AN OPERATIONAL MODEL OF THE DESIGN PROCESS
(WITH REFERENCE TO THE URBAN SITUATION)

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ABSTRACT

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by E. Owen Donnelly

Man exists in a time-space situation. The basic components of this relationship are man, both singly and collectively, and his context - the environmental system. Both components have a dependency for their existence and these dependencies define their boundary of interaction. The extent of this boundary as yet is not fully understood by man. His relationship to this environmental system has been and continues in a constant state of change. This dynamics brings to man a confrontation of new situations. A new situation places demands upon man to act. When he adapts to the situation, man interacts with his environmental context causing it to change, if only in a most minute way. With the evolution of time, the patterns of interaction have become very complex. Special classes of people in society were formed to help solve these complex adaptive situations.

Rapid urbanization, at a scale never experienced before, has brought with it great adaptive demands of man. The complex problems of the urban environment have prompted the appearance of the urban planner as a specialist in dealing with particular aspects of the urban situation. The basic goal of the urban planner, as defined by society, is a "good" arrangement of the urban pattern. As a class of decision specialists, planners have developed a body of theories, principles, and methods to deal with the city. Today the field of planning is experiencing a revolutionary transition in its development of new techniques. Its early method was greatly influenced by the physical design orientation of the architect, who was for centuries the specialist concerned with the city arrangement. New planning techniques are drawing heavily upon the work of the mathematician, the social scientist and the advances in technology, particularly in computer science. Many of these new tools are aimed at explaining the urban phenomenon and predicting human behavior. There is a strong orientation toward forecasting.

This thesis conceives of the urban complex as a subject for design. It is recognized that architectural methods are just not up to working with a problem of such scale and complexity. The new techniques that have developed have generally been oriented in other directions, with little attempt made to draw upon our technological capacities in improving the capacity of the design process. The whole mentality of urban design has remained at the architectonic scale. Present literature in the field seems to be recognizing the importance of design at the urban realm, but little has yet been done to develop a design theory for that scale. There have been some notable works in developing substantive techiques, but there remains a great need for a systematic, logical design process; one that can draw upon the newly evolving techniques and one that relates to the comprehensive urban planning process.

The result herein is a step toward formalizing the design process, as a phase in urban planning. The objective is a diagrammatic and verbal model of the design process. Model construction was carried on drawing principally upon problem-solving theory, receiving inspiration from the advances of engineering design. The important concepts, principles, and sequences of problem-solving are examined with reference to their relevance to design. The whole philosophy of design is considered as it affects the design model. Special reference is made in considering the complexities of the urban situation as a design problem. The concept of a city and its structure are vital in the design process, since to amplify the designer's capacity the problem must be broken down into its functional parts, assuring that this structure is recognized in the decomposition.

The model is the representation of a plan to carry out the work of solving a spatial problematic situation. It is operational in that it defines a framework for the designing processes, describing the content and objective of each process and defining the sequence of steps in the process. As a model it is a verbal, graphic abstraction of the processes that should be executed in solving the disorder of a problem situation. It consists basically of a linear series of activities moving from problem definition to solution outcome. The importance of the two basic designing activities of problem search (analysis) and solution search (synthesis) is discussed. Certainly the outcome of this research is but a small step. Important substantive features, along with the incorporation of decision theory and information processing theory have yet to be considered at length. It is felt, however, that many of these additions can be made without seriously affecting the overall rationale of the model.

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To the faculty of the School of Urban Planning and Landscape Architecture for the new challenges they presented and to my fellow students for their daily exchange of ideas. Both served to stimulate a real interest in planning for me.

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INTRODUCTION

The subject of this thesis has been an interest of mine for a number of years. During this period, I have found that my perspective of the subject has been a dynamic one. As a student of architecture I became submerged in an experience that could not be fully understood at the time. Here design was presented in its beaux-arts tradition. There were attempts made at defining substantive theory, but little was done in clarifying any logical discipline. Much reliance was placed on the creative intuition of the designer as he rendered a solution. One would submerge himself in the very heart of the problem and hope for the grand idea to flash across his mind. If you were fortunate to receive this stimulus then it was seized upon and developed as the answer to the design problem. If the grand idea never came then you were stumped and frustration soon set in. I was impressed by the mystique and the seeming inadequacy of such methods.

The perspective underwent a significant change with the initiation of my study of city planning. Here was an area of interest that depended upon design at several scales and as a discipline was more scientific in its methods. My initial view of planning, understandably, was that basically it dealt with the design of the city as a cultural artifact much like a building. The contrast of the analytical and logical methods of the planning processes with yet the basically intuitive design methods found in architecture impressed me.

An historical investigation of planning readily points out its heritage and makes somewhat clear the reasons for the state of design in planning today. There are a number of good reasons why architectural design methods are inadequate in dealing with the city at its urban scale. Merely to point out its dynamics, its size, its scale, and its complexities should be enough to make the point. Quite simply the planning profession is in need of a new body of design theory for the urban scale, as some current literature points out.

One other event added its impulse to my changing perspective of design. It was the challenge of teaching a group of undergraduates spatial design. These were planning students who had a bare minimum of time to get involved and learn about design. There was no opportunity for them to bump elbows with the master and slowly assimilate the wonders of the creative design process. For these people design had to be reduced to a simple, logical discipline. They wanted to know what design was, its utility, and how it accomplished its goal.

These major factors motivated me to consider design as a thesis subject. Of necessity only a particular part of the situation could be dealt with. In the pages to follow the efforts are concentrated on the discipline of design pointing to the development of an operational model with reference to how it applies to the city as a special category of design problem.

CHAPTER I

SETTING A FOUNDATION

A. Planning as an Adaptive Activity

Today, man is a complex being who lives in a vast and complex setting. The components of the basic model (man - environment) have through history been the subject matter of much of man's investigations attempting to understand himself and the world in which he exists. Certainly the relationship is not fully understood even today. This is true probably for no other more important fact than that the interrelationship is always changing. But more than mere change, it has been a change from simplicity to complexity. That is to say, the model is not the same today as it was several millennia ago in primitive societies. The flux or change arises by the action that occurs in one of the components of this simplified system, and by the resulting reaction or effect upon the other component. This on-going change is the process of adaption which takes place in this system. We can trace the rise of complexity in the man component, in the environment and in the total system by describing the evolution of complexity in this adaptive process.

The environment is the source of support for the livelihood of man. Over the centuries he has attempted to use elements of the environment for his good; for an improving life. It is the particular way a group of people go about using the environment that significantly fashions its cultural characteristics. Man, as a member of the animal world, ranks poorly with respect to his physical capacities to exist in his setting. It is only through his adaptive abilities that he has been able to last this long and to attain the level of civilization and culture we have today. The most basic needs of man, food, shelter and clothing - those basic requirements for him to live in his environment - have been fulfilled through exercise of this ability to adapt elements of the environment for his use. Many times the resolution of these needs has been met by artifacts or tools that man fashioned. These artifacts then increased man's capacity to exist, to use the environment, and to build a better life.

In primitive societies the needs were simple, the methods of adaption were simple, and the tools to meet the needs were simple. Through time, as man grew more complex, and the needs or problems confronting man grew more complex and difficult to understand, methods of adapting became more sophisticated. Somewhere along the historical continuum, man (in some simple group form) in his efforts to improve his life or to overcome some problem which threatened his existence found it beneficial to work along with other groups in his adaptive activities. With the recurrence and re-enforcement of group formation, new settlement patterns arose, initially as small aggregates but, as we now know, growing to extremely large agglomerations.

Several things are important here with respect to the use of human settlements and the man-to-environment relationship which I would like to make clear. With the advent of group settlements came more complexity to this relationship because both the man and the environment components became more complex, as well as their interaction. The man component was now complicated because it was no longer man, in a singular sense acting as a simplified and unified group but it was a complex group - a society. There was a more intricate relationship of one man to others and of groups to groups, with ever increasing patterns of human intra-action.

Then, too, with group living man also became part of the environment of other men. Where before it was a simple unified group widely dispersed in the environment interacting mainly with nature, it was now man in settlements interacting with the natural environment but also with the societal environment. But this was not all that complicated the environment component. With increased settlement sizes and along with permanence of their location came the development of a man-made or artifactual environment. It was only through this product of man's adaptive activities that enabled him to live in large complex groups. At first the man-made environment probably influenced the character of living very little, but certainly in a group settlement of today, call it city or metropolis, or even megapolis, and characterize it as being urban, as we do, and we find a living environment that is predominantly an artifactual or man-made environment or at least man-modified.

Certainly the development of this historical vignette is highly simplified and unsophisticated in terms of describing a more complete picture of this evolution. Simplicity has value here for my purpose. I have essentially described the development of the sophisticated man, the rise of society and culture, and the increasing complexity of the man to environment relationship in terms of the evolution of man adapting to his setting as he attempts to survive and to improve his life. Alfred Kuhn, in his book The Study of Society, points out that the survival of a human system depends upon a delicate balance between its input and output. The human system, or man, receives an information input from his environment through his senses and there is a behavioral output. This output must correspond with the input or the whole relationship may terminate. As Kuhn illustrates, if the incoming information is that the surrounding atmosphere is 175 degrees, then some output of behavior must be closely fitted to the input information or its whole relationship will end. This activity he called adaptive behavior which is generally regarded as synonymous with "intelligent behavior." I am interested in two aspects of this adaptive activity. I have already suggested some insights into one of these aspects: that activity, where man fashions artifacts or tools to improve his capacity to live in his setting.

"Since food, shelter, and clothing are considered as the most essential needs of man, the art of making them characterizes the various civilizations on earth. This art is design."[1] These words of Paul Grillo describe man-made objects or artifacts as being designed. Then, man designing is basically man adapting. Figure 1 portrays graphically man's growing sophistication in designing (adapting). It parallels the historical sketch of the man-environment relation discussed earlier, pictoralizing the growing complexity of man adapting to his environment; here specifically in terms of designing.

Besides designing, the other adaptive activity of concern here is planning. Planning in a highly simplified sense has been characterized as a universal activity of all men. Individuals today plan for future events, to avoid future happenings or to

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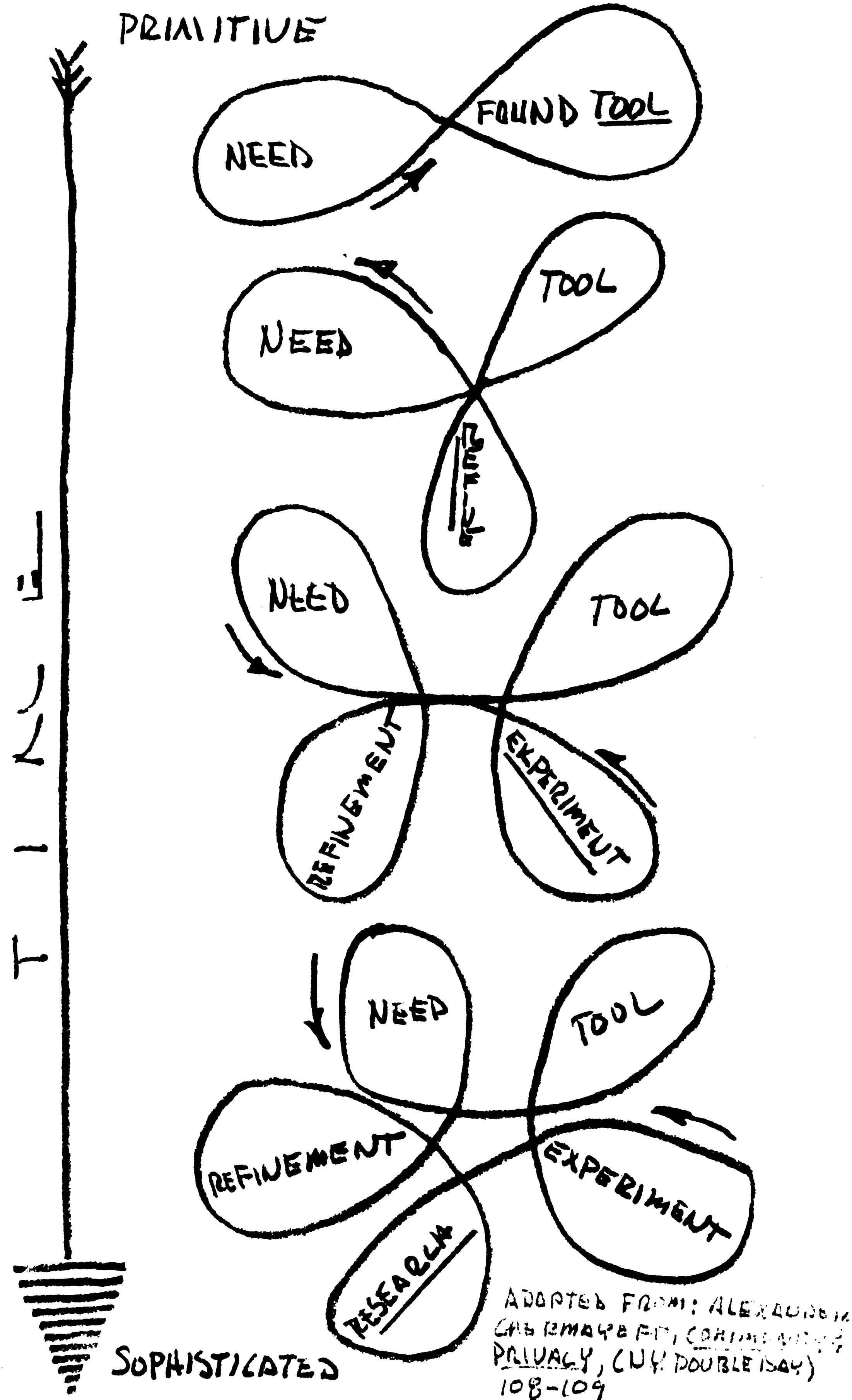
[1]Grillo, What Is Design, (Chicago: Paul Theabold and Company, 1960), Preface.



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CYCLES of THE DESIGN PROCESS: HISTORIC DEVELOPMENT PRIMITIVE → SOPHISTICATED

FIGURE 7.

bring about certain results. Planning can be described simply as a method of acting, a way for doing things, a means of arriving at decisions or solving problems. With this description we can see that planning is very much an adaptive activity of man and that it is somehow related to designing, in the sense we discussed above. Webster's dictionary suggests this relation of planning to designing, as activities. It defines planning as ". . .a scheme for making, doing or arranging something"[2] and design as ". . .to plan, to form (plans, etc.) in the mind, contrive . . .to plan to do."[3] In a synonymic description Webster's continues by stating that "plan refers to any detailed method, formulated beforehand, for doing or making something (vacation plans); design stresses the final outcome of a plan and implies the use of skill or craft. . ."[4] It is sufficient here to recognize that design seems to be an activity that is nested within the planning activity. Figure 2 shows this relationship on a sophisticated level in management activities.

To describe the relationship of planning to design in the primitive situation, earlier discussed with regard to man's

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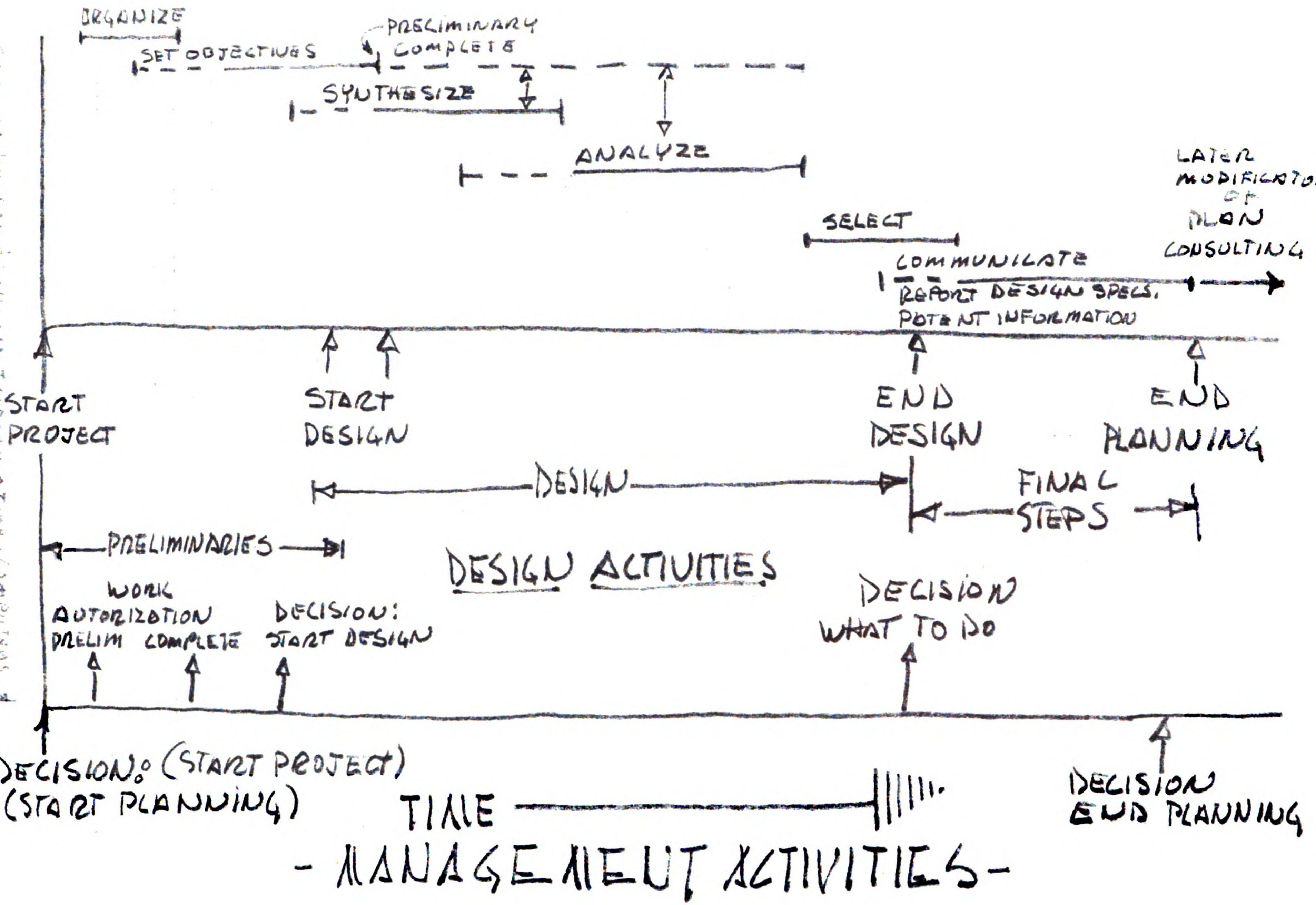
[2]Webster's New World Dictionary of the American Language (New York: World Publishing Co., 1958).

[3]Ibid.

[4]Ibid.



SOURCE: WILSON & WILSON, INFORMATION, COMPUTERS, & SYSTEM DESIGN, (N.Y.: J. WILEY & SONS, INC.), 138

FIGURE 2.

interaction with his environment, is quite difficult. If we think of planning simply as a way of arriving at a decision perhaps we can see that, even in this primitive illustration, there is an interconnection between design and planning. Before man designs an artifact, when confronted with the need to adapt, he would have to make a decision, if it were only to decide whether to act or not. Decisions in this setting, of course, were unconscious and impulsive at first. Spontaneous action of this sort certainly must rank as the most simplified kind of planning. In fact, spontaneity would seem to suggest the absence of planning as we know it today or at best an inferior "seat of the pants" variety of planning. Miller, Gallanter and Pribram in Plans and the Structure of Behavior[5] suggest that spontaneous response is the result of plans that are built into the organism and is not a result of conscious planning. It is important to accept that planning was part of even the earliest adaptive activity. Stewart Marquis makes this quite clear when he stated that, "the Image-Plan-Action-Evaluation model implies that plans and planning are central to all forms of human behavior, that plans guide all action, that ideas are turned into action through the development of plans, that planning is a universal form of human mental activity. This implies that no human action occurs without a

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[5]Miller, Gallanter and Pribram, Plans and the Structure of Behavior (New York: Holt and Co., 1960).

plan, that even automatic activity is performed in accordance with a plan that is built into the functioning human organism, that such diverse human activity patterns as kinship structure, and mass behavior are sequences of action guided by some form of plan or 'set of instructions' built into the individual and his society."[6] Early in the evolution of this planning activity one would see man call upon his immediate past experience, from which would come activity patterns and eventually traditions, which became part of a more intricate pattern of planning behavior.

For the purposes in this treatise let it be made clear finally that both planning and designing will be thought of as two activities in man's process of adaption to his environment. The concept that design is related to planning, in the nested fashion described earlier, is a key idea that will be explored more fully later. And finally, let it be said that this adaptive process is infinitely more complex today, reflecting the evolution of complex man in his complex situation.

B. Evolution of Urban Planning

The main focus of this paper is design, as a part of the planning process. The initial section suggested the evolution

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[6]Marquis, Stewart D., "Plans and the Planning Process" (Unpublished paper for Community Development Seminar, February 29, 1963), Mimeograph), 1.

of man's adaptive activities, moving from the simple to the complex as it parallels the evolution of all culture. The objective of this section is to examine this historical movement, specifically in terms of urban planning. In describing the evolution of urban planning we will be more concerned with the characteristics of contemporary planning, but a brief look at the past should be helpful in understanding the complex nature of planning activity today. As the cultural traditions and content of our society today reflects the accretion of the past experience from which it came, so too with the content level of contemporary urban planning activity. Simply put, where we are today in planning is possible only because where we were yesterday. At the conclusion of this section we should have a better understanding of contemporary urban planning as a product of its history.

Of necessity this investigation must be brief. The main concern is with the last seventy-five years of the urban planning evolution, so we will consider this period more intensely. As a means of setting the discussion in a more complete historical framework we can look at this evolution using Christopher Alexander's[7] convention of dividing all cultural development into two periods; the unselfconscious and the self conscious.

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[7]Christopher Alexander, Notes on the Synthesis of Form, (Cambridge, Mass.: Harvard University Press, 1964).

The idea was introduced that even in a folk societal situation planning was carried on in some simplistic fashion. This had clearer meaning when we understood that design was nested in planning activity, so that when man designed (fulfilled basic needs for food clothing, shelter) he therefore had to plan, if only in a simplified manner. At some point in history, man drew upon his immediate past experiences in making these kinds of adaptive decisions. This early form of planning activity was uncritical and spontaneous. The decisions were 'felt.' It is the result and the way these choices were made that define a culture. "One does not arrive at the cultural realm until one has information as to how and when a particular people eats and sleeps and what they report about their eating and sleeping. In short, the student of culture is interested in those repetitive behaviors that involve a selection from two or more alternatives that are physically possible and functionally effective, that - from the standpoint of a detached observer - are equally open."[8] The repition of particular choices which become part of a body of experiences upon which man drew to make later choices gave rise to unformulated, implicit ways of making choices of doing things. From this experience it was learned that there

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[8]Clyde Kluckhohn, "Parts and Wholes in Cultural Analysis," Parts and Wholes, Daniel Terner (ed.) (New York: The Free Press Glencoe, 1963), p. 114.

was a way of doing things and a way not to do them. With this experience we see the rise of tradition.

Tradition plays an important role in understanding the evolution of planning. A simplified way of looking at this evolution is described by Christopher Alexander when he introduces the concept of dividing all of cultural history into an unselfconscious period and a selfconscious period. He explains these two broad cultural periods with reference to their method of artifactual production (planning-designing), particularly shelter. His description of the characteristics of each culture and the nature of these adaptive processes (form-making, designing, planning) will be useful for us to understand. It explains the two basic periods in the evolution of planning. The particular distinctions of the unselfconscious cultures that Alexander points out are in specific reference to "making things and buildings," in other words, in terms of man fulfilling his shelter needs. Whereas our own culture is very selfconscious about its architecture, art, and engineering, certain cultures are rather unselfconscious about these things. In these cultures there is little thought about architecture or design. There was simply a right way to make a building and a wrong way. Alexander tells us that they may have had generally accepted remedies for specific failures, but there were no general principles comparable to Albert's treatises or LeCorbusier's. Specialization and the division of labor is limited, there being no architects, with each man building his own house. The lack of written records and cross cultural interaction meant that the same experience had to be won over and over again, generation after generation - without opportunity for development or change.

He further explains that this lack of variety of experience results in offering no alternatives as a contrast to their own actions. Instead of becoming selfconscious, they simply repeat the patterns of tradition, imagining no others. Actions in this setting are governed by habit. The design decisions are made more according to custom than according to any individual's new ideas. In this period little value is attached to inventiveness, taboos discouraged innovation and self criticism. With no architectural principles, concepts, or theories there is no means to criticize. There is simply no measure that could be used and in fact, nothing to criticize since there is no "awareness of architecture." The key that Alexander uses to distinguish between an unselfconscious and a selfconscious culture is the method that the crafts of form building are taught. In the former cultures teaching relied on gradual exposure to the craft. The rules are implicit and are revealed through the correction of mistakes. Contrast this to the methods used in a selfconscious culture where there are explicit rules, with general principles that are taught in a formal educational situation.[9]

We come now to our culture, a selfconscious culture in Alexander's terms, in this investigation of the evolution of planning activity. Ours is a society today which displays an increasing division of labor and specialization of activities. We find a highly developed means of recording our past and newly found experiences. Not only are we able to retain this information but we are able to pass it on to whomever wants it, in a variety of ways. With this capacity we find knowledge developing at an increasing rate and the melding of cultures that in the past were, to varying degrees, self-contained in some geographic portion of the earth. These means are interjecting new experiences, new situations, needs, problems, ideas, and values into every contemporary culture.

