suggestions, a sequence of questions emerges. First, what is an integrative model? Before one can sculpt an elephant, one must know what an elephant looks like. The views reported by three (or five) blind men who describe different parts of the elephant's anatomy, by themselves will not allow us to sculpt an elephant. And if we validate our model by having the blind men check it, thay can only verify the particular portions whose input they supplied, which means we could satisfy each of them and still not have an elephant. How, then to proceed? The sculptor knows the elephant is an animal, so it must have certain anatomical parts to enable it to perform requisite life functions and these parts are known to be located with respect to each other in standard ways. Hence with the fundamentals of animal anatomy and physiology the sculptor can derive the general guidelines of the design. The dimensions of the legs, the size of the ears, the shape of the trunk, etc, inputs supplied by the blind men, can then serve as the boundary conditions which constitute the specifics to which the general anatomical principles are to be molded. Redundancies in the inputs are no problem, they are actually helpful in checking the fit; but inconsistencies in the inputs pose problems for the sculptor and he must make decisions to favor certain inputs over others. Extricating ourselves now from the metaphor, what are the fundamental processes and techniques for synthesis and integration and where have these methodologies been developed?

A visit to the science section of a typical university library reveals that about 95% of the books limit their subject matter to a single branch of science or to some specialized topic within one branch. The bulk of the remaining books are general science textbooks that cover several fields and are written primarily for use in introductory science courses, or are survey books touching on several fields of science written for laymen. But few of either the general science or survey books have anything integrative to say about the various branches they describe. In fact books of an integrative nature inter-relating the principles in the various fields of science are almost non-existent. This lack of books on integrative aspects of science is not only a comment on the nature of present day science, but on the concerns and capabilities of scientific epistemologies in general. While there exist unifying schemata like the periodic table of chemical elements or the electromagnetic spectrum which inter-relate restricted domains of scientific phenomena, there are no general unifying schemata or integrative processes in science. Only a few books in the philosophy of science have anything integrative to say and these only on the so-called scientific method. (Which is largely what unifies what is presently called science.)

Looking next at the various system disciplines, cybernetics, General systems theory, information theory etc, we find that their epistemologies allow the subsuming of diverse phenomena much more than do those of science. Although a discipline like general systems theory is based on the recognition that everything is related to everything else and that there is no such thing as a isolated system and that you can never do just one thing (Hardin's Law), at the present time GST possesses no systematic methodologies for synthesis or integration or techniques for discovering unifying schemata even though it emphasizes the importance of these pursuits. It thus appears that the sculptor must himself develop the fundamentals of 'anatomy' and 'physiology'!

Historically, scientific and technical disciplines grew out of the analysis of specific problems--planetary motions, plant fertilization, ore reduction, etc-- It is therefor not surprising that the present condition of scientific knowledge is fragmented and that there are but the most primitive tools for synthesis and integration, while powerful analytic methodologies exist in abundance. When the new problem is ~~to integrate~~ synthesis, we naturally expect it to yield to the old approaches because it is a problem. But the best that has come from the analytic approach to the problem of synthesis consists of a few "hybrid" analytical/synthetic techniques such as Zwicky's morphological method and some of the methods developed in management sciences--relevance trees, graph theory, etc. But this is a beginning and where we had best start.

Types of Integrative Systems

Morphologically, integrative constructs may be considered as static or developmental, outer or inner, leading to four general classes:

Static integrative constructs are schemes for organizing information having the property that additional informational inputs are anticipated and suitable 'boxes' exist for the incorporation of new material. Examples are libraries, expandable files and unifying schemata such as the preiodic table of chemical elements mentioned before. General morphology is a useful technique for constructing this type of system.

Developmental integrative constructs, on the other hand, may be anticipative with respect to much new information* but also include in their structure a reorganizing process for restructuring the file so that it logically incorporates the new material. Only developmental files are integrative in the full meaning of this term. Restructuring of the file each time a bit of new information is added is a process which provides for the continuity of the file and at the same time optimizes retrievability. Such a developmental integrative construct is homologous to an evolving bio-organism in its manner of information adoption and optimization of performance. Successful bureaucracies are developmental integrative organizations, (some, however, appear to fallinto the static category). In general, the adaptive processes in evolution and succession are those of developmental integrative or self organizing systems.

Outer or external integrative constructs are those that organize information of a tangible and practical sort: facts, data, processes, plans, and activities. These systems may be either static or developmental in the above senses.