With this evolution in our society has come the emergence of highly specialized disciplines with their attendant rules of operation. Indeed, today we find second, third, and perhaps higher institutions of specialized activities. Parallel with this development comes the movement of man from a multi-activity livelihood to one of an exclusively singular and specialized orientation. Man now essentially devotes his societal contributive energies and self supporting efforts to a single kind of

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[9] Ibid., 33-35.

activity. With specialized activities comes the constant development of principles, concepts, and theories within each activity, in a perpetual and self-regenerating fashion. Because each man performs within only one of these specialty areas, it is necessary to pass on the rules of the discipline to those who choose to participate. The rules had to be made explicit and institutions were founded to do this and to also teach them. The vast amount of knowledge could only be passed on by teaching aids. We see then that the unformulated precepts of tradition have given way to clearly formulated conventions and universal principles, all teachable rules.

Irwin D. Bross adds a different view to the evolution of man's adaptive activity, when he describes the evolution in terms of the way man has made the decisions that were necessary to him. He states:

> The decision problem is as old as life itself, for a biological mechanism for decision was a necessity for survival. The human animal evolved itself out of a biological mechanism and substituted a cultural mechanism. This cultural process was so successful that human civilizations developed, but these civilizations led to decision problems which were too complex for the cultural mechanism. The civilizations therefore produced classes of specialists whose business was making decisions. These specialists devised intellectual mechanisms for decision. The first mechanism was the Devil theory, the next was Reason, and the latest is Science. Statistical Decision is an intellectual mechanism based on the Scientific Method.[10]

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[10] Irwin Bross, Design for Decision (New York: The MacMillan Co., 1953), 17.

So it has been the case with the adaptive activity of concern here, planning-designing. Repetition of forms do not fulfill the new purposes of our selfconscious culture. Today's problems are entirely new or at least modifications of old problems and vastly complex. Innovation and modification is necessary, and concepts of how things get their shape must be formulated. The selfconscious period finds the development of decision specialist in form-making. The so-called designer was one form-making class to emerge; from the master builder of the past to the architect of today, in the case of the shelter situation. Many other specialists,however, are included in shelter form-making today including the interior designer, several types of engineers, and the landscape architect. With the birth of the consciousness of the city as an artifactual form, capable of being shaped by man in a holistic and comprehensive manner, we find the development of a new form-making, decision-making specialist - the urban planner.

We have considered, then, the development of planning as it evolved as part of a form-making class, from the unselfconscious to the selfconscious period. We cannot really talk about planning or, particularly, urban planning in the earlier period, but form-making in general. In terms of this discussion of the evolution of urban planning, it is thought of as a form-making specialty. The growing complexities of man's situation in the selfconscious period brought about the development of the form-making decision class, initially characterized by generalists as members of this group. Further development of this class has since taken two directions in what seems generally to follow a single historical continuum. From the general form-maker, call him the master builder, the movement has been one of concentration on the elements of the form subject. As was suggested earlier, we see the development of such subclasses, in terms of the shelter situation, as structural, accoustical, mechanical, and decorative specialists. Each has a particular role in shaping the shelter form within the design program. The other movement has been one moving in the other scale direction. Instead of concentrating on a particular element of the shelter problem, it moves toward a comprehensive and holistic perspective of the situation. It is in this movement that urban planning has evolved.

The activity we call urban planning is today somewhere in its evolution as a second or third order level decision-making specialty. Exactly where in the evolution of the discipline can not be accurately judged from this perspective. We do see, however, that individuals in increasing numbers are exclusively devoted to its concern, both as practitioner and as theorists. The academies have now appeared to educate the individuals and to develop more sophisticated rules of the discipline. Urban planning today has grown from the primitive beginnings of form making, that were suggested, into a highly developed adaptive activity. David Parker has advised that contemporary urban planning has evolved from at least five chains of events during the past seventy-five years. He identifies these events and describes their importance. Their importance in this thesis is two fold. First, the major forces that have shaped urban planning today are defined and thus a better understanding of contemporary planning is possible, in that it is a product of these major factors. Secondly, it points out the significant importance that the design or form-making had on the early development of the discipline. The shortcomings of design theory and method in contemporary planning can be partially explained by this historical evidence. Design at first so dominated planning that when its shortcomings were recognized, as a kind of opposite reaction, there was a strong movement away from the importance of form-making instead of attempting to improve the design process along with the theoretical advancements in other phases of urban planning.

The first event that Parker identifies is physical design planning which found its source of inspiration in Daniel Burnham and his designs for the Chicago Worlds Fair of 1893. This touched off the "City Beautiful Movement," which was a rebirth or a renewed interest in the significance of decorative spatial design on a grand scale. Basic also to this development at this time were the social writings of Ebeneezer Howard, who was concerned about the overcrowded living conditions in the large industrialized cities, notably London. These developments gave the momentum for this movement that was concerned with civic design. At first concentrating on civic centers, parks, and streets, it grew to include all the physical features of the city in one plan. The rationale of this planning activity remained grounded in physical design principles, strongly influenced by architectural design theory. The second event Parker notes concerns community development controls. This was an exercise of the police power of the community to insure the health, welfare, and convenience of its population by directing the location, use, height, and bulk of all development. The first zoning ordinance was enacted in New York City in 1916 and the idea spread throughout the country with the notable work of legal leaders such as Edward Bassett and Alfred Bettman.

The emergence of budgeting, first at the federal governmental level, lead to the use of financial planning at all levels of government. This idea was linked with land use planning in the form of capital improvements programs, which enabled a community to allocate its expected revenues to capital developments in long range programs and thus being a tool in effectuating the future land use plan. The fourth event in the chain was social planning. This activity found a thriving environment during the depression era. Many social welfare programs were initiated then that still exist today at all levels of government. The concerns of social planning are now just re-emerging as an important part of community planning. Finally, Parker identifies natural resource planning as the final basic event in the development of public planning. This activity also became popularized during the New Deal era and was directly concerned with the conservation of natural resources. The United States Department of Agriculture and Interior were the chief public bodies concerned with conservation at the time. Conservation planning is carried on today at several governmental levels and recent years has found many federal programs, monies, and policies directed toward these ends.[11]

Contemporary public planning embodies the characteristics from the evolution of planning, from primitive adaptive activities of man through the events in the past seventy-five years that have been outlined in somewhat more detail. Today planning is found at virtually every level of government and in private business and industry. Figure 3 shows a detailed picture of the recent planning evolution.

C. Urban Planning and the Planning Process

It was stated earlier that artifactual production in our culture is a conscious and purposive activity carried on by a

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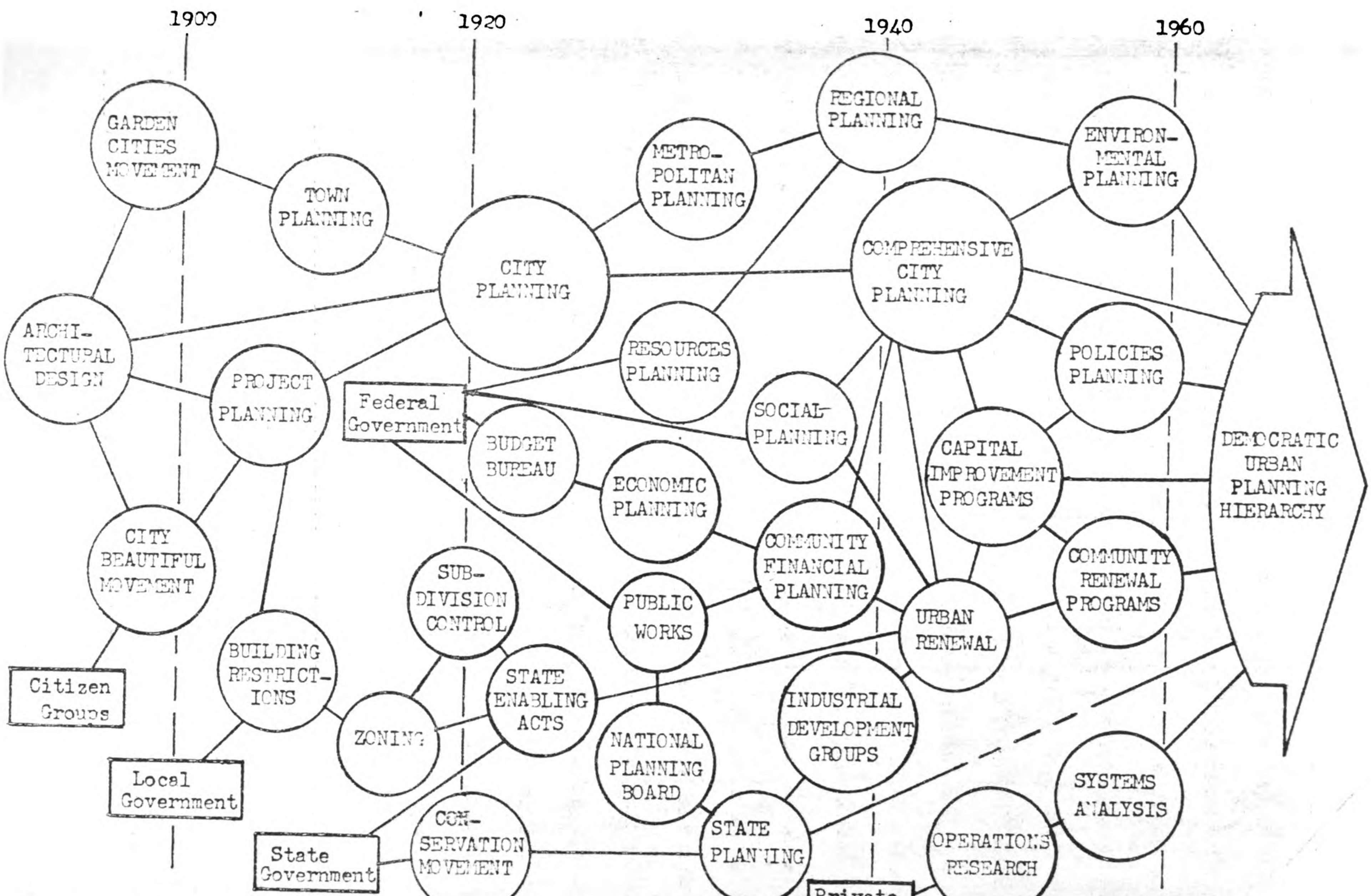
[11] David Parker, "A Long Look at City Planning," The American City, U. 80-2, July 1965, pp. 90-92, 138.



SOURCE: PARKER, "A LONG LOOK AT PLANNING", THE AMERICAN CITY, JULY 65, V.80: 91

EVOLUTION of CONTEMPORARY PUBLIC PLANNING

Figure 3

segment of the population. We have also seen, attendant to the growing complexity of these artifacts, the growth of a more sophisticated and formalized form-making process. Again, this was explained as the increased complexity of the man-environment relationships along with its more complex need situations. Man now looks at the city in its totality, as a most complex cultural artifact. It has only been in recent decades that this consciousness on such a comprehensive level became evident. We now have a complex understanding of the man component, the environmental component, and the interaction of these two in a systematic fashion. The sophistication of our adaptive processes, in some areas, has lagged behind the potential our awareness affords us and behind the technological means that could support a new level of sophistication. The urban planning process is now a formalized conscious activity. Efforts are underway by the young discipline to improve upon its usefulness in the face of the complex situations that it confronts today. Basically, the need is for a more systematic, comprehensive, and logical process, in a highly formalized structure. The efforts of this paper will, in a small way, be concerned toward that end in that they will be directed toward considering urban design as a significant part of the planning process. It is important first, however, to establish some understanding of urban planning and the basic urban planning process, to define the relationship of design to planning, as proposed in this paper.

A review of planning literature reveals myriad ways of understanding and defining planning. Generally, each understanding is closely influenced by a particular philosophical rationale. In this regard, planning is thought of, for example, as a problem-solving activity, a decision-making process, or perhaps, an information processing mechanism. The few words of the following planners point up most of the important characteristics of planning. Edward C. Banfield writes:

> Planning is a way of defining purposes and of choosing means for attaining them. It is therefore a way of arriving at decisions. Decisions which are made consciously, deliberately, and reflectively, i.e. which are not wholly impulsive or capricious, are in some way planned. . . Ideally, then, planning is a rational way of deciding what to do and how to do it; this means that ideally the planner takes account of all possible alternatives, the consequences which would flow from each alternative, and, on the basis of this knowledge, chooses the course which will maximize the attainment of ultimate ends.[12]

Dr. Joseph Heikoff adds:

> All planning involves two kinds of decision. First, goals - we must know what we want; second, means - we must decide how we are to attain them. Planned decisions in these matters are deliberate and are based on careful study and analysis. We include precise definition of ends, collection of relevant information, and analysis of alternative ways of achieving ends. We also attempt to forecast the consequences of following each possible cause of action. Then we can choose the way

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[12]Edward Banfield, "The Field of Planning," no reference, (mimeograph), p. 1.

> we feel will best accomplish what we want, within our available resources, and with the fewest objectionalbe side effects. When we make that choice, we have our plan for action.[13]

Finally, Professor Stewart D. Marquis states:

> Conscious, formal planning is a highly deliberate rational process, dependent upon carefully worked out procedures for searching for problem statements, problem solutions and means for carrying out the problem solutions.[14]

With few words, each author has pointed out important features of planning. We are not so much concerned with the differences here, but more with the similarities that may form a foundation of understanding of planning. As a means of summary, planning, as understood herein, is a conscious and deliberate process of defining goals, ordering them according to a value system, and systematically selecting means to attain the desired goals, in an optimizing fashion. The techniques of the process so far as possible are precise, logical, and scientific, drawing upon many fields of knowledge.

We are, however, not only interested in a basic understanding of planning, but, perhaps more importantly for the purpose here, an understanding of the planning process itself. Sometimes when describing planning authors lean toward a step by step description, suggestive more of the process rather than

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[13] Joseph Heikoff, "The X, Y, Z's of Community Planning," Public Management, Vol. XLIV, No. 3, March 1962, p. 56.

[14] Marquis, loc. cit., p. 1.

the nature of planning. Admittedly, it is difficult and perhaps unnecessary to separate the two. It is important at this point to briefly consider the planning process, its content, parts, and particular qualities.

In this respect Professor Sanford Farness stated that:

> All modes and levels of individual or collective planning follow a universal pattern of human actions. The essential steps are namely: concept and theory formation, goal forming, survey and fact gathering, analysis, plan-making, and programming.[15]

Philosopher Sidney Hook lists five basic components of every planning scheme. They are:

1. the formulation and acceptance of a clear objective.

2. an accurate survey of the terrain and resources on and with which the work must be accomplished.

3. the accumulation in strategic centers of the appropriate powers, materials, and auxiliary supplies.

4. the coordination in space and of human effort and labor power, and

5. the supervised execution of the rate, tempo, and results of activity.[16]

Finally, for Henry Fagin:

> The essence of urban planning is the deliberate coordination of the activities of many individuals through disciplined research and creative inventions. Planning comprises five functions: research

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[15] Sanford Farness, "The Planning Process and Environmental Health," paper presented at the Conference on Environmental Health Planning, University of Michigan, Ann Arbor, March 1964, (mimeograph).

[16] Sidney Hook, as quoted in Banfield, loc.cit., p. 5.

> and information, general goal formulation, specific plan making, coordination, and the furnishing of assistance and advice.[17]

It is important to realize, of course, that a process is a continuous series of actions or activities. This makes it difficult to describe in terms of grouping the activities into meaningful sequences. The various perspectives that the authors above bring to the question of describing the planning process, coupled with the nature of process itself, gives rise to somewhat different steps in the respective definitions. The samples used here are most basic and show a strong similarity of rationale. An attempt to describe the planning process in some detail is illustrated in Figure 4, which was prepared under the direction of Professor Richard D. Duke at Michigan State University. Nine important sequences are identified and structured in a time sequence, giving the process a movement of direction. By subdividing each major sequence component, it suggests that in application the process gets very complex. Worth noting at this time is the sequence labeled Plan Design, pointing out the place of the design function in the planning process.

In understanding the urban planning process several important conclusions can be made. The number and name of the

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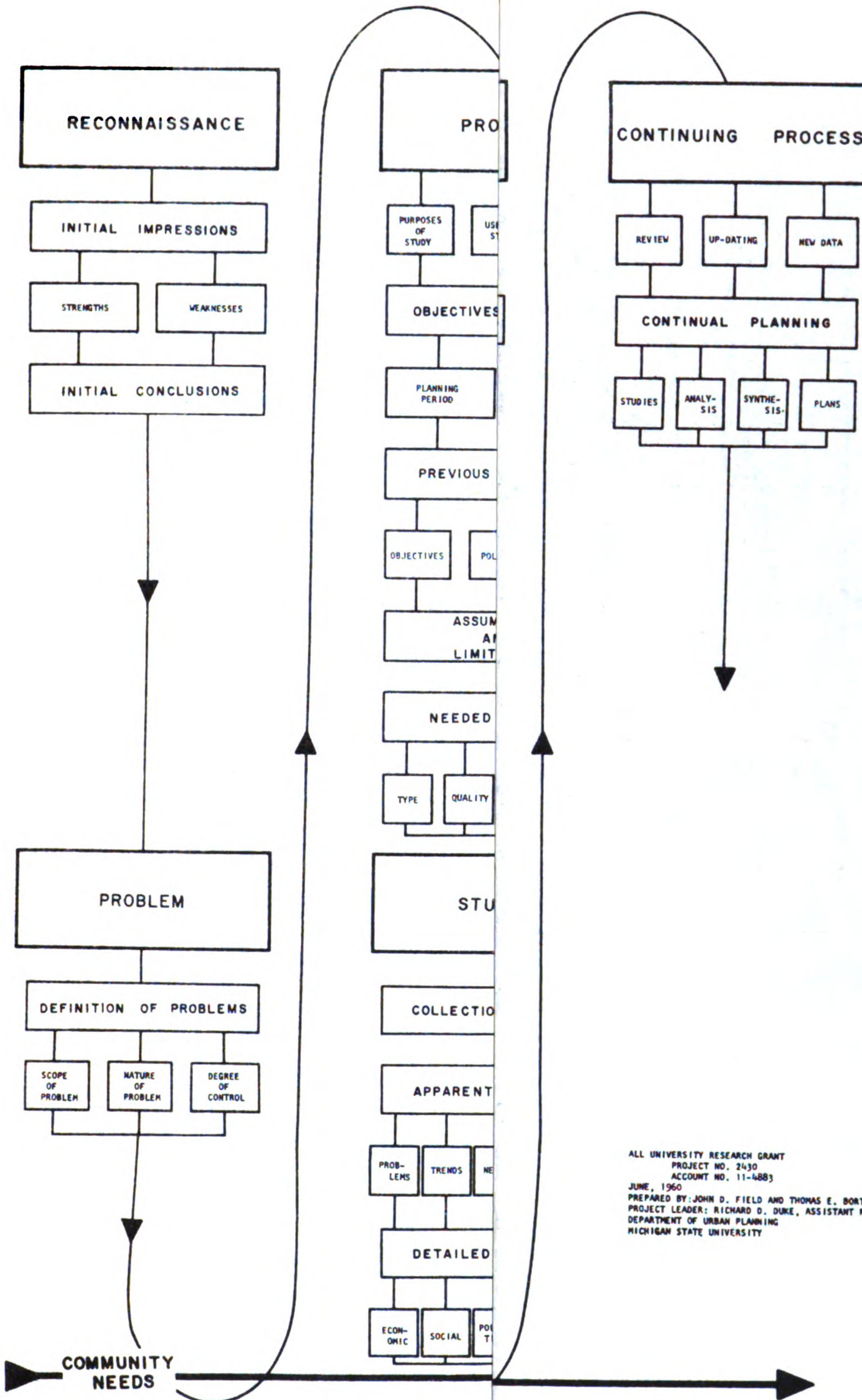
[17] Henry Fagin, "Organizing and Carrying Out Planning Activities within Urban Government," Journal of the American Institute of Planners, XXV-3, Aug. 1959, p. 168.



ALL UNIVERSITY RESEARCH GRANT
PROJECT NO. 2430
ACCOUNT NO. 11-4883
JUNE, 1960
PREPARED BY: JOHN D. FIELD AND THOMAS E. BORTON
PROJECT LEADER: RICHARD D. DUKE, ASSISTANT PROFESSOR
DEPARTMENT OF URBAN PLANNING
MICHIGAN STATE UNIVERSITY

THE CESS

basic sequences suggested are not significantly different to warrant further discussion. The substantive content of each remains basically the same. The fact that there are identifiable elements in the process and that they are structured into a particular dependency network is important to recognize. This gives form to the process and meaning to its parts. The process has a directional movement, Stewart Chapin suggests that it follows "a circular rather than a straight-line sequence."[18] This means that there is a general re-cycling or feedback action that takes place, where the process is repeated as new information is found and as change takes place over time. These iterations improve and refine the planning process. One further directional feature to note here relates directly with the re-cycling process, but on a sequence to sequence basis. Here "the planner can return to re-evaluate and perhaps redefine conclusions from earlier phases after later work has pointed up discrepancies. This type of continual iteration is an inherent part of all phases of the planning process."[19] In this case it is possible to have minor iterative loops within the process as suggested by Figure 5.

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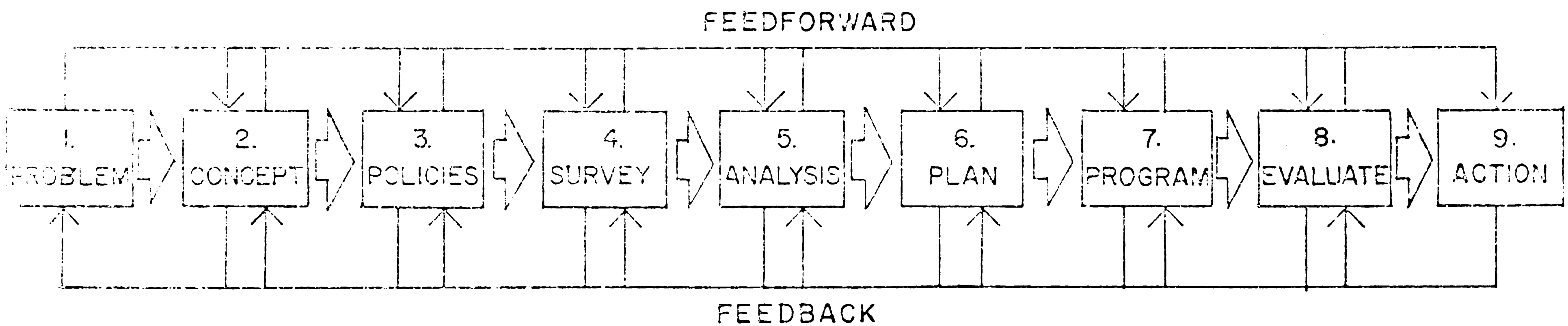
[18] Stewart Chapin, Urban Land Use Planning (Urbana: University of Illinois Press, 1963), p. 272.

[19] David F. Parker, "An Operational Model of the Planning Process," (unpublished Master's thesis, School of Urban Planning and Landscape Architecture, Michigan State University, 1965), p. 18

PROGRAM PLAN MODEL



SOURCE: Parker, op cit. 20

FIGURE 5

One final conclusion. If we consider the planning process as a problem-solving or a decision-making process each sequence that is identified in the process represents a component or element of the problem solution or the decision to be made. This would indicate that each sequence then represents a subproblem or a subdecision or, from another perspective, a problem or decision situation in its own context. The importance of this characteristic becomes clear when it is then recognized that each major sequence in the planning process can be thought to have an organic, cellular structure, where the form of each cell (sequence) reflects the form of the whole. These qualities of planning and the planning process are basic and important to further discussion.

D. <u>Design and the Design Process</u>

It has been suggested earlier that design is the response to individual or group needs and, as such, is a common activity to all kinds of human behavior that relate to the changing environment of man. In discussing planning as a form-making adaptive activity it was noted that design was a phase of the more encompassing planning process. Recalling the description of the planning process and its qualities, the design process as a sequence in planning reflects the basic planning process rationale. As we move on to investigate the relation of urban design to urban planning it is important to establish, along the way, an understanding of design.

Design, through the centuries, has defied those who have attempted to package it into a neat capsule of succint definition. This is generally true most probably because design is an admixture of science and art. The balance of scientific method and the process of art within design activity varies with the particular field of concern within which the process is being executed. This would suggest that there is always some philosophical setting that gives meaning to the process. Generally, it has been in those fields that, for one reason or another, place more emphasis on the importance of the art process in design where formalization, which then allows definition, has been lacking. In certain areas of applied science, engineering being a good example, where more the opposite is true, attempts at definition have been more welcome and indeed more fruitful. The fields dominated by aesthetics have continued, even to today, to stress, perhaps overstress detrimentally, the creative artistic aspects of design. These areas, such as architecture, have resisted the attempts to systematize design and to make explicit the design process. They have preferred to keep design secretive in an egotistical manner. Keeping it locked deep in the depths of the subconscious of only the initiated, they have clouded it in an aura of mysticism. The result is that it is difficult to really understand what design is. The only way one learns about this design is by working closely with and by being inspired by one of the "masters." Indeed much of architectural education at today's universities still greatly reflects this thought.

Some designers have gone so far as to claim that by its nature, design defies the parameters of definition and that should the time come when it can be defined, then, because of its nature, it will cease to exist. "They insist that design must be purely intuitive; that it is hopeless to try and understand it sensibly because its problems are too deep."[20] "There is a good deal of superstition among designers as to the deathly effect of analysis on their intuition - with the unfortunate result that very few designers have tried to understand the process of design analytically."[21] Alexander suggests that these designers rarely confess their inability to solve the more complex functional problems and because they don't understand the problem they cloud the real issue by falling back to only implicit processes of design and concern themselves only with the art form, the way it looks, and arbitrarily

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[20]Alexander, _op. cit._, 8-9.

[21]_Ibid._, 6.

choose some formal order for which there is no functional justification. As he points out, the problem remains unsolved. For this reason, the term design in reference to architecture, for example, has lost its full meaning and is commonly used today in reference to only the aesthetic features of the form. As we will see later, this is also the case with the meaning of urban design today. This situation exists mainly because of the heritage of these design fields. At one time these processes were sufficient, but they simply have not kept up with the growing complexities of today's functional problems.

A cross disciplinary investigation offers the best perspective on design and the design process. Webster's dictionary definition states that design is "to plan; make preliminary sketches of; sketch a pattern or outline for or the arrangement of parts, details, form, color, etc. especially so as to produce a complete and artistic unit, or a thing planned for or outcome arrived at."[22] Burl N. Osburn uses a technique of examples in attempting to convey his meaning of creative design to his readers. Thus, he writes:

> When a house is planned the architect studies the needs of the people and decides what building features are necessary to supply these needs. He organizes these elements into a unified plan, adjusting them to secure the best use of each. The furniture designer knows styles, woods and methods of working and joining parts. His plans show the

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[22] Webster's, <u>op. cit</u>.

> cabinetmaker all the essential requirements of form and construction. A silversmith uses a plan in order to work without waste of time and material. It is much easier for him to make changes on paper than for him to make changes in a costly piece of metal, once it is partly shaped. A design is a plan.[23]

Grillo states that "design is an end in itself. It is the achievement of man's logic in adapting his creations to his natural environment and way of life."[24] Of design Alexander adds that it is "the process of inventing physical things which display new physical order, organization, and form, in response to function. . .the ultimate object of design is form."[25]

Each of these brief insights makes an addition to a basic understanding of design. Webster points out that design is that part of making a plan which is most concerned with the outcome. Osburn, by means of his various examples, makes clear that design is the process of meeting needs in an efficient manner by means of an organizing function. Grillo adds that the organizing technique that is used should be logical in its adaptive action. Finally, Alexander ties these all together by simply stating that the ultimate concern of design is a physical form to meet man's needs. With this accomplished, we now have a feeling of what the process of design is about. Other features

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[23] Burl Osburn, Construction Design (Milwaukee: Bruce Publishing Co., 1948), p. 1.

[24] Grillo, op. cit., p. 11.

[25] Alexander, op. cit., pp. 1 and 15.

of design may be important to briefly review at this time.

Morris Asimow, in describing engineering design, suggests a number of principles which make a significant addition to understanding the purpose of design and the movement of the design process. The process can be thought of in terms of a trial and error process, that is, as a series of tests. In this regard certain optimal standards or criteria must be established as part of the process. With these standards it must be determined that the material good of the design is physically realizable, that it must have sufficient utility to the consumer so that he is willing to pay for it, and that it is financially feasible to design, produce and distribute the goods. The movement of the process is from the abstract to the concrete as it continually proceeds to reduce the uncertainties involved. In attending to the solution of a design problem, there is uncovered a complex of interrelated subproblems. The solution of the design problem depends upon the solution of the subproblems. With reference particularly to the sequential movement of solving the subproblems, the process tends to be iterative. That is, cyclical looping takes place where the process moves from the solution of one subproblem, a design step, to the solution of the next subproblem, but because of any number of reasons returns to the earlier step to make adjustments and improvements. This process constantly refines, clarifies, and increases confidence in the designing activity. Another important aspect to recognize with regard to the subproblem characteristic of a design problem, which Asimow points out, is that a principle of minimum commitment should be followed for the most effective use of design. To follow this principle, the design process attempts to make only those decisions or commitments that are necessary to solve the subproblem at hand, attempting to minimize the affects on future design decisions. In this way maximum freedom to investigate alternatives for future subproblem solutions is possible.[26]

J. Morely English offers added insights into understanding design some of which are closely linked to Asimow's ideas, but are included here for special emphasis. In his observations, English discusses design also in terms of engineering. He conceives of the design situation as dealing with a system, the inputs to the system, and the outputs from the system. Design deals with the identification of the controllable and uncontrollable inputs, as well as the specification for the output or performance of the system. Data or information must be gathered and processed about the inputs, the system and the outputs. In that a specification of performance is a key element in design, the process must, to some level of certainty, be capable of prediction

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[26] Asimow, Introduction to Design (Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1962), pp. 5-6.

in advance of construction of the real system. The selection of desired outputs involves decision processes in design. The decisions are made based on certain criteria of acceptability that are defined. In this manner certain alternatives in each case are measured for their value or utility. The system is conceptualized on a component by component basis and tested. When it meets desired standards and goals the system can then be materialized and the design process is terminated.[27]

This cross-discipline view of design clearly points out that design activity is common to a variety of human endeavors, with always a common movement of rationale, but with a variety of means of execution, from the highly intuitive art process dominated fields to the formal scientific dominated methods of the applied sciences. Most of these views of design dealt with the nature of design as an activity of man's. While the main purpose was to establish a foundation of understanding about design nevertheless many insights have already been gained about the process itself. At this point there are some other features of the process which should be considered. In this respect we will rely again mainly on those fields which have formalized the process.

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[27] J. Morely English, "Understanding the Engineering Design Process," The Journal of Industrial Engineering, XV-6, November-December, 1964, p. 292.

The discipline of design is a detailed method of applying certain theories, laws, and rules to recognizable categories of problems. For this reason the discipline is dependent upon a particular body of principles and general concepts, which provide a structure of reference for the application of these laws. A body of principles and general concepts which are organized to form a useable intellectual structure is called a philosophy. Asimow describes the relationship of the discipline and the philosophy by stating:

> Whereas a philosophy forms an intellectual superstructure or overall strategy which molds and guides the development of discipline, discipline provides an intermediate intellectual structure or strategy which molds and guides the attack on categories of problems. The practitioner, when an immediate and particular problem, must develop from his knowledge of discipline a specific attack or tactic which resolves that problem.[28]

This clearly points out the relationship of philosophy to discipline to practitioner. Important here is to see that the designer has a key role, and will always have a role in the application of the discipline to the particular problem at hand. This means that not only is there a philosophical superstructure to the discipline, but also, "a consistent and integrated personal attitude toward life, or reality, or certain phases of them,"[29]

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[28] Asimow, op. cit., p. 3.

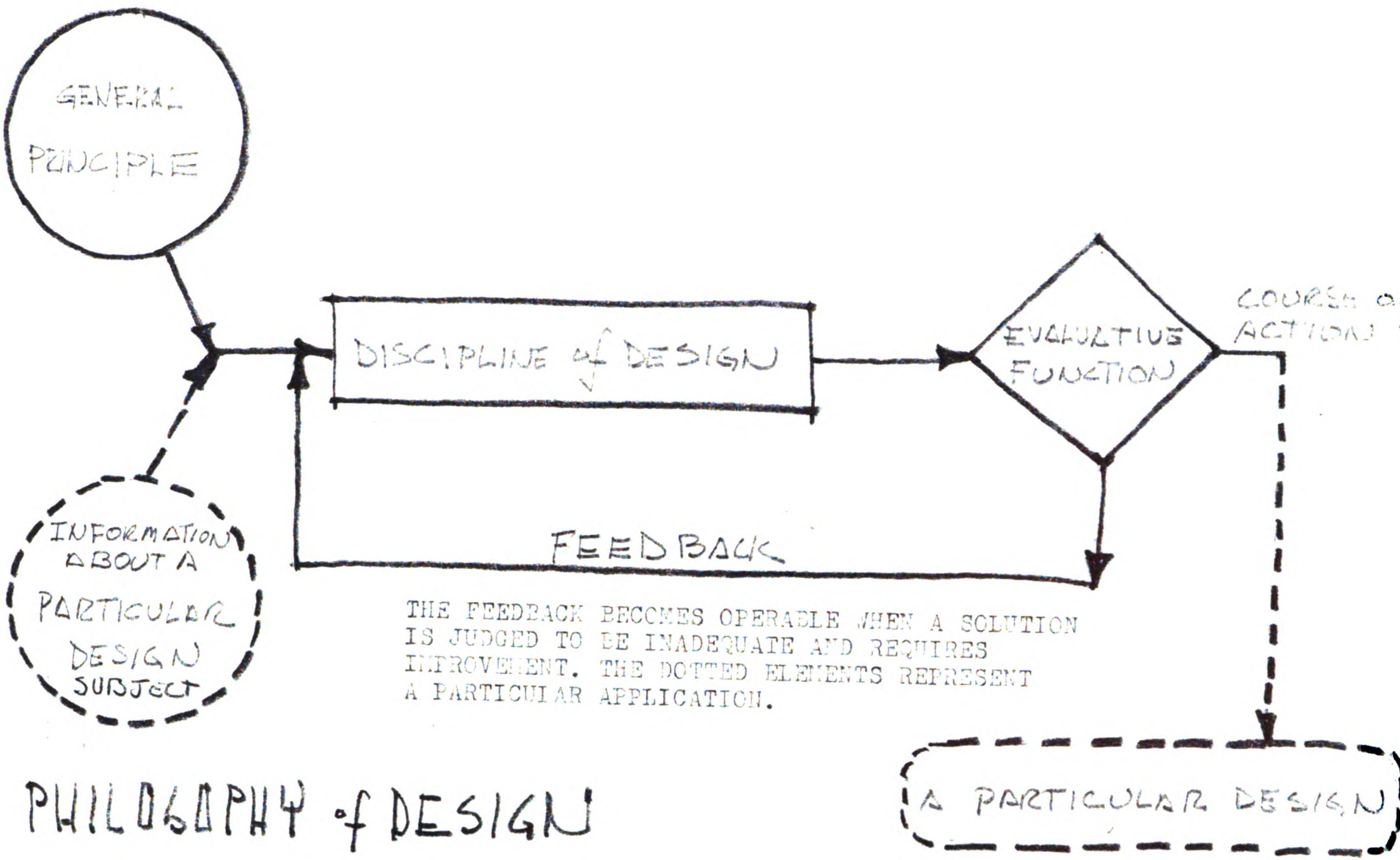
[29] Asimow, op. cit., p. 3.

a personal philosophy. Of course, there is no one philosophy or any particular human endeavor, as no one philosophy of history, or philosophy of science. Indeed, I remember clearly the friction caused by conflicting philosophies of architecture that was experienced in the "jury room" as an undergraduate student of architecture. Figure 6 identifies those parts of the philosophy which must be identified, within which the design discipline is a part.

Alger and Hays point out quite simply the utility of the design process. They suggest that often times the designer moves repidly from a statement of a problem to a specific solution and to find out later that another available solution would have been better. While some designers never overcome this habit, the more successful designer spends considerable time developing an understanding of the problem before proceeding toward a solution. "Therefore, it is often helpful to understand and use a plan for carrying out design work. The plan is called the design process. It is a series of steps or stages through which any design will pass before it is completed."[30]

> The design process resembles the general process of problem solving in the main features, but it uses shapes, and for the most part, more analytical tools, which have been especially shaped and sharpened for the problems of engineering design. It carries the process through analysis, synthesis,

[30]Alger and Hays, Creative Synthesis in Design (Englewood Cliffs, N.J.: Prentice-Hall, 1964), p. 4.



THE FEEDBACK BECOMES OPERABLE WHEN A SOLUTION IS JUDGED TO BE INADEQUATE AND REQUIRES IMPROVEMENT. THE DOTTED ELEMENTS REPRESENT A PARTICULAR APPLICATION.

PHILOSOPHY of DESIGN

SOURCE: ASIMOW, OP. CIT., 5.

R.D.P

figure 6

> and <u>evaluation</u> and <u>design</u>, and extends it into the realms of <u>optimization</u>, <u>revision</u>, and <u>implementation</u>.[31]

Table 1 compares the six steps of the design process, just described by Asimow, with three other authors.

Figure 7, on the other hand, pictoralizes the Alger and Hays concept of the design process and suggests the relationship of one sequence to the next.

J. Morely English defines two inclusive functions in the design process; the iterative or looping function and the decision process with each step representing a decision that must be made. Figure 8 graphically describes the design process as outlined below in English's six steps.

1. It starts with a need. This may be internal to the organization or to the system.

2. The need must be recognized, identified and formulated by means of a specific set of requirements. It must be bounded. Constraints must be identified.

3. The designer, having specified what he wants, must also decide how he will measure or test what he finally gets to insure that it does satisfy the requirements. Indeed, the concept, the design, and the prototype must all satisfy their respective requirements as intermediate assurance that the end product will also. There must be criteria of performance established. This means a value system or perhaps better described, a "utility function."

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[31] Asimow, <u>op. cit.</u>, p. 44.

TABLE 1*

	ASIMOW	INDUSTRY A	INDUSTRY B	ALGER & HAYS
1.	ANALYSIS	RECOGNIZE	INVESTIGATE DIRECTION	RECOGNIZING
2.	SYNTHESIS	DEFINE	ESTABLISH MEASURES	SPECIFYING
3.	EVALUATION & DECISIONS	CONCEIVE	DEVELOP METHODS	PROPOSING ALTERNATIVES
4.	OPTIMIZATION	APPLY	OPTIMIZE STRUCTURE	EVALUATING ALTERNATIVES
5.	REVISION	EVALUATE	COMPLETE	DECIDING ON A SOLUTION
6.	IMPLEMEN-TATION	COMMUNICATE	CONVINCE OTHERS	IMPLEMENTING

*Source: Alger and Hays, op. cit., p. 10

STEPS IN DESIGN PROCESS

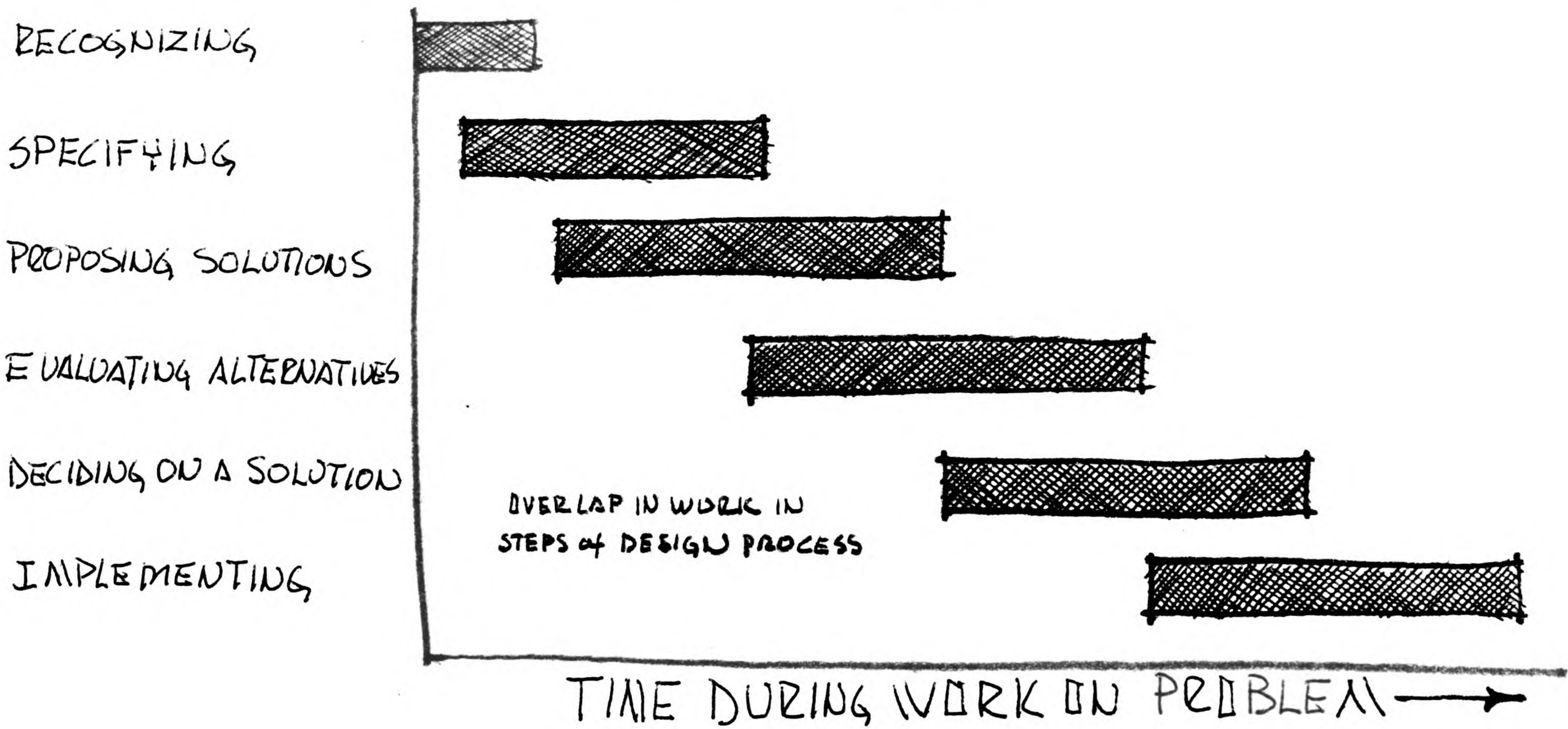
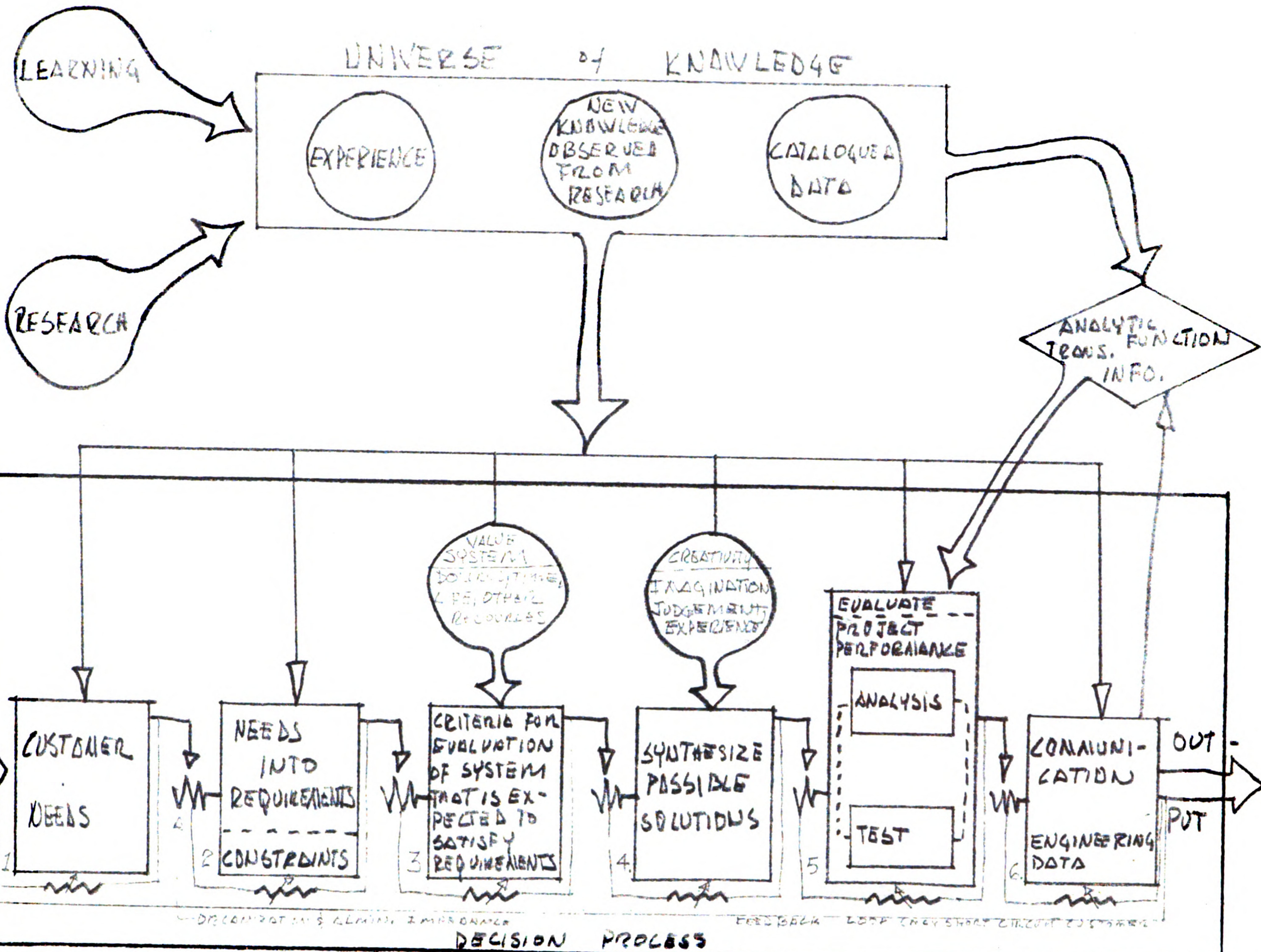


figure 2

Source: Alger & Hays, op. cit., 22.

E.O.O



THE DESIGN PROCESS

FIGURE 8

4. At this point the designer must synthesize the concept of a system which will do the job. He draws on experience in a complex and little understood way and comes up with an idea that "maybe this will work!" Creativity! There are many ways he will do this. In all of them he will proceed from a mental image to some form of conceptualization on paper. This is sort of a self communication loop.

5. Having hypothesized a system, the designer must evaluate it. That is, he must predict its performance in terms of the criteria of step 3 and compare it to the requirements. Two methods,or combinations thereof, are useful-analysis and test.

6. The sixth step, communication, is also a costly one. At the outset the design engineer may only need to communicate with himself. As the project unfolds, there is extensive communication with the customer and feedback to step one-need.[32]

This investigation of design has pointed up a number of its important features. Moving from a brief discussion that served to establish a basic understanding about design, a number of significant features of the processes of design were described. We can conclude that the basic rationale of design is much the same as planning. That is, the process is directional, hierarchical, iterative, cyclical, moves to the concrete, and to higher levels of confidence in a trial and error manner, always testing and re-evaluating its decisions as it moves to a solution. The design process understood in a simple manner is a logical work organization moving to produce a useful solution to some need. Figure 9 begins to suggest the complex levels of the process that are neces-

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[32]English, loc. cit., p. 294.

sary in complex situations.

E. Urban Design and the Urban Planning Process

We have discussed the planning process above, but before we can begin to suggest the relationship between urban design or the urban design process to the planning process, it is first necessary to define what is meant by urban design. As a concept, urban design has suffered the fact of its heritage in much the same manner that was suggested in terms of design as a whole. The result today is that we have a "narrow" concept of urban design. This urban design mentality is contributed to by many classes of decision specialists on the urban scene; the politician, the architect, the engineer, the planner, the entrepreneur and many others. While each role ranks significantly in this situation, we will direct our concern to the architect and the planner in discussing urban design.

The architect has been concerned with city design or the art of city building for centuries, perhaps it should be said that this is true of the group of people who we now label as architects. The key to the concept of urban design of this group is scale. Their concern is directed generally to the building or to space at an architectonic or experiential scale, while attempting to organize space and activity in some order. In the past only special instances found many buildings and spaces

SOURCE: ASIMOW, DESIGN, 19

MORPHOLOGY + DESIGN

FIGURE 9

involved in a single design. Even these cases had a singularity, a dominant force which offered a unifying design concept. In these instances everything in the design was subordinate to this social force. Versailles, Karlsruhe, some Bastide towns, a number of grand garden schemes, and the work of Hausemann in Paris are diverse examples of this larger scale design which, however, was treated in an architectural sense. Most examples of urban design in the past were at the building or single magnificent space scale. Great examples of these are too numerous, but merely as an indication of what is meant, certainly the following would be included: Place Royale (Place des Vosges), Paris, the Campidoglia, Rome, Piazza del Popolo, Rome, and the Park Crescent, London. As there were different "style" periods in building design, we can also classify periods in the design of the urban spaces at this scale.

Edmund Bacon describes several periods that characterize the development of urban design; each with its particular interest. The _intuitive_ period found that the scale allowed unity to be obtained easily. The _Individual-Centered_ period of urban design started with the discovery of scientific perspective by Brunelleschi early in the 1400's. This allowed the designer to represent on a flat plan what is seen by a single individual at a single point in space at a single moment in time. Space was then considered in terms of a fragmented series of disconnected individual-centered movements. The next period identified by Bacon is the Single Movement System Centered which was a logical outgrowth of the one-point perspective with the vanishing point on the center line of the picture plane. Designers thought now in terms of symmetrical buildings or groups of buildings seen from a single vantage point. Today Bacon leans toward the Related Multiple Movement Systems as a base for contemporary city design - of course still in the architectonic realm.[33] In each of these periods urban design is essentially architectural, with great concern for artistic principles, visual forces and aesthetic composition. These periods identified in Bacon's functional terms correspond with such periods as Medieval, Baroque, Romantic, etc. Our concern is not whether these methods fulfilled the needs of their time. Perhaps the single axial movement of the Baroque did express the aristocratic view of that society.