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* In the rigorous definition of information it cannot be anticipated.

e.g. Education

<u>Inner</u> integrative constructs organize and process information of a psychological nature. Typical materials include beliefs, values, worldviews (core beliefs), and personal psychological materials such as images, fantasies and dreams. Inner integrative systems are <u>necessarily</u> developmental since the processing of this sort of information, whether cultural or personal, invariably restructures or alters the system. This fact is at the root of psycho-therapy and non-conditioning processes that result in value, attitudinal and behavioral changes, such as consciousness raising group techniques and various self-referential devices for value clarification (Ages of Man, Jungian types, worldview charts, value profiles...).

	STATIC	DEVELOPMENTAL
OUTER	Unifying Schemata	Self Organizing Systems
INNER	Empty	Psycho-Therapy Value Clarification

TYPES OF INTEGRATIVE SYSTEMS

WILSON

An additional property of developmental integrative systems must be taken into account. A general principle of systems theory reminds us that in self-organizing systems, any change that leads to a state more resistant to further alteration is immediately assimilated ( ), or in informational terms, acquired information is subsequently used to close the door to further incorporation of information. This principle assures that within a stationary environment, every purely self-organizing system will be converted from a developmental to a static system. This is consistent with the maximumization of stability of the system. However, in a fluctuating environment, due to the demands of fluctuating equilibrium, developmental integrative systems defer their transition to static integrative systems and maintain longer developmental lifetimes. This principle accounts for the termination of evolutional modification and the extinction of some species and for the necessity for revolution in human political and social affairs.) ~~But~~ There is no a priori reason why a developmental integrative system could not be designed to artificially alter its environment so that the demands of fluctuating equilibrium be maintained and the crystalization into a static system indefinitely postponed. Man, indeed, appears to be such a system.

Intentional self-redesign the alternative to ossification & obsolescence

Design of Integrative Models

Several organizational forms have been ~~used in the~~ design of static integrative systems. These all have in common the satisfying in one way or another, of the specification requiring the provision of a relational network of addresses in which information may be stored.

This relational net is so structured that a few simple 'navigational' rules permit it to be easily traversed to any point and thus allow, usually through some coding procedure, for the informational elements to be readily stored and retrieved. The structure of the relational net together with the coding format adopted should display all of the connections and interactions that exist between the stored informational elements.

Static relational nets include simple node-link diagrams which display systems and/or concepts as nodes and connections and/or flows as links. Such node-link nets may take the form of trees or latices. A special type of tree that displays levels of organization or complexity is called a hierarchy. The levels must involve either sequential inclusions or sequential self-references, an example is Bouldings System Scala. Whereas the nodes in a node-link net may be decomposable into sub-systems containing 'micro' nodes and links, the links are generally not divisible. Nodes typically represent locations in the net where there is relatively high entropy production, high density, low extension and long persistence; links are relatively low entropy producers, have large extension and are of brief or intermittent persistence.

A second static format is the matrix which employs rows and columns (or may even be higher dimensioned) to give a simple (x,y,z,...) address net for stored information. Examples are again the periodic table of elements, morphological boxes and in a one dimensional case, the electromagnetic spectrum coded with wave length. Characterizing properties of the stored informational elements are mapped onto the positions in the matrix, thus displaying the informational relations through the geometric relations.

The simplest forms of developmental nets are static nets that are periodically restructured to fit new informational inputs. But a more sophisticated developmental schema not only contains self corrective circuits but contains prescriptions governing the manner of network growth. The most common developmental integrative nets are axiomatic languages such as logics or algebras. An axiomatic language is constructed from a set of elemental propositions (nouns, postulates, system core themes) joined through prescribed operations (verbs, pperators, combinatorial core themes) subject to certain rules (syntax, algebraic laws, general systems principles). Axiomatic languages, like common languages, involve semantics, syntax and grammar,i.e. involve the characterization and definition of the elemental propositions, their relational properties, and the rules governing the manner in which they are to be combined. The construction of such a language involves the identification of a self-consistent set of generating axioms and the allowable rules of combination. The linkages in a network of such linguistic statements are not mere connections or flows, but possess inferential or predictive powers. Thus the network has the capability to grow through epitactic extensions derived from its generating base and additional informational inputs. In this sense an axiomatic language is integrative and developmental. Examples of axiomatic languages include Euclid's geometry, Aristotle's logic and their descendents, modern abstract logics and meta-logics. A systems language developed from a set of core themes (system, stability, information,...) according to certain combinatorial or relational rules (analogy, homology, isomorphism, micro/macro,...) would constitute a developmental integrative model.