The architectonic concept of urban design still prevails with the architect, for indeed this is his realm of concern. The emergence of the land use planner, initially from the architectural fields, saw the adoption of the traditional urban design philosophy and methods. The planning profession in the United States received much of its early stimulus from the wide acceptance of Florentine-style palace-like civic buildings set around

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33Edmund Bacon, "Urban Design as a Force in Comprehensive Planning," JAIP. Vol. 29, No. 1, February, 1963, pp. 4-5.

numerous lagoons at the Chicago World's Fair of 1893. This great white image brought mass attention to the appearance of cities and helped to initiate the "City Beautiful" movement, which was in the old tradition of urban design. This fair of 1893 influenced public architecture for the next two generations. These events have left a lingering impact on the planning process, as well as prolonging the traditional understanding of urban design. Morton Hoppenfeld with reference to the City Beautiful period has said: "Some few bold and worthwhile projects remain as heritage of that time in many cities across the country, though as an approach to city design, it left too much to be desired."[34]

What prevails generally today in the planning field is a narrow or traditional concept of urban design relegated only to the architectonic scale and the use of the traditional intuitive architectural methods in developing the urban spatial, now called the "land-use," plan. It is suggested that a new higher order realm of urban design is now appropriate, recognizing that part of the planning process which brings spatial form and organization from the community context as, in fact, design -- urban design. Secondly, it is suggested that the designing

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[34] Morton Hoppenfeld, "Toward a Consensus of Approach to Urban Design," Journal of American Institute of Architects, September, 1962, p. 37.

activity on the urban realm scale must be more, or other than just the traditional urban design methods.

Bacon states that "the full potential and proper role of urban design within the total comprehensive planning process is just now beginning to be apprehended by the planning profession."[35] He identifies urban design as covering a range from the Area Plan to the Architectural Image. In Figure 10 he identifies seven steps and their interrelationship in the comprehensive planning process. Whereas Bacon identifies urban design as the range from Area Plan to the Architectural Image, the more traditional view, in this paper we would include the functional plan, even according to Bacon's own description of each. In this range Bacon describes each:

1. Comprehensive Plan deeply rooted in an understanding of the community, based on both experience and research, sets forth an interrelated, sensitively balanced range of community objectives.

2. The Functional Plan sets forth the physical organization, on a regional basis, of a manageable number of factors in their primary interrelation.

3. The Area Plan sets forth, for a limited geographical section of the city, the three-dimensional relationships between the full range of physical factors, correlated with the functional plan, which bear on the problems to be solved in the area in order to achieve comprehensive plan objectives.

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[35] Bacon, loc. cit., p. 2.

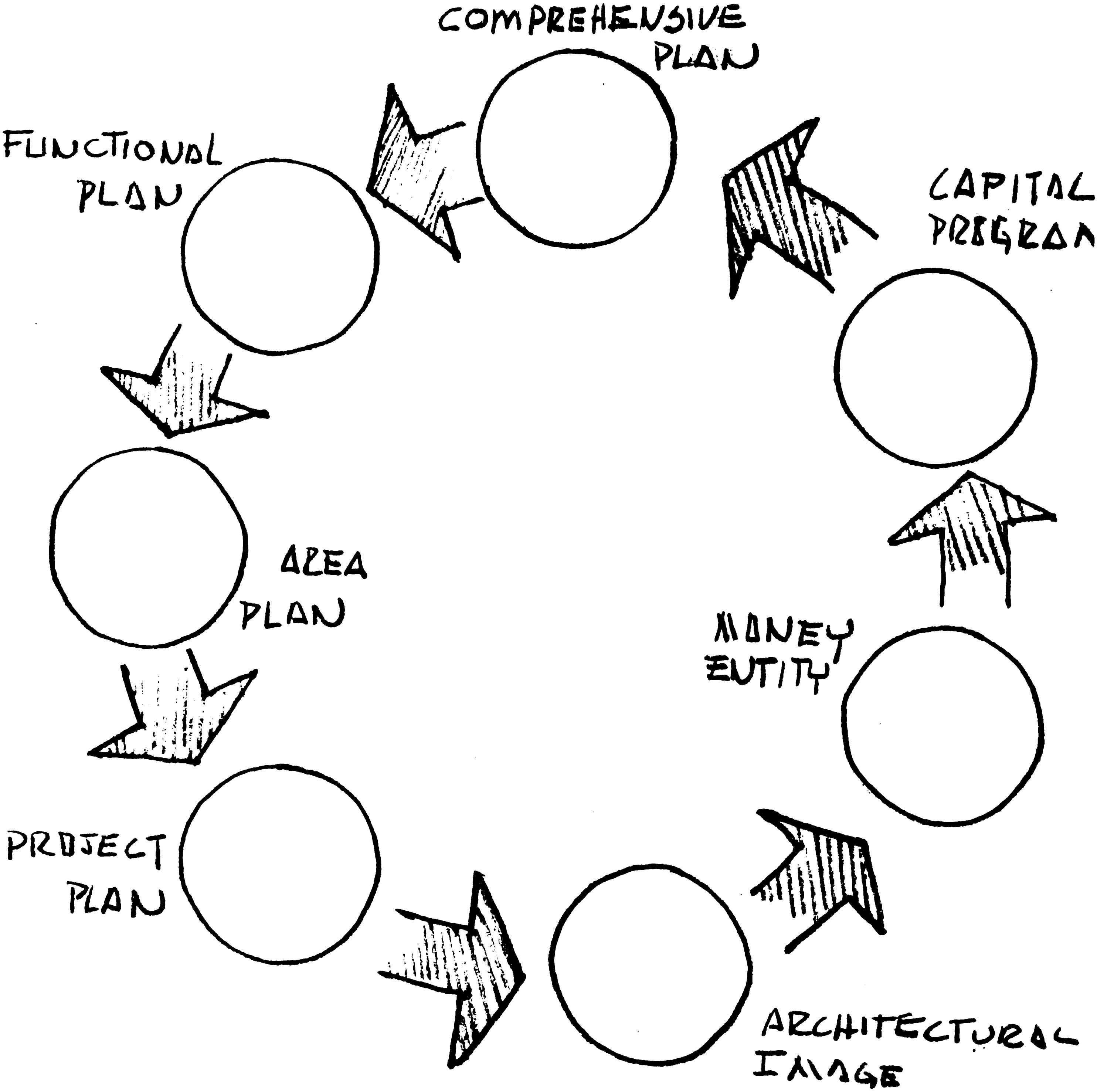

FIGURE 10.
SOURCE: BACON, [illegible].

4. The Project Plan sets forth, in explicit three dimensional terms, the essential nature of the project or projects which are necessary to achieve the objectives of the area plan.

5. The Architectural Image sets forth in human experiential terms what it would be like to see and to move about in the project when it is completed, providing a powerful impetus toward popular understanding and acceptance of the ideas of the plan and popular support for action toward its achievement.[36]

What is suggested is that urban design has several realms within an urban area. Whereas the traditional philosophy recognized the architectural image realm, then slowly accepting the project plan, Bacon includes the next higher scale the area plan. It is suggested to now include what Bacon calls the functional plan, which again is another scale order higher. Of the functional plan, Bacon says it calls for a physical organization on a regional scale. "The specific relationship of components acting on each other is form."[37] And as Alexander suggests, the ultimate object of design is form, physical order, organization. It seems quite easily justified that urban design includes the urban realm as a whole. We must now add this new realm to the concept of urban design because now we have the opportunity, that is, we are now conscious of this realm as a design subject and we

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[36]Bacon, loc. cit., pp. 2-3.

[37]Jesse Reichek, "On the Design of Cities," Journal of American Institute of Planners, Vol. 27, May, 1961, p. 141.

have the technology to make possible its design. We now need the design theory for this scale, more than the present rationale that is used in designing the land use plan.

There is strong evidence in planning literature today that urban design must now include the spatial city as a whole. Morton Hoppenfeld, for one, in several articles has stated quite clearly that we have generally thought of urban design in terms of relatively small areas. He strongly suggests that it ranges to the metropolitan scale as a part of the larger process of urban planning. The key role he sees for the designer, as one specialist on the urban scene, is to interject his formal objectives into the planning process right at the time of program-making. Only in this way can the spatial values of the product outcome be formulated in the program to insure that the design or plan program is not so restrictive from the start to make it useless.[38]

To continue, Hoppenfeld adds that:

> Little by little, with the increased opportunity to rebuild our cities on a major scale, the realization of this urgent need for a higher order of design is becoming apparent. To be truly significant, design must be an integral aspect of the planning process. Just as planners have striven to alert the public to the need for a comprehensive and long-range view of the city so must the

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[38] Hoppenfeld, loc. cit., pp. 38-41.

> planners themsleves now be alerted to the necessity of integrating design into the comprehensive planning process.[39]

Kevin Lynch and Lloyd Rodwin add:

> A systematic consideration of the interrelation between urban forms and human objectives would seem to lie at the theoretical heart of city planning. But the expectation would bring a wry smile to the face of anyone familiar with the actual state of the theory of the physical environment. Where has there been any systematic evolution of the possible range of urban forms in relation to the objectives men might have? Although most attempts at shaping or reshaping cities have been accompanied by protestations of the ends towards which the shapers are striving yet in fact there is usually only the most nebulous connection between act and protestation, not only are goals put in a confused or even conflicting form, but also the physical forms decided upon have very little to do with these goals. Choice of form is most often based on custom or intuition, or on the superficial attraction of simplicity. Once constructed, forms are rarely later analyzed for their effectiveness in achieving the objectives originally set.
>
> What does exist is some palliative knowledge and rules of thumb for designing street intersections, neighborhood, and industrial areas, for separating differed land uses, distinguishing different traffic functions, or controlling urban growth. Analysis of urban design is largely at the level of city parts, not of the whole. The prevailing views are static and fragmentary. When ideal models are considered, they take the form of utopias. These serve to free imagination but are not substitutes for adequate analysis.[40]

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[39] Hoppenfeld, "The Role of Design in City Planning," Journal of American Institute of Planners, Vol. 26, May, 1962, p. 102.

[40] Kevin Lynch and Lloyd Rodwin, "A Theory of Urban Form," Journal of American Institute Planners, Vol. 24, 1958, 201.

Ordering the urban structure certainly presents a formidable problem to design, but only in facing up to the real problem can we hope to resolve it and we can only face the real problem with a logical urban design process for the urban whole. Edward W. Strong substantiated this view when he stated:

> We cannot be sure that human art in design of cities will have the amplitude, the competence, to reconstitute within a totality, intricate and complex, a more humane and beautiful habitat. But, I think we can be reasonably sure that a better ordering will not arise spontaneously.[41]

Urban design at the urban realm has a distinct place in the comprehensive planning process. Certainly Bacon's diagram points this out, as well as his definitions of each step in the process. In terms of the planning process as diagramed in Figure 4, urban design at the urban scale would take place in step seven called Plan Design, but also as Hoppenfeld suggests the design specialist must be included from the start. If we think of the ultimate goal of the planning process as an ordered environment then we can see that urban design is a key sequence. In summary then, urban design has several realms of meaning and at the urban whole realm it is an intimate part of the comprehensive planning

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[41] Edward W. Strong, "The Amplitude of Design," Journal of American Institute of Planners, vol. 28, May, 1962, p. 102.

process. The purpose of this sequence in the planning process is to bring ordered spatial meaning to the outcomes from all preceeding sequences.

F. Urban Design - What Is Needed?

The need for a systematic, logical urban design process arises simply from the fact that the urban realm, as a design problem, is just too complex to be dealt with within an intuitive design process. The prejudice of the designer using an intuitive process fails to allow the sensitivity to all the important forces at play on the design situation. "A good urban design must be consistent with the urban forces at work - the forces of social and political action and urban land economics. In short, a good solution demands a clear, precise and profound statement of the problem itself, and from that the ideas will emerge."[42] As Hoppenfeld points out, the first key is a clear statement of the problem to be dealt with. The problem of an urban realm is infinitely more complex than at the architectonic scale. There seems to be conclusive evidence that the capacity of the designer using architectural methods has been over taxed when applied to this higher order of urban design.

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[42] Hoppenfeld, loc. cit., p. 38.

Jesse Reichek echoes the same concern for the designer's attempt at bringing structure to the urban chaos. Despite our increase in knowledge, he points out, the urban problem has remained a puzzle because of the dynamic relationship that exists between the multi-dimensions of the city, which the designer must deal with. Design concepts such as "axial lines," "dominant landmarks," and "vistas," he suggests might lead to imposing a structure on the city for which there is no present utility.[43]

Hoppenfeld has forcefully and yet quite simply expressed his cry for new design methods. His case is built on the idea that size does, indeed, change things in kind and that over simplification of the urban design process by making it analogous to design at the scale of the building can only lead to bad design at the urban realm.[44] The vast size and complexities of the urban system along with its dynamic forces readily suggest that it is a much different problem than a single building with no further description necessary. Today's approach to the complex problem is different than in the past, in terms of the use of the comprehensive planning process. That part of the process, however, that deals with the spatial plan has its roots in the theories and process of architectural education. There

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[43]Reichek, loc. cit., p. 142.

[44]Hoppenfeld, loc. cit., pp. 41-42.

is generally lacking a true understanding of the problem or an adequate design program. Most designers focus quickly upon a single bold design statement, often symmetrical or at least of two dimensional balance, susceptible to rapid visual cognition, and generally photogenic. The pattern of organic or systems order that exists are not perceptible in the traditional concept of purely visual order. A new approach which would consider the social and physical context, the infinite nature of the urban pattern is needed. The placement of an employment center in the urban pattern requires something different from the designer than the placement of a tree in the urban landscape. Design on the urban realm by its "scale and complex nature defys a formalistic or architectonic approach."[45]

Lynch and Rodwin have stated that planners need better design theory. They call for theories formulated operationally so that they can be tested and verified. The need is for understanding and controlling the physical environment if planners are to be treated as more than "lackeys,"[46] David Crane places the fault of a lack of theory for large-scale design on a lack of imaginative thinking on the part of the planning profession.[47]

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[45] Hoppenfeld, loc. cit., pp. 39-42.

[46] Lynch and Rodwin, loc. cit., p. 202.

[47] David Crane, "The City Symbolic," J.A.I.P., Vol. 26, 1960, p. 280.

The need in urban design can be easily concluded from briefly stated ideas of the authors above, as well as other sources in planning literature. The solution to the need is quite another task. Quite simply, the profession needs an acceptable body of theory for design at the urban realm with the capacity to incorporate the advantages of our present and future technology. This chapter has attempted to set a foundation upon which further investigation and discussion can take place. In introducing planning and designing as form-making adaptive processes the objective was to point out the growing complexity that now places new demands on these activities of man. The obvious conclusion being drawn here is that new methods are needed today and for the future, as they have been needed in the past. Moving to discussing the evolution of planning as one part of all cultural evolution, the important historical facts that strongly influence the body of professional knowledge were enumerated to clarify the orientations found in the profession today.

The investigation of planning and the planning process, design and the design process, and their interrelationship served to establish an understanding of the functional characteristics of these processes. The discussion of urban design is extremely important to the remainder of this work because it is suggested, as some others now have, that urban design needs now to exist at the urban realm, if we are to succeed with planning the urban environment. Having reached the conclusion that design at the urban realm is necessary, we move quite readily to recognize that a new body of design rationale is needed. It is in recognition of this need that we embark on continued research in the future chapters, drawing upon the foundation that has been described.

CHAPTER II

DESIGN - A PROBLEM-SOLVING PROCESS

A. The Perspective

In attempting to understand the adaptive activity which has come to be called design, different investigators have used a number of intellectual constructs. Each of these should not be judged in terms of being right or wrong, but rather in terms of what insights it brings to an understanding of the design process. Because of the particular orientation of each perspective, different characteristics of design are pointed out for a fuller understanding. Several of these categories have been suggested earlier, such as: problem-solving, decision-making, and information processing.

The concern in this paper is the design process in its application to a particular problem category - the city. We call this designing process urban design. For the purpose of constructing a formal, logical urban design process we will look upon this subject as essentially being a problem-solving mechanism. Of course urban design, like design, is never just a problem solving process, or just an informational processing activity or just something else. In fact, it is all of these at once. By taking a single perspective some things are both lost and gained. Certainly, a full or many faceted understanding of urban design is lost, but what will be gained is a consistent and logical description. The ultimate objective of this investigation is not a "complete" description of the urban design process, but an operational model. A problem-solving perspective offers a meaningful limitation, a manageable subject, recognizing the scope of this work. None of the categorical constructs are, in fact, pure, but contain an admixtrue of principles drawing from each other. It will then be urban design as a problem-solving process.

B. <u>What is a Problem?</u>

Man does not exist in a vacuum, but rather in a situation. Earlier this relationship was described in terms of man and his environment and it was suggested that it remains in a state of flux. A situation is merely one's position with regard to the conditions and circumstances of his context and applies to everyone. While this description seems so abstract that it has little utility, it in fact, is basic to understanding what a problem is. A situational change places demands on man. He can either be ignorant of the "new" situation, or hope that it will go away, or because of any number of reasons he may be motivated to action. When one is motivated to action on the change and the action goes beyond the application of known means in achieving a solution, man finds himself in a perplexing situation. Eugene Von Fange defines a problem as "a perplexing situation."[1] Edward Hodnett describes a problem as a "state of disorder."[2]

There are several important aspects of problems that become apparent in the definitions of a number of people. The several following synoptic definitions reveal these important features. To Donald Johnson "a person may be said to have a problem if he is motivated toward a goal and his first goal-directed response is unrewarding."[3] For George Humphrey, "a problem is a situation which for some reason appreciably holds up an organism in its efforts to reach a goal."[4] As

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[1]Von Fange, Professional Creativity (Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1959), p. 122.

[2]Edward Hodnett, The Art of Problem-Solving (New York: Harper and Brothers, 1955), p. 3.

[3]Donald Johnson, as quoted in Braybrooke and Lindblom, A Strategy of Decision (New York: The Free Press of Glencoe, 1963), p. 54.

[4]George Humphrey, as quoted in Braybrooke and Lindblom, op. cit., p. 54.

expressed by Arthur Gates the formal statement of a problem is: "The condition that exists for an individual when he has a definite goal that he can not reach by the behavior patterns which he already has available."[5] Von Fange adds that: "Since a problem involves a perplexity, something new to our experience, it is therefore creative in nature. Thus, a problem may also be defined as a situation demanding creativeness on the part of the individual seeking a solution."[6] Frank E. Williams states:

> By definition, then, a problem situation presents a state of disorder or dearrangement of one's conditions or circumstances. When an individual becomes aware of a need, and a goal is sought which will alleviate the need but the immediate attainment of the goal is not eminent, a block appears which constitutes the problem. This block produces a state of disorder between present behavior and the requisite behavior for reaching the defined goal.[7] (See Figure 11.)

Braybrocke and Lindblom add a final dimension when they state: "The problem is in fact a cluster of interlocked problems with interdependent solutions."[8]

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[5]Arthur Gates, as quoted in Williams, Foundation of Creative Problem-Solving, (Ann Arbor: Edwards Bros., Inc., 1960), p. 15

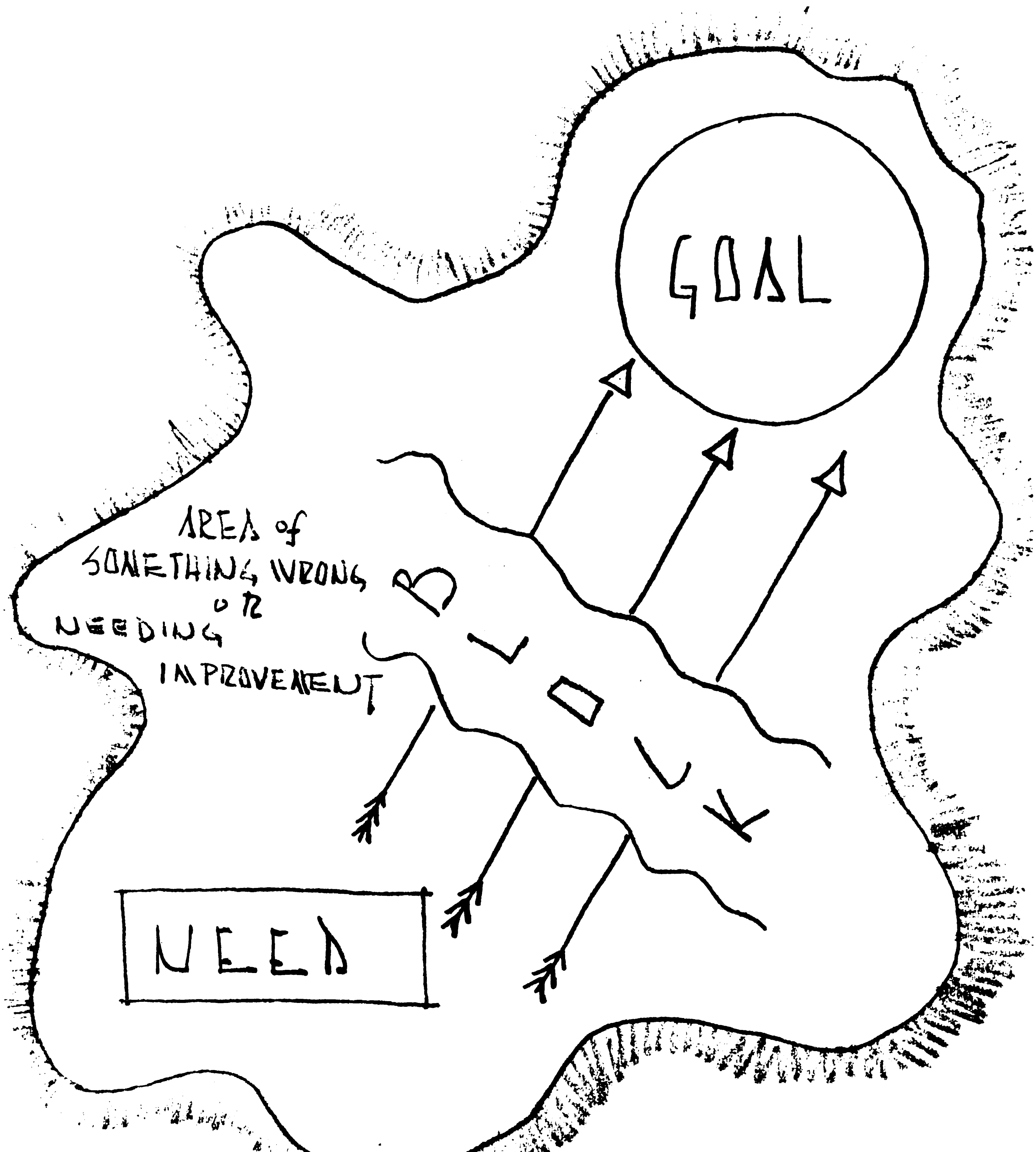
[6]Von Fange, op. cit., p. 122.

[7]Frank E. Williams, op. cit., pp. 15-16.

[8]Braybrooke and Lindblom, op. cit., p. 54.

This selection of problem definitions points up much about the nature of problems. A problem doesn't exist as a neat entity or thing, but rather as a situation. The situation consists of several major parts that can be identified. There must be a felt need. No problem would exist until a need is perceived. Secondly, a goal must be established as that outcome which satisfies the need. If the path to the goal is clear and unrestricted, then there is no problem. Hence, a third factor is the block; that which prevents obtaining the goal immediately. Three other factors don't show up in Figure 11. There must be motivation to act in which case the goal must be a desirous good. There is a time factor or parameter which must be identified otherwise there would be no time limit in attempting to reach the goal, thus no block. Finally, problems are conditions only of people, not things.

Asimow identifies other properties of the problem situation, each of which is part of the block that Williams identifies. He points out that the block consists of those difficulties which must be overcome, the resources available in overcoming the difficulties, the constraints which circumscribe any acceptable solution and finally what criterion that can be used to measure the goodness of a solution or whether a proposed solution can be, in fact, accepted as a



PROBLEM SITUATION

SOURCE: WILLIAMS, OP. CIT., 16.

FIGURE 11.

solution. It's of interest to note here that what Asimow calls difficulties are closely related to what Alexander has labeled misfits. The significance of this close meaning between difficulties and misfits will be made clear later.

We see that a problem is really a situation which may have many perplexing elements interrelated in complicated and often obscure patterns. In fact, a problem usually consists of many interdependent subproblems. Because of these qualities, problems rarely exist with a clear statement of all the factors involved. This complexity makes it difficult to find relevant clues to a solution. Problems are often equated with the difficulties which exist in the situation. More accurately, however, the difficulties are the obstructing elements in the situation, whereas the questions we ask when we reflect on how to overcome the difficulties structure the problem. In solving a problem then, it is necessary to identify all of the elements in the situation before the problem can even be clarified. Certainly one can not hope to solve all but the simplest of problems before the problem is itself defined or understood. This seems to be elementary and yet it is one of the rules of problem-solving that is broken most often.

C. The Problematic Situation

The perspective has been set - design as a problem-solving process. What needs to be considered now is the nature of a problem situation. When dealing with any complex situation in problem-solving, it is necessary to define the structure of the problem situation if the problem solver hopes to succeed. In our case, we will be concerned with the city as a particular category of problem, but before we move to the specific, first let us deal with the general theory. Not only will we consider this matter of problem situation, but at the same time suggest a construct to help the designer understand the situation better. If you will return to Figure 6 in Chapter I for a moment, it will become clear what will be discussed here, and how it relates to the method of design that will be discussed later. We will now be discussing the element labeled as "general principles" in that figure. Later we will move to the element labeled "information about a particular design subject." The importance of these two elements in design philosophy is suggested in this diagram.

The first thing that should be considered, to set a foundation for the general discussion, is the spatial city as the subject for design, or, as I suggest, as the problematic situation. Many current land use or spatial planning models reveal a strong emphasis on explaining and predicting human behavior. These approaches conceive of the urban complex as phenomenon to be explained, in a scientific manner, as an organic configuration that can be predicted much the way the solar system can be predicted from certain physical science theories. The viewpoint taken in this paper conceives of the urban complex as a subject for design. In this approach, the design is a conscious synthesis of urban form to meet human needs and goals. The plan or design product serves as a positive force for the directed development of the urban pattern and form. In this instance design, and not explanation or prediction, becomes the primary problem for solution. Design as a problem-solving method solves the problem situation before the situation arises for which the problem solution has to be carried out. In this way it is the deliberate anticipation directed toward bringing order and control to an expected situation.

The urban environment is a most complex design subject. to understand and to design. Our only hope in making any sense out of this milieu is to use an organizing framework of one sort or another. For a functioning system we must have an adequate model or image before we can design an intellectual structure which unites the seemingly unrelated and infinite number of elements into a logical consistent whole. In this way each of the components and patterns of components has meaning, definition, and dimension in relation to how it fits into the construct. Figures 12 and 13 respectively, suggest how the apparent chaos of an unstructured pattern begins to show a pattern when structured. In this case the constellation categories are merely arbitrary but illustrate the organizing force in using constructs. One such model of a problem situation that has proven useful to me has been described by Christopher Alexander.[9] Let me describe how his model might work in helping to understand the urban complex as a design subject.

In terms of his model, the object of design is form. The problem of design is to fit the form with its context. These, in combination, form the ensemble. The design problem then, consists of a problematic situation that requires the designer to direct his attention to more than just form, but to the problem ensemble, which consists of both the form and its context. The validity of the design outcome cannot be measured outside of the ensemble, but by a condition of fit or "effortless contact" which must occur at "several boundaries within the ensemble, in concert." A "good" design is a "good" fit, one in which form and context are in frictionless coexistence. Figure 14 suggests the relationships in Alexander's model.

In this model, form is the result of "forces" in the environment. If there were no such forces, the world would

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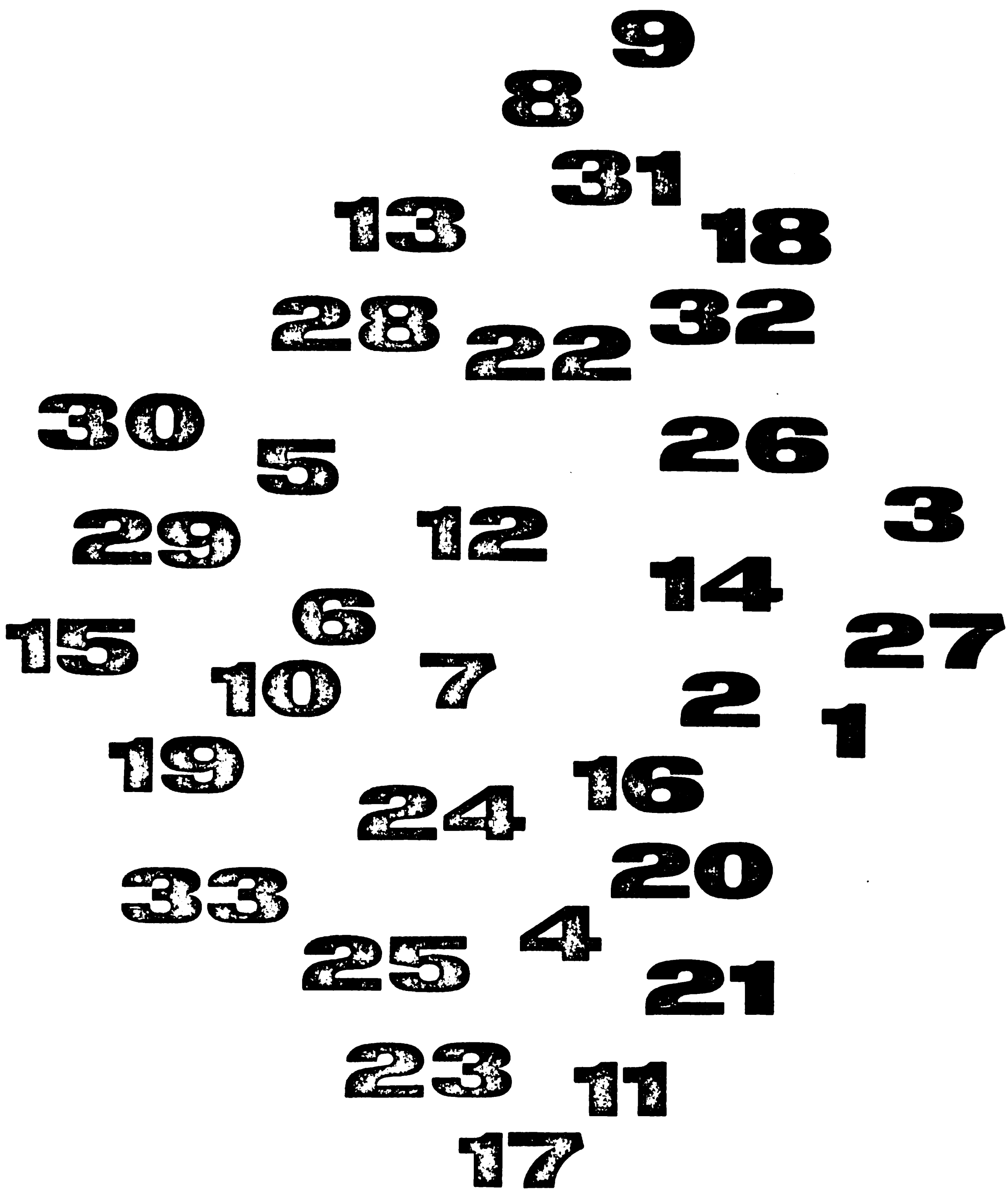
[9]Christopher Alexander, <u>op. cit</u>.



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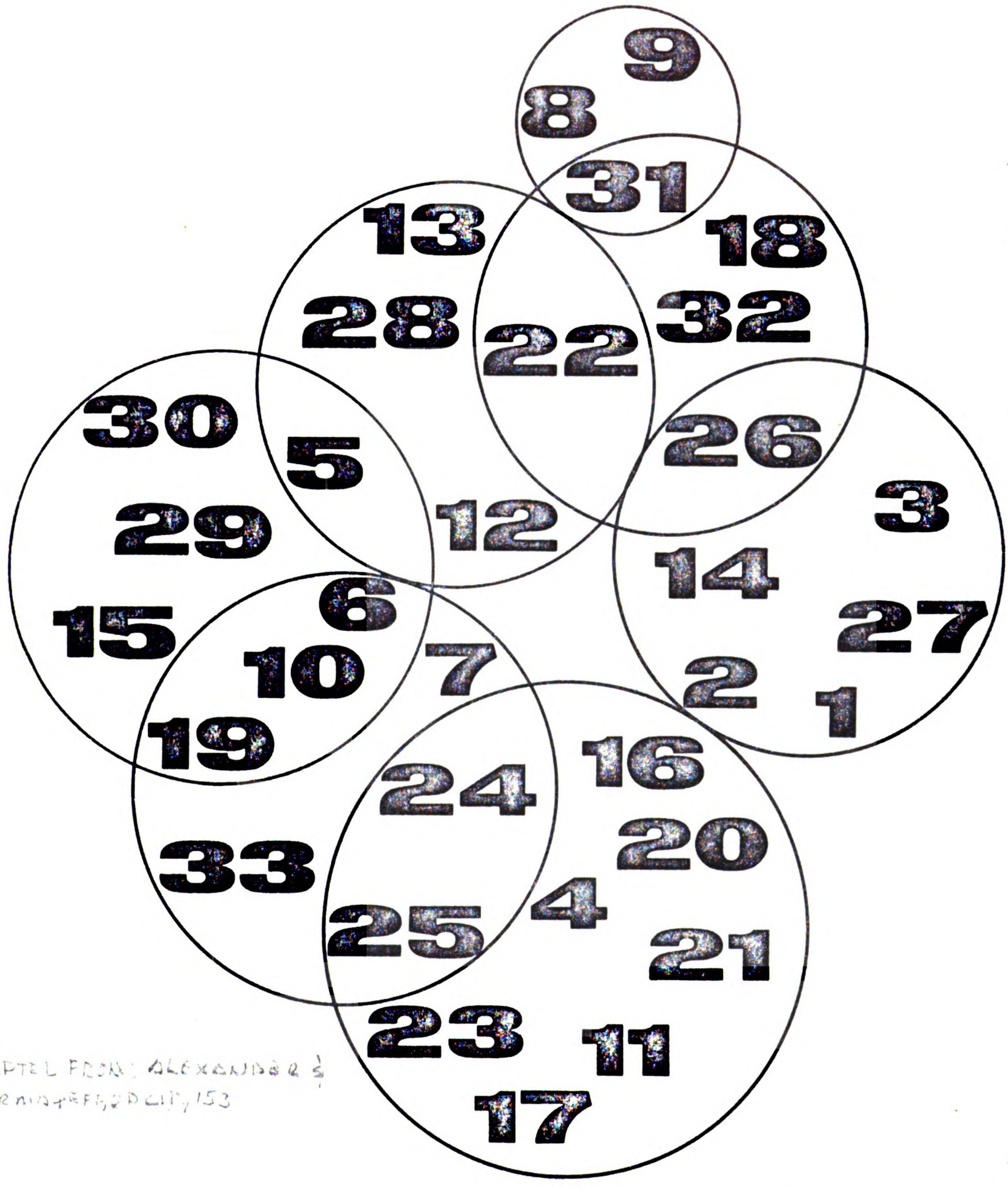
APPARENT CHAOS: THE PROBLEM UNSTRUCTURED

FIGURE: 12



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CONSTELLATION: THE PROBLEM STRUCTURED

FIGURE 13

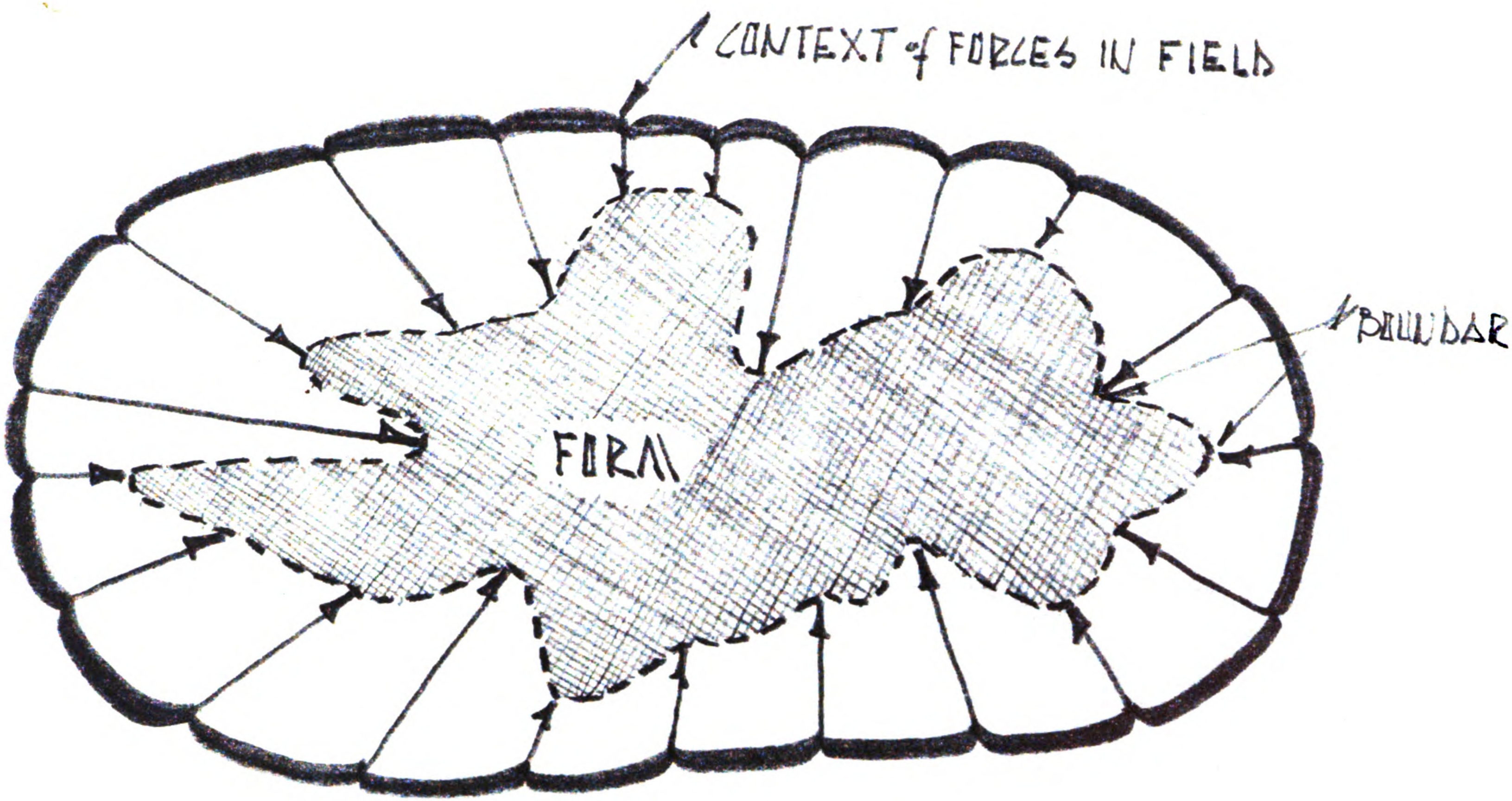

Figure 14 PROBLEM ENSEMBLE

be homogeneous, there would be no articulation of form, only an amorphous environment. To help explain how these forces work Alexander uses the illustration of iron filings in a magnetic field. The pattern of the filings is a direct result of the forces in the field. Architectural design theorists have used many similar illustrations from the inevitable soap bubble to snowdrifts, crystals and crab shells and have explained their form as being products of the forces in the natural environment. The forces in the field that play on the form of the urban complex must be explained by concepts in addition to those developed by the physical scientist. Though certain physical forces exist in the situation, we must look to the social scientist to identify the cultural forces, which are more important in this field. But more about these forces later.

Alexander explains that the form, in the problem ensemble, is that part of the world over which the designer has control: context that part of the world which puts demands on this form and which he cannot control. It is here that we will challenge Alexander, for to accept the context as given is to accept the status quo of a social situation, and to design for that situation so that it may be preserved. The problem for the ambitious designer (the term designer should be generally replaced by the term design team throughout the thesis) is that the context also is subject to his control to some degree. The context consists, at least partially, of human attitudes toward urban life, and these attitudes can be and have in the past been modified. Right from the beginning it was pointed out that the man to environment situation remained in a state of flux. This is why man is constantly adapting, because of change. Alexander seems to have missed this point. It is important to realize that there is interaction between the form and the context. The designer, in the case of the urban situation, must recognize that community goals are dynamic and change by the interaction of community life with the environment, which includes the artifactual components.

Confronted by a flexible context, the designer will be tempted to play the role of social philosopher. He does this when he sets human needs and attitudes in a certain priority. The urban design process at the urban realm, however, is nested in the comprehensive planning process. The planning team, made up of social scientists, planners, and others, is charged with the task of defining community goals, and along with their interaction with the designer (by means of the iterative and interrelated planning and design processes) must evaluate the proposed urban form in terms of its effect on changing community goals. Planners are also noted for their attempts at imparting a priority of goals into the community system. Indeed, this is an important role of the planner. The form of the city is the ultimate result of a "thousand designers;" that is, every decision maker, within and without the community, who makes alternative choices that ultimately have spatial consequences affects the urban pattern. It is the responsibility of the politician via the planner to define the policy (interject values, goals, etc.) that unifies the thousand decisions for the community good, toward the community goals.

What is suggested is that the designer cannot accept the whole context as uncontrollable. On the other hand, the context <u>is</u> a fixed element during a particular phase or loop of the iterative designing process. Perhaps this is the sense in which Alexander uses the term context as uncontrollable. The completion of one complete loop in the design process will result in feedback to the initial design program (context) and perhaps cause a restructuring here, initiating a new loop or iteration. This happens not only symbolically in the problem ensemble between form and context, through the action of the design process, but also in reality. There should be an interaction between the outcomes of the on-going design process and the urban complex (organism) in flux. What is suggested is that the urban design process never gets where it is going, so to speak. The urban form is not a thing but a process. Urban design at the urban realm never finds "the form" then shuts off, but within any form solution that it produces are the seeds of its own destruction. This is the inevitable dynamics of interaction between form and context in reality.

Jessee Reichek suggests this same idea quite well when he wrote:

> A city, as I see it, is process. Not a process leading to some result, but a constant series of motions, actions, and events. It is process in itself. This distinction is important. The city is in constant flux, always going but never arriving. It is process, ever-changing and limitless. This process, the city, is a combination of forces. The question is, then, what forms do these forces have. We wish to find their forms. And beyond that, we wish to find the structure of their relationships. Our problem is to represent the forces which create the city. The total form of the city is the structure of these forces in process; the form is a structured process.[10]

But to get back to describing the design problem in terms of the form-context ensemble. The context, being that which puts demands on the form, when formalized constitutes the problem statement and the design program. Physical clarity, in terms of urban form, if it be more than chance, can only come from a programmatic clarity. This seems only to make sense, to be obvious. When the design is of an urban environment, the number of requirements which characterize the context

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[10] Jessee Reichek, loc. cit., p. 143.

is infinite. The designer cannot possibly keep them in mind at the same time and invent a form that will satisfy them all. An obvious device in simplifying the problem is to classify the requirements into categories such as economy, circulation, safety, legal, and aesthetics. It then becomes possible to make diagrams, each of which expresses the demands of a particular category. But such categories will not help the designer in finding a well adapted solution unless they happen to be independent. For example, the diagram that satisfies the demands of economics is likely to conflict with that which satisfies the demands of safety. The designer finds that his separate schemes cannot be smoothly fused into a compound whole. In practice then the designer is likely to let the category which can be most clearly expressed carry the greatest weight. Others suffer and become the source of misfits. What is needed instead, Alexander suggests, is to give a logical structure to the multitudinous requirements that constitute the context of design. The logical structure does not prescribe form; but it does express pattern, order, and relations which can then be translated into an orderly complex of forms. His logical structure is made up of mathematical entities called "sets." A set is a collection of elements. In design the elements are the individual requirements that must be met at the form-context boundary in order to prevent misfit. The elements may be as various as they need be; they may be quantifiable (e.g. parking spaces per unit of commercial floor area) or they may not (e.g. neighborhood identity). What is important is that each element be clearly enough defined so that any design can be classified unambiguously as a fit. The task of design is not to meet certain conditions but to create an order, that is, removal of all boundary conditions are in a state of non-conflict.

The elements may or may not be interconnected. The requirement for parking spaces, for instance, is connected with commercial space size but not with neighborhood identity. Where two elements are related in some way they are said to be joined by a link. The problem of design can then be translated into a structure composed of two sets; one of elements and another of links. Any graph of this structure tends to pull the elements into natural clusters. Figure 15 is such a structure which points out the links between thrity-three requirements of a problem. The sets pointed out in Figure 15 can be described as subproblems. A complete problem can be described as a hierarchy of sets. Figure 16 illustrates a tree-like diagram that Alexander has used in describing a Kettle problem. Each element is a subset of the sets above it in the hierarchy.

Figure 16 is a decomposition of the design problem and as a constructive diagram it describes the formal and

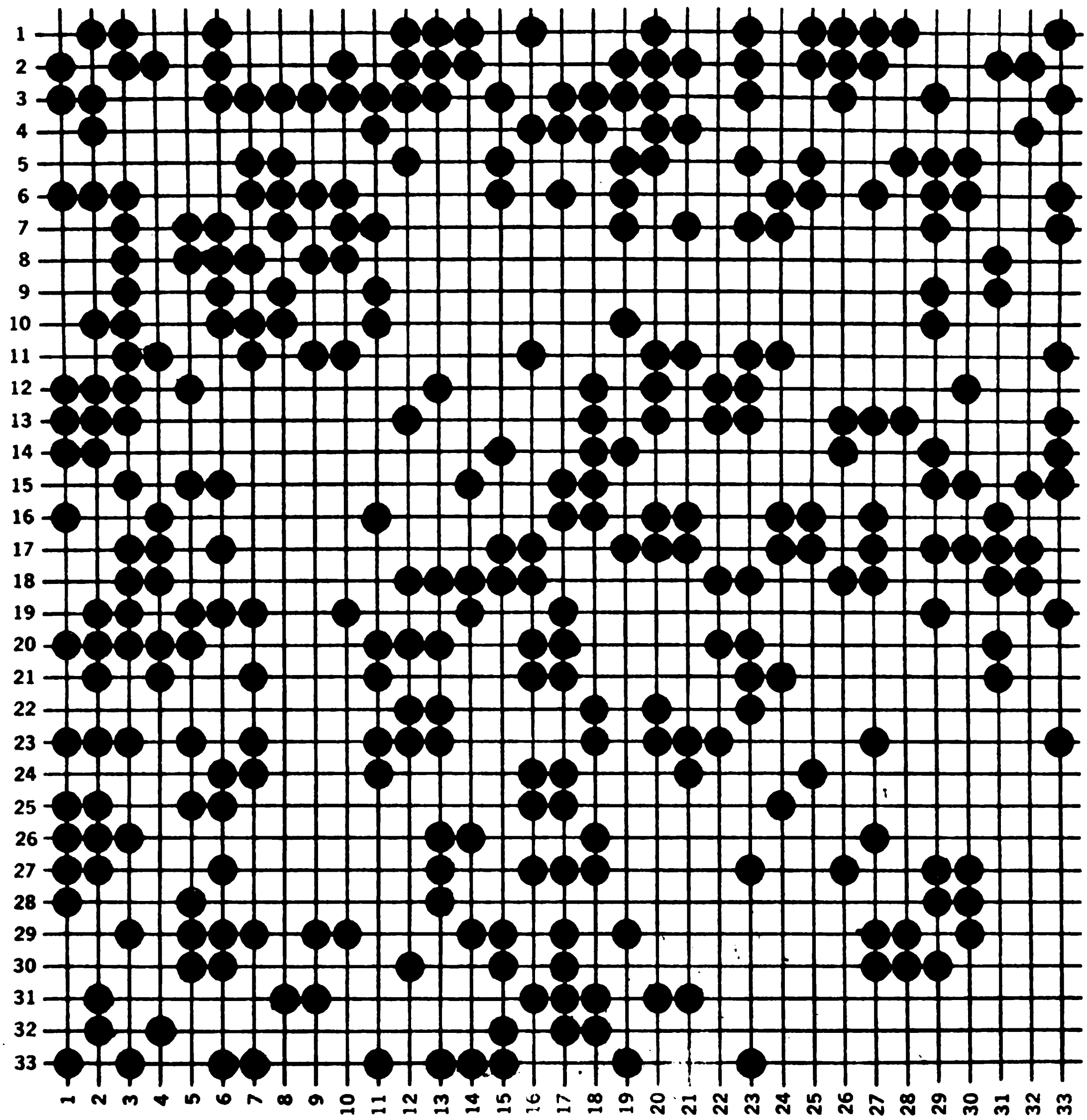

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DIAGRAM of INTERACTION BETWEEN THE 33 REQUIREMENTS of A PROBLEM

figure. 15

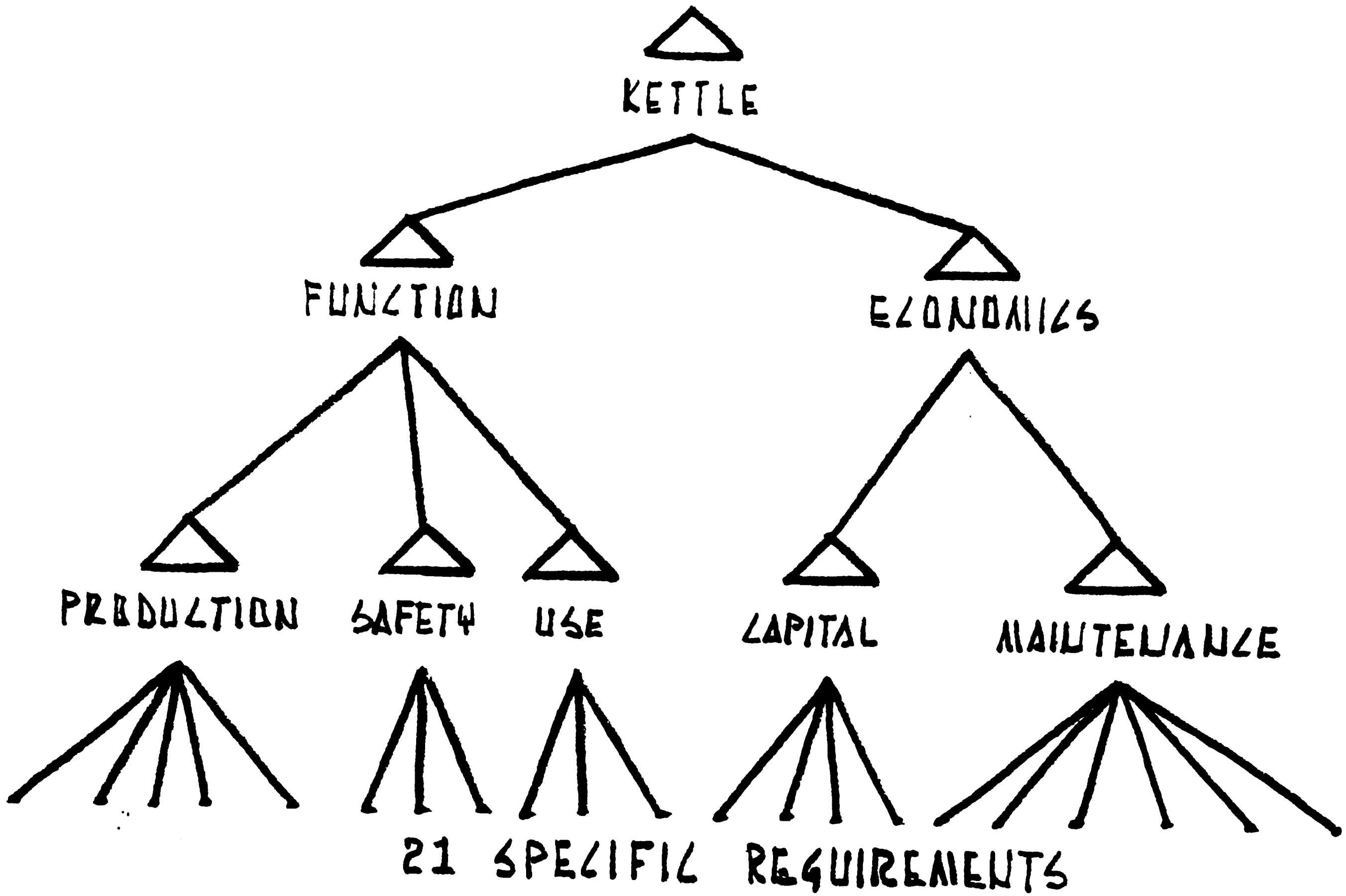
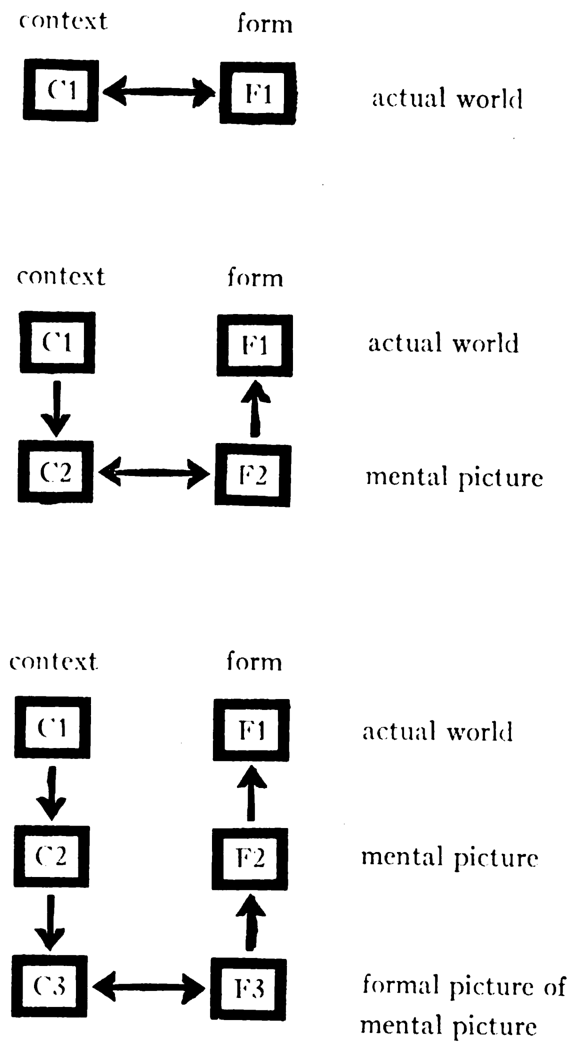


Figure 16 PROGRAM HIERARCHY FOR KETTLE PROBLEM

functional characteristics of the form. In Figure 15 each cluster defines an independent component of the total problem in design and can be solved independently. The decomposition of elements into components (subproblems) is unique. It is likely to be different from the one in the designer's head, which is based initially on verbal concepts like circulation, economics, neighborhoods. The solution to the problem consists in constructing a diagram for each of the components, a compound diagram can then be built from the simpler ones. Unlike diagrams based on arbitrary categories, diagrams based on mathematically derived clusters will not conflict, since each is (as far as possible) independent of the other.

Figure 17 describes what Alexander is generally suggesting. This diagram depicts three kinds of design process. The top scheme represents the unselfconscious situation, which was discussed earlier. The form is shaped by a simple interaction of context and form, with man acting as an agent in the process. In the second scheme, the selfconscious situation, the form is shaped by the interaction of a conceptualized context and a symbolic image of the form. In the third scheme he suggests a further abstraction from the mental conceptual level. And as was described, he attains this abstract level using mathematical set theory. The advantage here is in attaining independent subproblems and in doing away with the biases



THREE KINDS of DESIGN

figure 17

[illegible]

in the mental concepts of the designer.

The use of his method to arrive at programmatic clarity does not, by any means, remove the element of choice and invention in the design process. Invention or ideation is needed in translating the program diagram into concrete form. Choice is necessary, for instance, in deciding on the list of requirements and on the interrelation between elements. For these reasons, a philosophy of the city is needed by the designer to help him, for example, make the choice of interrelated elements. This philosophy is a systematic and consistent understanding of the city.

D. Problem Solving Theory

Major Elements

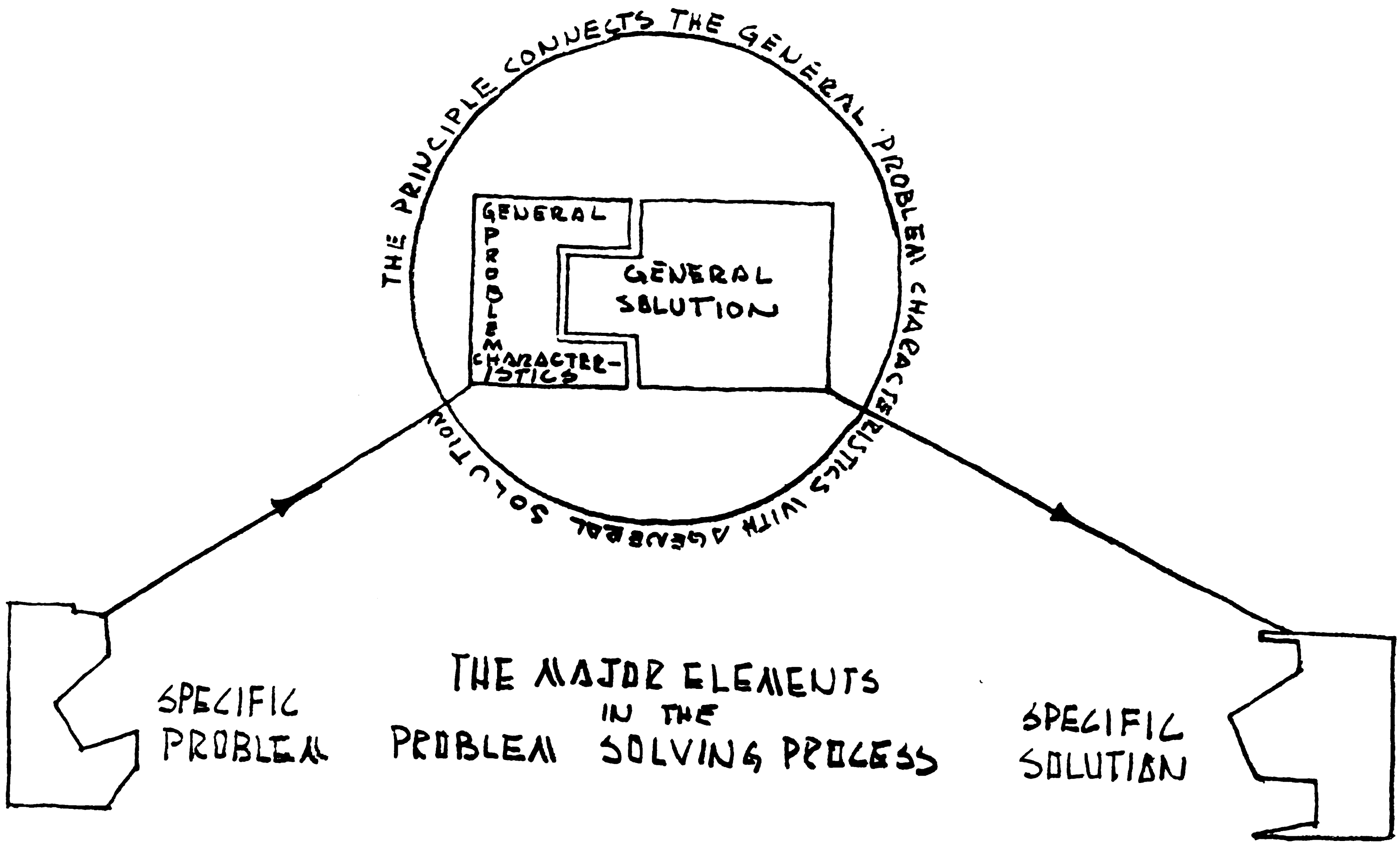
Since problems confront man as complex and perplexing situations they tax his capacity to act in solving the situation. A problem-solving process is quite simply a method-tool that amplifies the problem solvers capacity to solve problems. It is a plan to be executed in solving the problem at hand. As a plan it recognizes all of the parts to the problem situation and structures them in a meaningful sequence. Each part to a problem situation is, in fact, a subproblem. The problem solving process focuses the ability of the problem solver on the subproblem at the proper time sequence in the process and thereby increases his problem solving capacity. The process points up the proper times when information, ideation, and evaluation should be introduced in solving the problem. Since the process focuses on the subproblems or problem situation elements, it is a process within a process, or better, many subprocesses within the total process. This means that when attention is focused upon a subproblem the process of solving the subproblem is the same basic problem-solving process at a higher order level. Any problem-solving process is a universal rationale that embodies certain general principles and a general structural framework. The application of the process to a particular problem takes more than blind utilization. The relationship of the process and a specific problem and solution is illustrated in Figure 18.

Context of Problem-Solving

The prime interest in the investigation of problem-solving is the operational process itself, however, there is a whole context of relevant factors that reveal many circumstances about problem-solving. It is not possible in this thesis to consider this cultural context in great depth, but because it is important to recognize the qualities of this context and how it affects problem-solving and the problem solver it must be considered. Because of its summary form this information is included in Appendix A.

Problem-solving techniques have at least partially been developed by careful study of the thinking processes of the human brain. The formalized process which has been developed essentially has expanded the capacity of the three basic faculties of the brain. The three important thinking processes are critical to recognize not only to consider for mechanized substitution where possible, but also to define those proper places in the problem-solving activity where each should be exercised. Each of these faculties can best be used only when the other two faculties are shut off temporarily during the thinking action of the human brain. In terms of a formal problem-solving method each of these activities has a particular role to play; they are not interchangeable.

Jack Taylor identifies the three parts (functions) of the human brain. In a simplified but important sense, each of us really has three brains. The first brain is called the retainer. This is the "storehouse" and the memorizer. Its role is to save up experience, knowledge, and information for use by the other two brains. The utility of this brain is to provide the facts or information needed in problem-solving. It relies solely on past experience. The second brain is the analyzer. It does the sizing-up, the judging, the evaluating. It appraises, weighs, and makes decisions. This brain is useful to problem-solving when applied in the right way at the right time. Too often, however, it is so over-developed, misapplied, dominant,



THE MAJOR ELEMENTS IN THE PROBLEM SOLVING PROCESS

SOURCE; [illegible]

FIGURE 18

and misused that it blocks the action of the other two brains. The third brain is the imaginer. It is the "thinker-upper." It generates new ideas by structuring new concepts with the information from the retainer and comes up with the "big ideas." This is where the creative, intuitive "leap" takes place. It is both the least used and the least understood, yet the most beneficial or critical in problem-solving. It seems to be that part of the brain, or in our three brain terminology, that brain that at present is the least substitutable by a machine. Figure 19 suggests that percentages of total time to be spent on each thinking phase of problem-solving. Figure 20 depicts the relationship of these three basic types of thinking processes or problem-solving sequences in the elementary problem-solving unit sequence.

Frank E. Williams considers the same faculties of the brain and their role in problem-solving. His different classification system points up new insights not totally made clear in the Taylor system. Essentially, Williams lumps the imaginer and the analyzer into a category he calls the thinking mind and puts the retainer into the knowing mind. The knowing mind mental category contains the non-logical processes that are difficult to express in words. These processes are unconscious, complex, and often occur so rapidly that they cannot be analyzed by the individual in whose mind they appear. This portion of the brain absorbs and stores information as it interacts with its environment.

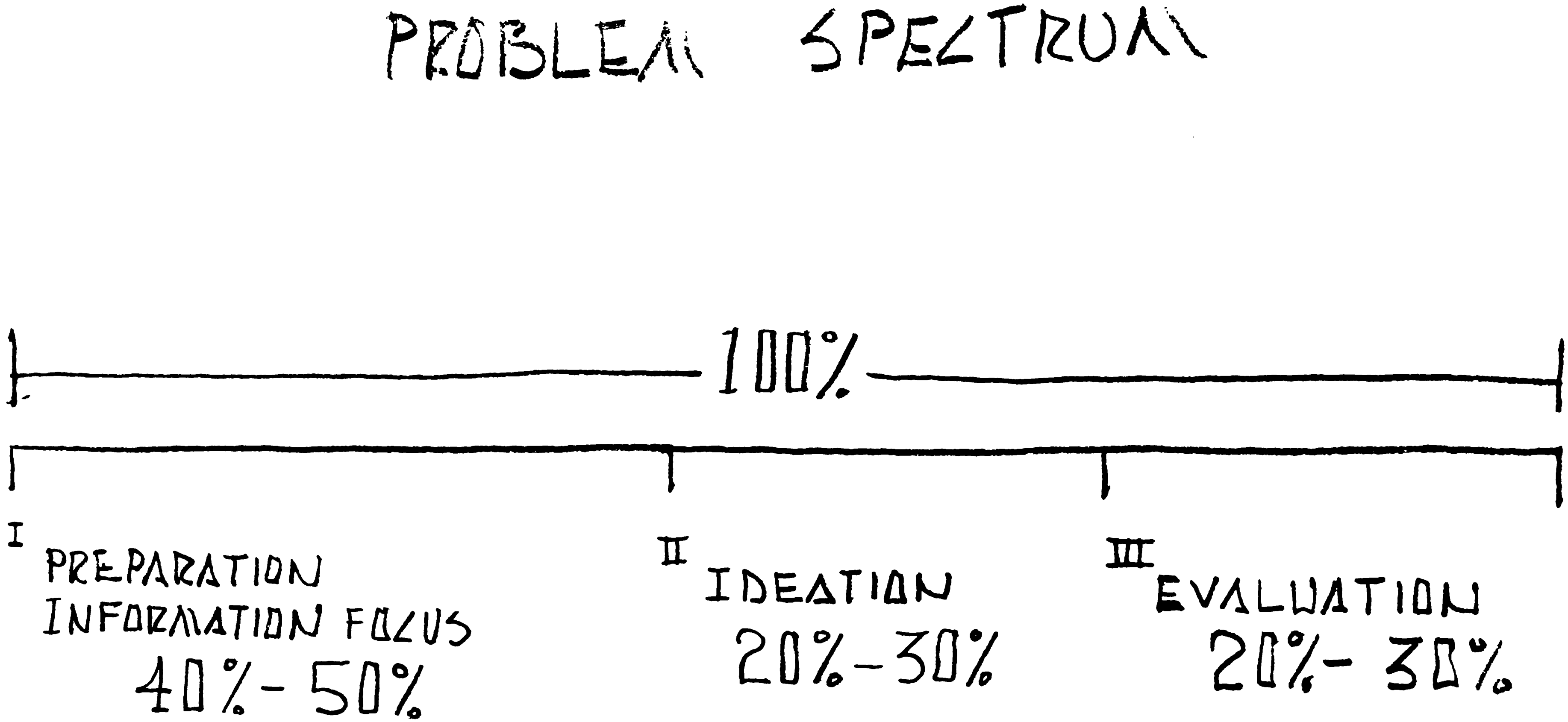


Figure 19.
SOURCE: B. GOLDNER, *OP. CIT.*, 51

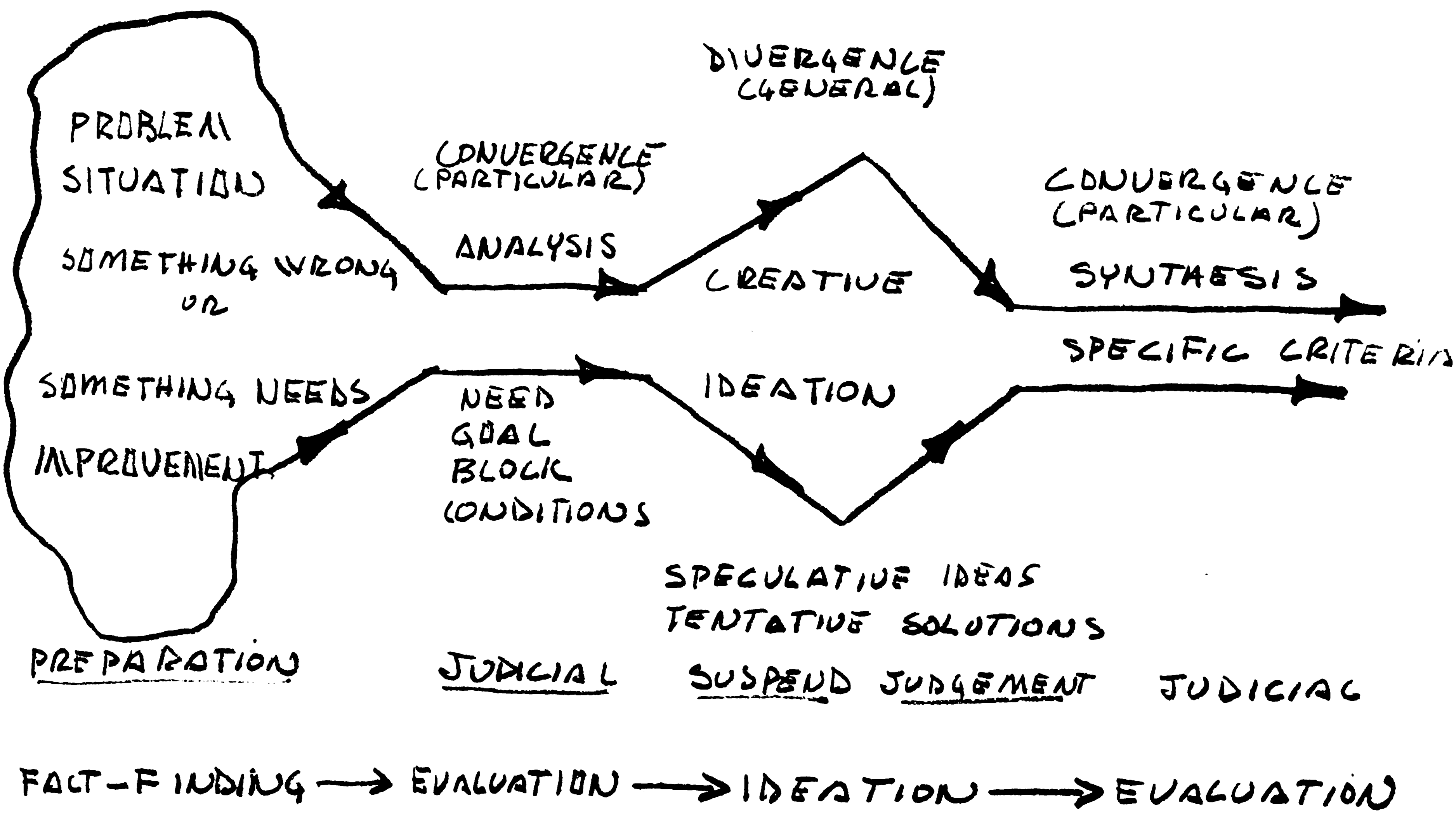


FIGURE 20.

SOURCE: WILLIAMS, op. cit., 66.

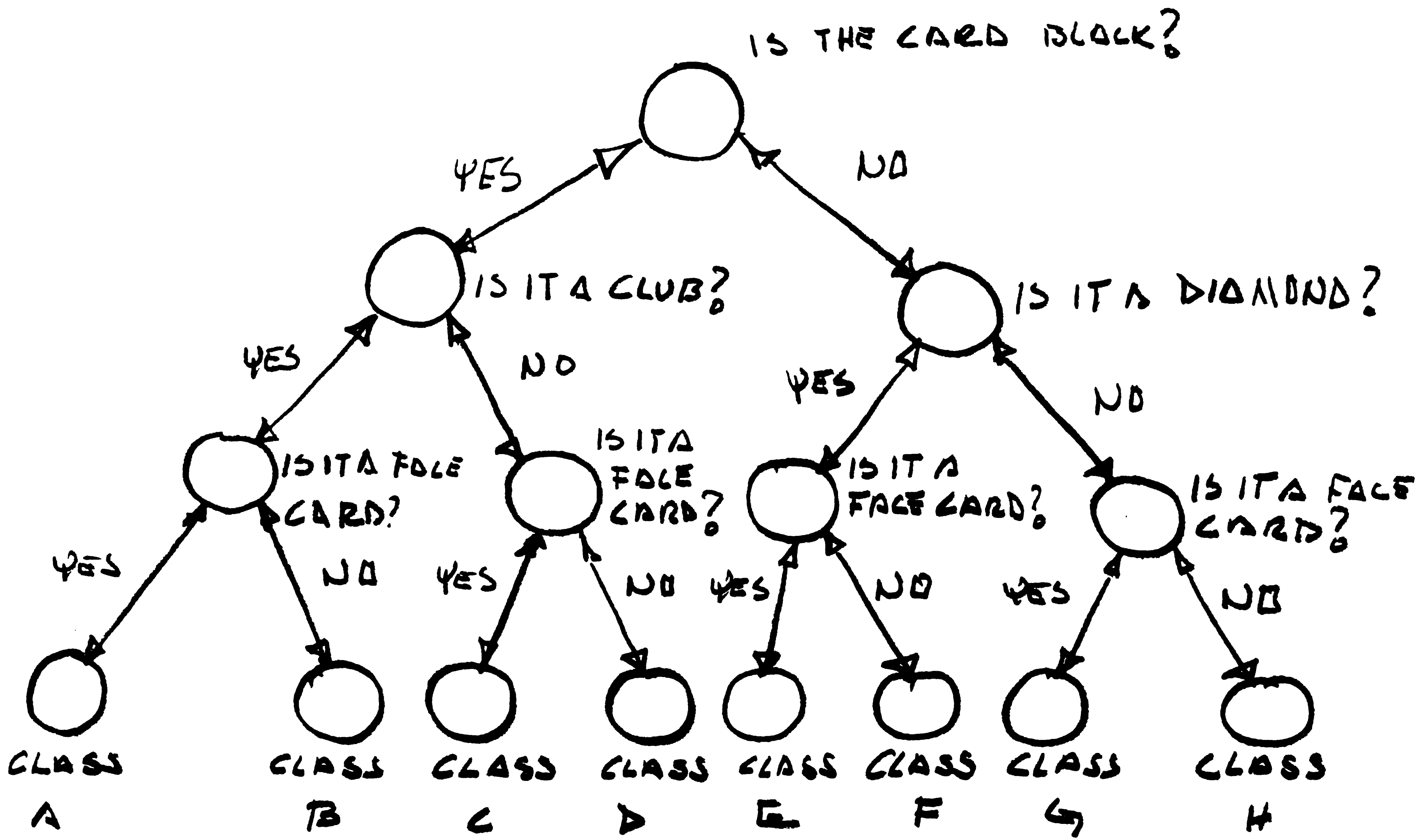
It is not just a barrel of facts, however, but is ordered in some way into a meaningful framework. These meaningful patterns are organized constructs which we call concepts.

Learning in this sense amounts to information processing and concept acquiring. Concept learning can be thought of in terms of a line graph called a decision tree, where decisions are linked in a meaningful network. In Figure 21 the operation begins at the apex with each node representing a test to establish whether an object is (or is not) included in a set of objects defined by a particular description statement. Concepts, in their matrix of interrelatedness, serve the critical cognitive function of providing a system of ordering by means of which the environment is broken down and organized. The use of decision trees to explain concept formulation by Earl Hunt offers a useful clue for the use of decision trees in a formalized way in a systematic problem-solving process, especially where the complexity of the situation calls for a conceptual organizing force.

The thinking mind, on the other hand, is capable of handling abstract problems by defining, generalizing, deducting, analyzing, synthesizing and understanding. The processes of the thinking mind are conscious, logical, and capable of reasoning. The two acts of ideation and evaluation take place here. In this way new contributions or responses toward solving a problem can be made. The table following outlines in summary fashion the facets of importance under the knowing mind and the thinking mind categories.

Figure 22 diagrams two important features of the knowing mind and the thinking mind in problem-solving. First of all, it suggests that problem-solving through history has moved from a maximum use of the knowing mind and a minimum use of the thinking mind to something close to the opposite. It points out that where one process is dominant the other must be subordinate. Secondly, the sinuous line, representing the execution of a problem-solving process, suggests that during the action of the process, it weaves between the two basic thinking processes within the individual mind. Each curve phase represents preparation - ideation - evaluation - fact gathering - ideation - etc. This shifting action should be included in a formalized problem-solving method.

Figure 23 should be studied along with Figure 22. It illustrates the relationship between habit and understanding in problem-solving. At the far left is the historical, traditional, or unselfconscious approach using complete repetitive response with a minimum of understanding. The type of mental processes used in solving problems in this manner are diagrammed on the left side of Figure 22. The right side of Figure 23 shows problem-solving using the most insightful reasoning in today's complex problem situation. The mental processes used here are illustrated on the right side of Figure 22. These



SOURCE: EARL HUNT, CONCEPT LEARNING, (N.Y.: J WILEY & SONS, INC.), 226

Figure 21

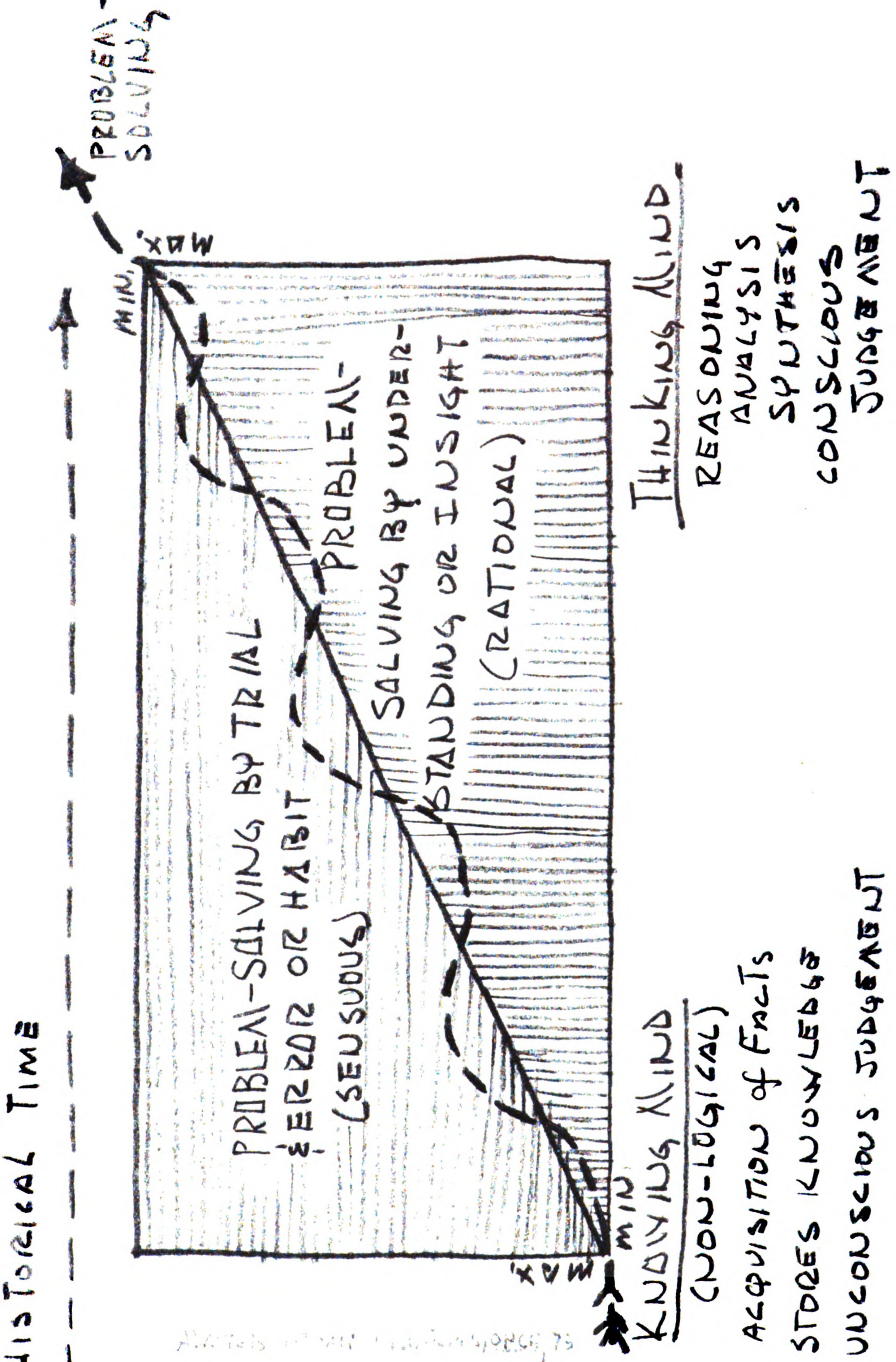

HISTORICAL TIME
PROBLEM-SOLVING
MAX.
MIN.
PROBLEM-SOLVING BY TRIAL & ERROR OR HABIT
(SENSUOUS)
PROBLEM-SOLVING BY UNDERSTANDING OR INSIGHT
(RATIONAL)
MIN.
MAX.
THINKING MIND
REASONING
ANALYSIS
SYNTHESIS
CONSCIOUS
JUDGEMENT
KNOWING MIND
(NON-LOGICAL)
ACQUISITION of FACTS
STORES KNOWLEDGE
UNCONSCIOUS JUDGEMENT

figure 22.

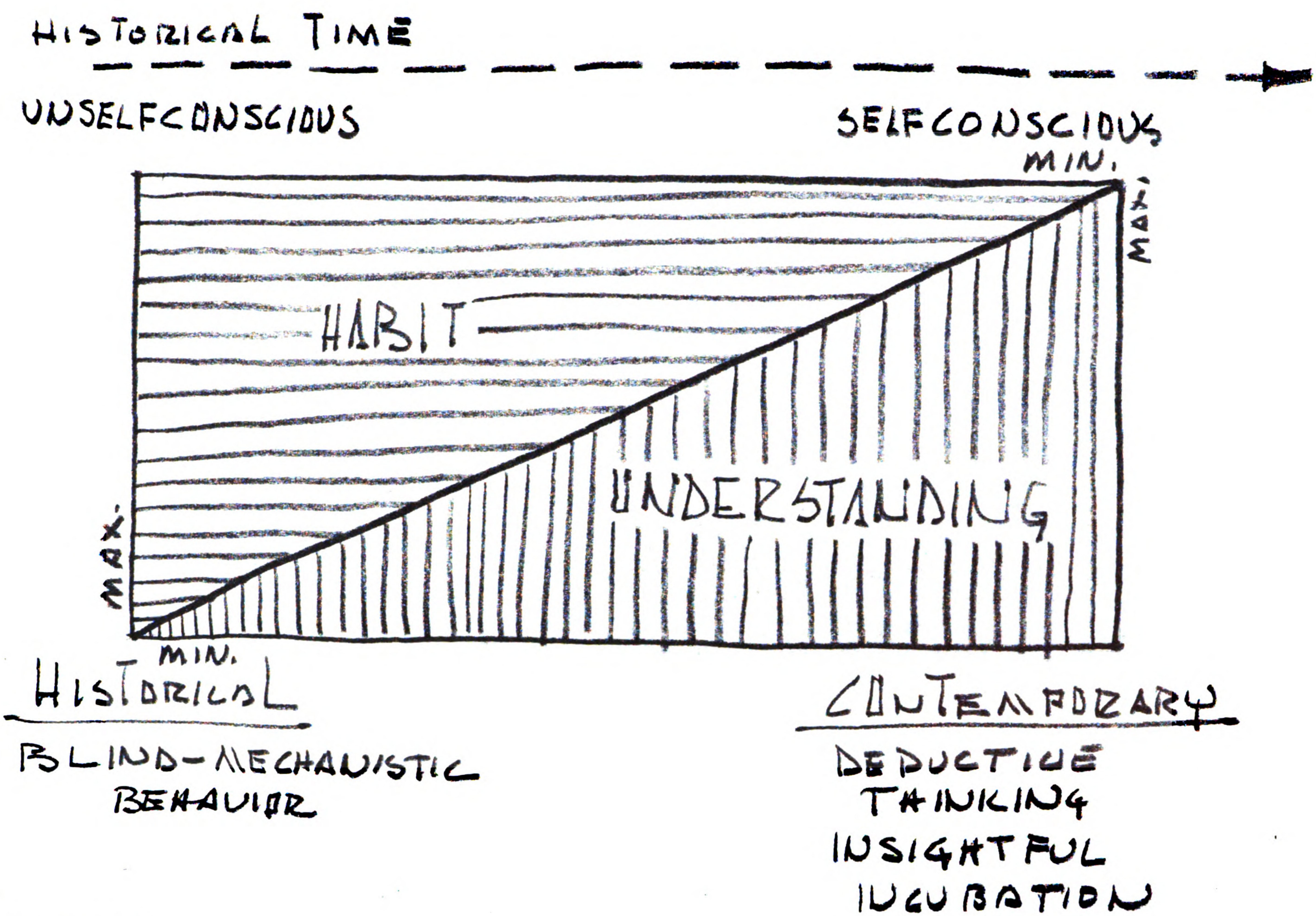


FIGURE 23.

ADAPTED FROM
[illegible] & WILLIAMS, OP. CIT., 89

TABLE 2

TWO PROCESSES OF THE BRAIN*

The following table summarizes the general kinds of evaluative techniques that are used. They are not operational but are merely lists of criteria. I include them merely as an indication of the kind of criteria that must be considered in listing problem solution ideas.

Thinking Process (logical)	Knowing Process (non-logical)
Reasoning: induction deduction	Acquisition of facts: Storing knowledge:
Judgment: (conscious) synthesis analytic evaluative	Absorption and retention: Learning: trial and error
Cognition: problem awareness solution improvement	tension-reduction conditioning recpetion through impression sensuous memorization
Conception: idea fluency idea receptivity	Problem-solving: habit or repetition immediate nature
Understanding: concept formation problem definition hypothesis formation learning	Judgment: (unconscious) preconceived bias-rigidity

*Source: Williams, _op_. _cit_., Chapter 3.

Application of principles
and inferences:

Creativity:
- contribution through conscious effort
- imagination

Insight: (intuition)
- knowledge without judgment
- inspiration-insight while thinking
- illumination-insight while not actively thinking

two diagrams together clearly illustrate the need for highly rational, logical, and formal problem-solving methods today for at least two reasons. Problem situations today, evolving so rapidly, are predominantly new to man and therefore can not be solved by relying on the habitual or repetitive responses of the knowing mind. The knowing mind can only solve problems in a familiar situation where past experience is relevant. Secondly, today's problem situations are infinitely more complex and need logic, reasoning, and understanding to be solved.

Within the thinking mind, the ideation and evaluation processes are important enough to consider in some detail. These two activities are key factors in developing a formal problem-solving process. A number of techniques for creative thinking or idea generation have been developed. These can be found summarized in Appendix B.

Several important conclusions can be clarified in regard to the information brought forth in the preceeding discussion. It should be now clear that the problem-solver holds a unique and key position in solving problems. This makes problem-solving a personel activity that is highly dependent upon the executer. Two important consequences of this recognition were considered. First of all, the cultural context within which the problem solver exists becomes very significant in that it directly affects his ability to solve the problem at hand. Secondly, the brain becomes the keystone in all problem-solving activity, and in the attempts to formalize it. The component actions of the brain form the foundation for formalized problem-solving processes, as was pointed out. The important characteristics of the action of each component of the brain is basic to recognize before a useful problem-solving model can be structured. Having introduced these significant features of problem-solving theory we can now move on to a look at the formalized process itself.

E. The Problem-Solving Process

From the information gathered by studying the problem-solving context above we can derive the criteria that a problem-solving method should include. A problem-solving method should meet the following criteria:

1. The method should be directed by the goal of the problem and all of the essential elements of the problem situation.
2. The method should be selective in drawing upon past experience and information.
3. The method should be insightful in organizing past experience into useful concept.
4. The method must be creative for the development of new ideas, new concepts.

5. The method must be critical in that it must test and evaluate new ideas, hypotheses, and proposed solutions.

Various people describe the basic problem-solving methods with different terms and define the process in different numbers of sequences. The following table is included for the purpose of comparing each of several methods,, how it fulfills the criteria above, and the critical features described in the problem-solving context study.

F. A Problem-Solving Model

The problem-solving methods outlined in Table 3 show a clear overall similarity. Any apparent differences arise from different orientations toward problem-solving by the proponent. Since the process is a continuous iterative one, it is truly difficult to describe. About the only way this can be done is to define the apparent parts or sequences in the process. Here is where some of the apparent differences occur according to what level of complexity is being used and depending upon what sequences are felt to be most important at that level of description.

One other significant inconsistency occurs between each of the problem-solving methods included. The inconsistency occurs both between the methods of the various authors and within a given example. It has been suggested that a problem-solving method is a plan of action to solve a problem.

TABLE 3

PROBLEM-SOLVING METHODS PROPOSED BY VARIOUS INVESTIGATORS*

Investigator	Lists of Steps in Method
Dewey	1. define the problem 2. locate and evaluate data 3. form hypothesis 4. evaluate hypothesis 5. apply solution
Hutchinson Patrick Morgan (Scientific Method)	1. preparation 2. incubation 3. illumination 4. verification
Osborn	1. orientation 2. preparation 3. analysis 4. hypothesis 5. incubation 6. synthesis 7. verification
Yoder	1. clarify problem 2. determine alternatives 3. get facts 4. analysis of facts 5. decide on action 6. arrange for execution
Ott	1. understanding problem 2. preparation 3. frustration 4. incubation 5. insight 6. verification 7. communication
Polya	1. understand the problem 2. devise a plan for solution 3. carry out your plan 4. examine solution - check result

TABLE 3 - Continued

Williams	1. awareness of problem situation 2. analyzing and defining the real problem 3. problem restatement and collection of data 4. proposing possible solution idea 5. incubation and testing possible solutions 6. selecting the best solution 7. applying solution in action

*Source: Williams, op. cit., p. 161.

The plan spells out two basic kinds of activity and when each should be carried out within the process of problem-solving. The plan should point out when, in what order, the parts of the problem should be dealt with. That is, when should this subproblem be solved, for example. Secondly, the plan should point out when the three basic mental processes should be employed in finding the solution to a subproblem and to the problem as a whole. In this regard it should spell out when facts are needed, when concepts should be formulated and when tests should be carried out. In the examples illustrated, these two kinds of activities are indescriminately mixed. For example, one author suggests incubation as the fourth step in solving a problem. It is never made clear what is meant, what are we aiming for as we incubate. Is there a goal to be attained here, or a subproblem to be resolved, or is he merely suggesting that at this time the mental process of ideation should take place?

The basic problem-solving model that is illustrated in Figure 24 has attempted to incorporate the two kinds of activities discussed above into operational form. The model has been purposely kept simple to illustrate only certain aspects of problem-solving theory that has been discussed in this and the first chapter. Many of the operational features that have been suggested will not be incorporated

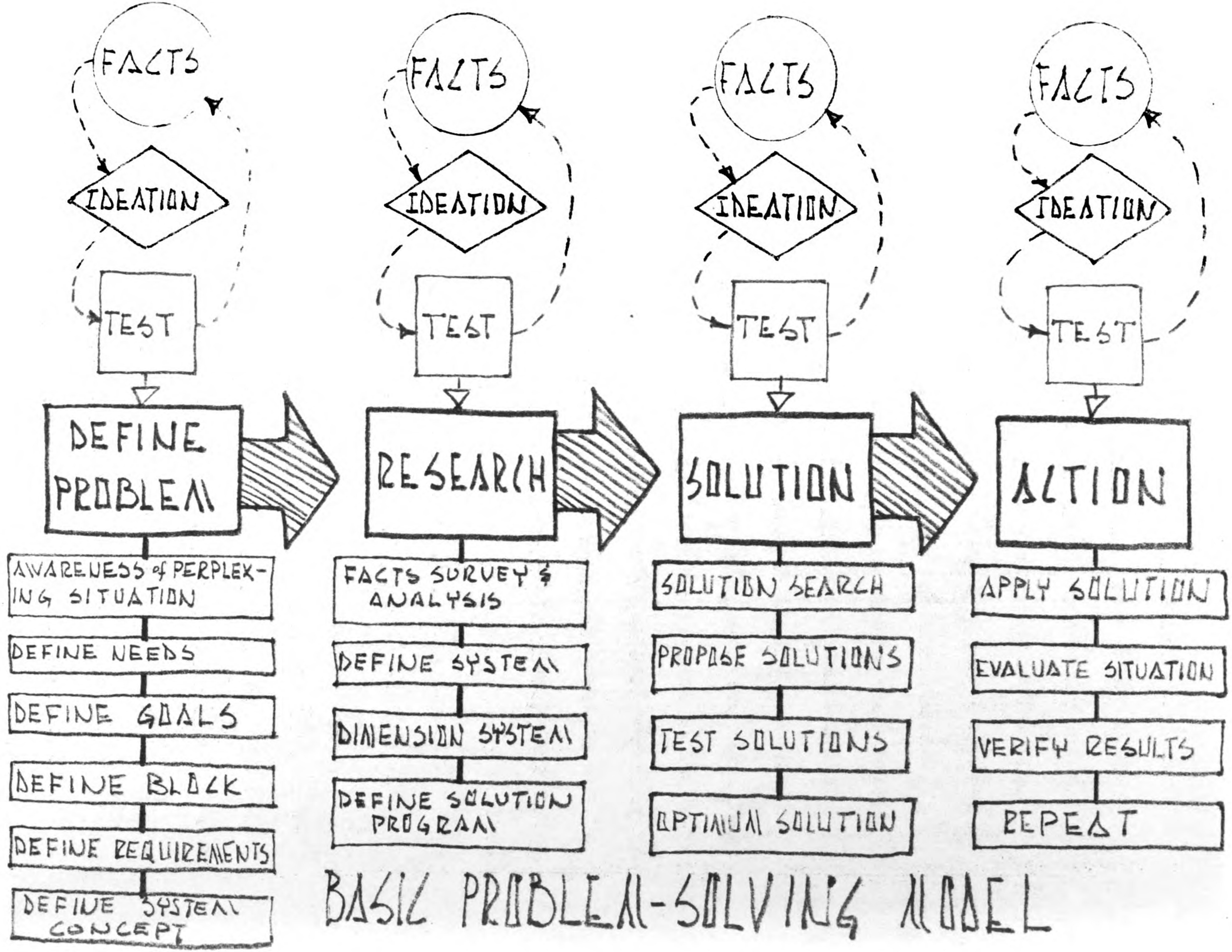

FACTS
IDEATION
TEST
DEFINE PROBLEM
AWARENESS of PERPLEXING SITUATION
DEFINE NEEDS
DEFINE GOALS
DEFINE BLOCK
DEFINE REQUIREMENTS
DEFINE SYSTEM CONCEPT
FACTS
IDEATION
TEST
RESEARCH
FACTS SURVEY & ANALYSIS
DEFINE SYSTEM
DIMENSION SYSTEM
DEFINE SOLUTION PROGRAM
FACTS
IDEATION
TEST
SOLUTION
SOLUTION SEARCH
PROPOSE SOLUTIONS
TEST SOLUTIONS
OPTIMUM SOLUTION
FACTS
IDEATION
TEST
ACTION
APPLY SOLUTION
EVALUATE SITUATION
VERIFY RESULTS
REPEAT
BASIC PROBLEM-SOLVING MODEL

figure 24

into a model until a later time.

The model as it stands represents a descriptive and diagrammatic plan for solving a problem situation. Four basic process sequences are represented by the major boxes which define four basic parts of a problem solution search. The sub-boxes below the main sequence suggest more of the subproblems that must be solved as the problem solver moves to a solution. The processes represented above each sequence reflect the concept that each sequence is itself a problem and that each of the basic mental activities of problem-solving must be carried on in the order suggested. In terms of solving a problem, the diagram would become operationally complex but would retain the basic theory as simply depicted. The later design model will help point this out.

CHAPTER III

THE DESIGN MODEL

A. Characteristics of the Design Process

The preceding chapters have established a basis from which a useful description of the design model can be developed. This chapter has three major objectives: (1) a discussion of the major characteristics of the design process that should be reflected in a model; (2) a description of the basic design model; and (3) a description of the design operational model with reference to a new town project.

Many characteristics of problem-solving have been described in the earlier chapters. The purpose here is to summarize those which are important to the design model. The urban design process is essentially a plan of action working from a need to a solution. The process has an overriding movement from the abstract to the concrete, or restated, from the general to the particular. It begins with a perplexing situation about which very little is known other than the fact that there seems to be a need of some sort. From this general situation the process moves toward a specific solution that has physical and spatial dimensions. Each sequence carries the process that much closer to a concrete outcome. Within this overall movement it is important to recognize that two quite directional actions take place, the problem search activities of analysis and synthesis. Martin Starr has described the nature of these important activities. To him the problem search is basically analytic behavior that follows what he calls "principles of disassembly." The operation involves "division, dissection, classification, separation, partitioning, and segmentation," etc. The solution search is synthesizing behavior that follows the "principles of assembly." It involves operations of "summation, integration, unification, combination, amalgamation, and in general the gestalt point of view."

The activities of the design process unfold in a pattern so that we can consider the structure of the process. Both a horizontal and a vertical structure can be defined. The process as a plan of action organizes a series of activities into a useful sequential framework. The framework defines the relationship of each component action, pointing out its place in the time sequences of the process. The horizontal structure of the process is made up of linkages of these activities. Each succeeding sequence builds upon the results of the preceding sequences. The outcome of one sequence serves then, as the starting point or premise for the activity sequence next in line. This dependency must be recognized in moving toward the outcome of each sequence. In this way, there is an awareness or a concept of what is to follow in the remainder of the process.

The process, especially in complex situations, must be iterative because of the occurrence of at least two events in the process. Iteration is essentially a looping function where one returns to a preceding sequence and critically re-investigates the actions within the loop, evaluating the outcome of each sequence, and eventually returning to the point from which the loop began. The loop may have any dimension and could include a loop of the complete process. Iteration is necessary or useful, as was mentioned, in two situations. With each succeeding sequence in the process new and more information is brought to bear on the situation. Many times information gained in one sequence may bring new insights on a preceding sequence or may reduce the level of confidence in the outcome of a preceding sequence and therefore iteration is needed. In a second case, while producing an outcome in one sequence, the outcomes in previous sequences may prove to be unsatisfactory or to be too constraining. Iteration becomes necessary if the design project is to continue. In the complex situation looping takes place continually. The features of the horizontal structure can be summarized as (1) iterative and (2) sequential.

In terms of a linear model, we can also describe a vertical structure of the design process. Each activity sequence has a purpose or role within the design process, moving from the problem identification to the solution formulation. This role is identified by the design model which has been suggested as a plan of problem-solving activities. Each sequence has an objective to attain according to its purpose. The outcome from a sequence is the sequence objective. The outcome is the description of a component in the problem plan. For this reason each sequence is a problem situation itself, or a subproblem situation and can be solved using the design model at a second level order. In a very complex situation, the vertical structure of the design model could include many higher level orders.

Before moving into a discussion of the basic model of design, there are several characteristically different activities that occur in the design process which should be first described briefly. These activities are basically related to sequences in problem-solving as described by some authors. They are the six basic activities that are included in a universal problem-solving theory. There is a subtle difference here, which must be made clear. The techniques discussed briefly below are processes that one activates in solving a problem. The outcome, however, from any one of these, for instance synthesis, could be any number of results important to solution of the problem. What is being suggested is that to say synthesis should take place in this sequence doesn't really tell us anything about the objective of synthesizing at this time in the process. On the other hand, if we say that the outcome of a sequence is to be a program, this tells us something specifically and substantively about what is expected from this sequence of the process, moving toward a solution. Many of these activities that will be described briefly were dealt with in Chapter II. Some of these techniques have been highly evolved while others remain relatively implicit and unsophisticated.

Concept formation and acquisition plays an important role in urban design and occurs at many levels of complexity and importance. A concept is an idea of what a theory in general is to be. Concepts are the means by which man orders his experience into coherent categories. Mental concepts rely on man's ability to think abstractions. A concept is also a thought or an opinion. In these senses a concept is a structure that relates many elements into a single class framework. In the design process many concepts are used, some of which are quite complex, to help organize the activity of the process. We have a concept of the problem, a concept of the goals, a concept of the design subject, a concept of how to attack the problem and what to do next, and a concept - traditionally known as "the design concept," etc. This latter meaning of concept can be complex, relating many of the important elements of the design into a unity which helps organize the future design activity. The remainder of the design process develops the concept more fully and continually tests the concept in light of the new information gathered in the process. Most of the concepts in design, whether important or relatively insignificant, follow this pattern. Earl Hunt has developed an information-processing theory of concept formation. His model is described as the manipulation of sets. The sets are linked in line in forming the concept. The line graph is called a decision tree. The concept is represented by a tree whose roots are not connected to any point outside the tree. Using his information processing model we can symbolically structure concepts in design where complex situations warrant it. See Figure 22 as an illustration of a decision tree.

A second important activity is <u>fact-finding</u>. There are basically three sources of data: our own experience, catalogued data, and new knowledge from observed research we might have to conduct. Information is necessary to learn as much as possible about the situation. Facts serve as a basis for every sequence activity. Since the amount of information collected is constrained by time and budget, it is important to collect only pertinent data and in an efficient manner. There seems to be no real scientific method in locating sources, usually information from each source is necessary. Social scientists have developed methods to collect information about the city. The methods, however, are usually conceptualized constructs of the city which allow the social scientist to organize his information. Planners also use these methods in dealing with the city. Most often they use functional concepts, such as systems theory, to collect and organize the collected information. More than bits of unrelated facts are wanted when collecting information, it must be organized into a useful form.

Analysis is another process that occurs continually in design. Its purpose is to discover relationships and to point out clues to the paths of outcomes. As was described earlier the operations of analysis is to divide, dissect, classify, partition, and segment, to discover the patterns of the information at hand. In design we analyze concepts, information, ideas, alternatives, and solutions.

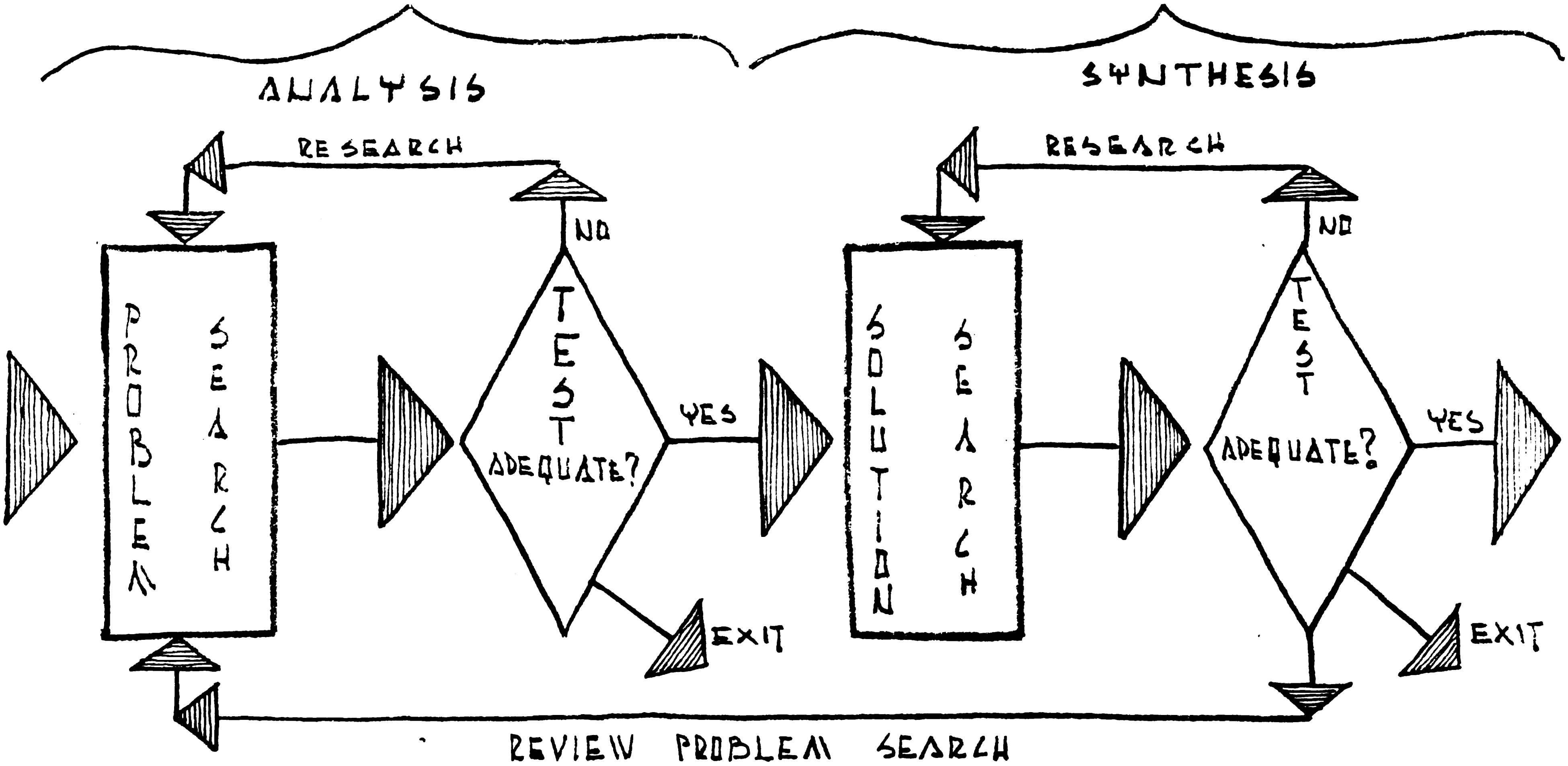
The process of ideation is concerned with generating ideas. This process is speculative, divergent and generally aimed at quantity at first. The new ideas produced are rarely ever new, but rather new combinations for a particular situation. Most ideas are improvements upon a combination of other ideas. Quantity is aimed for because it breeds quality. During the ideation process judgment must be suspended, otherwise it will block effective ideation. Ideation is used throughout design to add insights and new directions to each phase. The techniques of ideation are outlined in Chapter II.

Synthesis is the process of putting elements together inductively, in order to form a new general idea. Synthesis is the opposite of analysis. As was advised earlier, it is the process of summation, interpolation, unification, combination, and amalgamation. The design synthesis involves searching for the right combination of subproblem solutions, to make up an optimum solution. Synthesis is the most characteristic process in design. Several techniques were discussed earlier.

Testing is the last activity introduced here. Testing involves evaluation and decision. In the design process, three elements concern us in critical testing: the alternatives, the benefits, and the difficulty of implementation. To make a good decision we seek and apply relevant evidence. The objective is to find the most favorable outcome in terms of the three elements. The design matrix is a useful tool in tabulating the evidence of each proposed alternative. Evaluating criteria are defined, based on goals, policies, standards, and principles and are given weighted importance. The alternatives are matched across the criteria. Ultimately, the alternative that has the most favorable rating is chosen.

B. Basic Design Model

Figure 25 diagrams a basic design model. The design process is represented in its most elementary form consisting of the analysis and synthesis activities. The goal of analysis - problem search - is a decomposition of the problematic situation. The decomposed problem is generally referred to as the design program. The program structures the components of the problem into a useful framework. The framework relates the components of the problem into a pattern that points out the path to be followed in searching for a solution. The process labeled problem-search moves from a primitive statement of a need, or perplexing situation to an organized supportable design program. To attain the objective a number of subobjectives must be reached. The felt needs must be firmly established as really existing and a concept of what is desired as a goal is defined,



BASIC DESIGN MODEL

figure 25

to give direction to the search. The complete situation must be defined as well as the system or environment in which it exists. To reach this objective much data must be collected, analyzed, and organized into useful constructs. Goals must be crystallized, available resources, such as time, money, and technology, must be specified, constraints need to be defined and criteria to measure the adequacy of outcomes must be designated. The functional and non-functional difficulties or potential misfits need to be determined.

Ultimately, the requirements of the solution outcome are specified. These requirements are clustered according to their pattern of interrelationship. Each cluster is as functionally independent as possible. The clusters can be organized into a line graph hierarchy. This constitutes the design program. As the diagram illustrates the outcome is tested. If it is adequate, that is, if there is a high enough level of confidence, the design process then moves on to the solution search. If on the other hand there is a low level of confidence, then the process moves back to reserach that sequence. This is a single sequence dimensional loop. These loops or iterations may occur many times within a complex problem. With each iteration the design constraints of time and money become more critical. A point can be reached where the confidence level remains low even after many iterations and the design constraints become so critical that it would call for exiting from the design process. With each iteration, the design budget is somewhat depleted and if confidence remains low then exit may be called for. Exit may take place for other reasons, for instance, should it be found that no effective need exists.

Should the process continue past the problem search the outcome will be the premise of the solution search. At this point the design concepts have taken on more clarity and all of the design parameters have been established. The design program is made up of problem components, or subproblems at a sufficiently simple level. The search now begins for solution alternatives for each of the subproblems. The first place to look would be at problem solutions that already exist, that may be relevant to the component problem at hand. Should this fail then "new" solutions must be found. Sometimes these can be obtained by reorganizing parts from several existing forms. Other times new alternatives must be developed by "thinking-up" new concepts, analyzing them, synthesizing the best features of each and ultimately arriving at several alternatives for each component problem. Once proposed solutions have been found for each subproblem in a cluster, they must be synthesized into a solution for the cluster problem. The process moves slowly, synthesizing sub-alternatives as it moves from cluster to cluster to the apex of the design program hierarchy. These solution proposals are then tested, measured against a priority of criteria as defined in the problem statement. If a proposal proves inadequate the solution search is continued, the activity is reviewed and new proposals are developed and tested. New information, new insights, or a low level of confidence in the design program may warrant return to the problem search, especially if an adequate solution is not forthcoming. A new program may make a solution possible. After efforts have been exhausted and the design constraints become critical exit would be considered. This would mean that no effective solution can be found or seem feasible. If all goes well exit is made with an adequate solution.

C. The Operational Design Model

The brief discussion, just concluded, points up the rationale of the design model. We now have a concept of what the model is like, how it works, and what is to be generally expected in a more complex design model. The remainder of this chapter will be devoted to a discussion and description of the operational design model with reference to a "new town" project. As was suggested in Chapter One, design is a part of the larger process called planning. In an effort to make clear the relationship of design to the other phases of the planning process, the discussion will include description of the planning phases, other than design, in less detail.

David F. Parker has designed a planning model that will serve well in describing the relationship of the design activity to the planning process. The description of the planning process, in general terms, will be basically influenced by his findings.[1] Figure 26 is Parker's basic model of the planning process. The design model in Figure 27 is a higher-order abstraction of the box labeled design in Parker's model.

In considering the planning phases of our discussion, we are interested in what leads up to the design process, what the input is from the preceeding planning, and what succeeds in the remainder of the planning activity. The process, as discussed, might seem very straight forward but many iterations would be needed in actuality.

On the planning team we can assume that there is the group leader from the design sub-team, who has the expertise in spatial design. He is there to assure that

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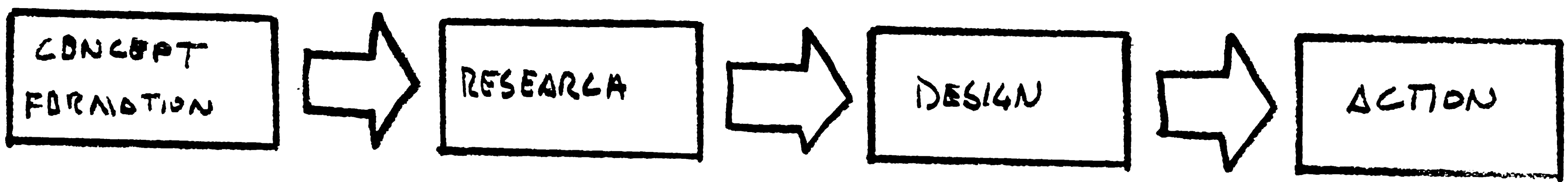
[1]Parker, loc. cit., Chapter III.



MAJOR ELEMENTS of THE PLANNING PROCESS

Figure 26

the design premise is relevant to the spatial design problem. Wherever necessary he attempts to interject the perspective of the designer in the planning and programming so that an impossible or overly-constraining design program is not left to frustrate the design team. The iteration between the design activity and the other phases of the planning process help also to resolve this concern.

Figure 27 at the end of the chapter is a diagram of the operational design model at its highest order level that will be discussed here. It can be folded out and referred to as the description progresses. There are eight basic sequences illustrated. The large box within each sequence represents the objective outcome for that sequence and not one of the problem-solving sequences as described in problem-solving theory earlier. This is important to recognize. The outcome from each sequence, as represented by the large boxes, is a step in the design plan. The problem-solving activities, illustrated in the smaller boxes: concepts, fact-finding, analysis, ideation, synthesis, and test, have the outcome of that sequence as their objective. In this sense each sequence outcome represents a component of the design solution.

The various operational features of the model work in the same manner as described in regard to the basic design model. The multi-sequential research information flow appears in a new dimension in this model. This feedback loop can initiate from all but the first sequence and can terminate at all but the last sequence, wherever the designer chooses. When it initiates from the last test sequence and recycles starting at the first sequence, it represents, essentially, the monitoring device between the interaction of the design outcome and the real system or environment. Since, as was explained earlier, the city is process, there always being a flux in the man to environment system; the design process is virtually continuous as is the planning process of which it is a part. The temporary exit illustrates that an adequate outcome has been attained for this phase of design.

The discussion of the model will deal with the kind of activities that should go on in each sequence of the model. Nothing will be gained by laboring the operational features of the model since they have been generally described in refernece to the more elementary model. There is no utility in repeating the looping process a hundred times or describing the concept formation, analysis, and synthesis, etc. processes time and time again. The main concern is to describe what outcome is desired from each phase and generally what type of activity is useful in reaching the objective. Now to move on to the description of the planning and design processes.

To help illustrate the relationship of design to planning the discussion will make use of a hypothetical situation in the planning (including design) of a "new town." In <u>concept formation</u> the decision is made to start planning the project. A group of Boston financial backers approach the Arthur D. Little Company (ADLC) about their interest in investing in the development of a new town somewhere within the Boston-to-Providence corridor. Their opinion, from some initial investigation, is that such a project may be profitable. They have about 100 million dollars to invest, but need advice to proceed with the project. ADLC, from a wealth of experience with like projects, needs little detailed investigation to decide whether such a project seems feasible. A dialogue between client and consultant concluded with a decision to initiate a detailed plan for the project.

With this decision the planning activity can continue. ADLC has a concept of what the outcome of the project will be, in a very general sense. This gives a direction to the planning activities of the project. As a basic planning goal, it insures some organization of the planning activities. They now begin to define the complex problem with which they are faced. First of all, they have the problem of laying out the planning activities. They start with a concept of what the planning program entails in this instance. They lay out the steps that must be executed, what funds can be allowed for each phase, what personnel on the planning team will do what, what the objective of each phase is, and how much time can be spent on each sequence in the process. They know that about 100 million dollars can be spent on the planning and construction of the project. This gives a sense of scale to the project, as well as the town. Working closely with the clients they define some basic concepts of the kind of town that is desired. The clients have some knowledge of the real estate market since they are confident enough to invest a large amount of capital. The goals are not detailed at this point. Since the town is to be located within a major urban corridor between two large metropolitan areas, it is desired to house a town that will attract commuters from both cities. A balanced community with enough schools, churches, libraries, and playgrounds to meet the residents' cultural and recreational needs is desired. Goals will be crystalized as the project moves along. With the conclusion of the concept formation phase ADLC has a concept of the problem at hand, a concept of the outcome toward which they are heading and a program to carry out the planning work.

They now move on to more detailed work on the project, called the research phase. The outcome from this phase will be a design program which can be taken by the design team and worked into a spatial solution. This phase requires a detailed survey and analysis. Each subgroup of the planning team made up of various specialists, sociologists, market, recreation and transportation people as well as a complement of planners, carries out its delegated work schedule. A complete description of the situation must be defined. That is, the new town has a locational, cultural, and socio-economic situation. The important components of the situation system must be delimited. This defines the relationship of the new town to its environmental system. The site must be located. It will be necessary to assemble about 5,000 acres that are near good inter-urban transportation. The difficulties of this assemblage must be defined before a final choice can be made. Certain on-site characteristics must also be searched for. A swampy area, for example, will decrease funds available for construction, while rolling wooded hills could prove to be a delightful site. Besides location features, the social, economic, political, etc. components of the environmental system must be defined. All of the land in this corridor is incorporated so the new town will need to work out a political relationship with one or more existing town governments.

The socio-economic components must be dimensioned by studying the expected customers. Most customers will be from the Boston-Providence area. What kind of people are they? What are their tastes, living patterns, incomes, family size, etc.? Do they prefer another small New England village atmosphere, the urban environment of Beacon Hill, or a mixture of the best of the two? Concern is not directed to ascertaining spatial patterns, but a concept of what the customer will buy. The investigation must define those factors which are easily controllable and those which are non-controllable. The latter put constraints on the new town design. These constraints could be existing local and state governmental policies and laws, the ceiling on expenses, particular site features, and such other factors as the weather and the economic vitality of this urban corridor.

Research must continue to define the important policies existing in the system. These can range from governmental policies at each level of government, to policies of transportation companies that might affect train or bus service to the major urban areas, as well as the intra-town transportation, to policies of industry that might be considered to locate in the town. Basically, the relevant objectives, principles, and standards which

might influence the town need to be defined. These policies must be analyzed in terms of the desired goals, and new policies of one sort or another may be designed for the town itself, within the context of the constraints. For instance, standards for the service radius of elementary schools in a typical suburban setting may be unacceptable because a different density is needed to make the project show a profit. The policies that are finally arrived at will reflect the goals and the realistic situation. They will serve as a basis for criteria for later decisions to be made during the project planning.

By the later stages of this phase the particular site will have to be decided on, after conferring with the clients. There must be substantial evidence to prompt enough confidence that the project is physically realizable, that it has economic need, and that it is financially worthwhile. This will depend upon many factors, most important of which are whether there are enough potential "customers" and what the cost of implementation might be. The site size, the projected population, with all its important characteristics and all dimension of the system have been defined.

The outcome from the series of activities within the research phase will be in the form a program context for the design phase. It will consist of a complete and detailed description of the problem situation as it exists in a given environmental system, detailed goals including the policies to guide good town design, and the constraints on the town design as they may affect the future environmental system in which the community exists, as well as the town system itself. What we really have now is a complete description of the non-spatial organization that is desired. What is expected now, is to interpret this non-spatial program into its spatial meaning. This constitutes the context for which a form must be found which will fit in a symbiotic relationship. With the conclusion of the research phase ADLC has advised on continuing the project and the backers concur. The project now moves into the design phase.

Need

The design process starts with the premise as defined by the sequences of the planning process up to this point. It starts with the non-spatial organization or program. Within the program there is an elementary statement of the spatial needs based on the planning work to this point, but generally unsupported by organized evidence. The program statement suggests the spatial problemmatic situation as an alleged need. The goal of this step is to gather evidence that needs exist and to gain some insights as to what they are generally. For example, ADLC has to demonstrate that present urban patterns will not fit this design program and that customers will be willing to pay for the removal of present misfits in a new town. It has already been demonstrated that the project is feasible, but now we are concerned with the form of the project. The need must have current existence or a strong evidence of a latent existence. The existence of the economic need can be established by studying the "market place" of the need. It must be recognized that the customers for the new town are New Englanders who are conservative and strongly oriented to traditional patterns of behavior. To establish whether there is an effective need, we need a concept of what the form goals may be, what the costs to the customer may be, and whether the concept seems to be a realizable solution.

The objective of this sequence is to gain enough confidence that needs exist, but not a detailed description of the spatial needs as yet. We do not want to get too specific too soon. Resources for study can not be committed too early in the process before we prove a need exists. It is possible to establish that effective spatial needs exist without having a detailed understanding of what they are exactly. We may find that new town dwellers do not like to drive a car to work. We know that the need exists, but not much else yet. Exit from this step takes place when ADLC has enough confidence that needs exist and a concept of the pattern of needs in the problematic situation.

Orientation

Having confidence that needs exist which cannot be met other than by committing funds to study the situation, ADLC moves on to define the orientation. In this phase, ADLC chooses the way of thinking about the problem situation, formulating concepts of the situation and the outcome which is expected. They set their sights, picking out all important aspects of the situation. Insight is gained about the complexity, about what information will be needed and how the remainder of the design activity will be carried out. ADLC chooses a useful construct to help organize an understanding of the problem. In the planning activity a model of the environmental system as well as a model of the project situation were made. This orientation should be useful here in the design phase. All of the components have been dimensioned during the planning phase, but they should be analyzed to see if other kinds of information are needed for this phase. ADLC, for example, has conceived of the problem context as a functional system and the new town as a component of the regional system or a subsystem of its environment. At the successful completion of this sequence ADLC has a complete relationship of the new town, as the subject of design, to its context - the regional system. The nature of the system construct has also been established so that a working knowledge of the problem had been defined. With the outcome of this sequence the perspective has been set, the direction of the design activity, and a useful understanding of the defined subject.

Problem

ADLC moves now to a detailed understanding of the design problem. A framework for this investigation has been set and the direction of the project is defined. In this phase the parameters for the solution search must be delimited so that a solution search program can be structured. ADLC cannot pose the program before they define the difficulties, and cannot uncover the difficulties until the goals have been clarified more specifically. The other design parameters must be defined: the potential technological capabilities, the available finances, the policies criteria for evaluating solution decision, specifically performance standards, existing policies, and all non-controllable factors in general. Most of this information is readily available from the planning phase. Some of it may have to be restructured in the solution search program. The design team looks for all things that might need improvement in present form, for unsatisfactory conditions, objectives not fulfilled, and opportunities to reduce inefficiency. The requirements must be detailed precisely in functional terms of the way in which the new town dwellers will use the solution outcome. The possible misfits in each form component must be found. This is a list of the possible components of the urban form that are not satisfactory. For example, ADLC in considering the circulation system of the new town has found many possible misfits. They include: (1) lanes too narrow, (2) lanes too wide, (3) insufficient illumination, (4) curves too long, (5) no access to service facilities, (6) pedestrians and animals are not safely separated from vehicles, etc. And finally, time-dependent characteristics of the system must be delimited with regard to their probable future effects in the system. The outcome of phase three is a statement of the new town design problem as detailed as funds allow.

Program

The outcome from the last sequence presents the design team with a list of all the functional requirements that the designated system must meet, along with the design parameters. A solution must fulfill these requirements without exceeding the design boundaries. The objective in this sequence is to define the solution design program. The program is a statement of the problem in terms of what must be done and in what sequence to search for a solution. One kind of effective program is represented by a dependency hierarchical network linking all of the functional requirements which the design form must satisfy. The task in this sequence is to find the pattern of interaction between the possible misfits, stated positively as requirements. Some requirements seem to contradict each other and thus have a negative interaction. Other requirements complement each other and thus have a positive linkage. In searching for the pattern of interaction, whether the linkage is positive or negative makes little difference at this time.

Each requirement is a problem of a simplified nature. The requirements that interact form a more complex problem with each requirement a component of the larger problem. These groups of requirements that interact form clusters. In turn the clusters linked together form a larger problem cluster, etc. The idea is to find independent clusters. If the cluster problem is an independent component of the larger problem then a form solution can be found for it, without being concerned with other requirements in other clusters. Unfortunately, a cluster is rarely ever completely independent. The search, more realistically, is to find those clusters which are the least dependent on requirements outside that cluster. In other words, the functional structure of the problem is sought, so that in the efforts to amplify the designer's capacity to solve the complex design problem by breaking the problem into its parts, the decomposition is carried out without cutting across the true structure of the problem. In Chapter III Figure 15 represents a matrix of the interaction of 33 requirements in a simple problem. Figure 16 represents a program hierarchy for a kettle problem. It shows how the problem is broken down to its basic components, which are the requirements.

Finding useful clusters of interacting requirements is critical to the solution search phases of design. Many patterns are possible, so several alternatives should be carefully evaluated. The requirements for the design of the new town form would be so numerous that the computer could be a useful tool to find the patterns of interaction. For example, if ADLC found 1000 requirements for the town pattern, the number of possible links is about 500,000 (1000 x 999:2). If a decision considering each possibility took only 5 minutes the task would be too costly.

The design tree is a line graph which moving from its apex downward into branches decomposes the problem into its parts. The graph can be complex with many levels of problem clusters. Once this structure is designed we have a program for the search of the new town form. The network is a clear programmatic statement of the design problem.

<u>Alternatives</u>

Phase five seeks to find form-solution for each of the component problems that are at the lowest level of the design tree. If present forms can be found that serve in a particular instance, then they can be proposed; otherwise new form concepts must be found. In either case, each of the components is a simple problem with a single functional requirement. Several alternatives must be formulated for each component, at the roots of the program tree. Each alternative must be tested against the design parameters to insure that they stay within the boundaries of the design field. This means that a proposed component alternative must satisfy the requirement, be physically realizable, economically worthwhile and financially feasible. The set of useful alternatives must pass all evaluative tests. Each alternative need not be new nor novel. The sets of alternatives that are confidently accepted as adequate serve as building blocks for the next sequence. Quantity, within the bounds of budget constraints, is desirable at this stage. It is easier to eliminate during the synthesis than to add to the alternative sets.

In terms of the new town design, it is a matter of starting with each of the component requirements and, within the design concepts, finding the component forms which meet the requirement. In the search judgement should be suspended until sufficient ideas have been generated. They may be old ideas but new to this problem. Then, each form idea is tested against the requirement and the policies that were developed. The result is a number of alternative form concepts for each specific requirement.

Proposals

Phase six is characterized by the process of synthesis. This, more than any other phase, requires inventive and creative effort. This is where the intuitive, creative leap takes place at a significant scale, as synthesis proceeds. Creative intuition is the talent for discovering combination of components which are suitable as solutions. ADLC has the sets of acceptable alternatives as the design blocks to work with. In finding workable combinations the process will be highly iterative. If you recall, should ADLC have defined 1000 requirements for the town development pattern there were about 500,000 links between that number. Since

ADLC now has a set of alternatives for each component, the number of possible combinations is fantastic. Several things help to organize the search for combinations. There is the dependency network of the program which channels the synthesis to some degree, there are the design concepts which help to eliminate some combinations immediately, and there is the creative intuition of the designer.

The synthesis moves from the roots of the program tree to the apex. Alternatives are synthesized for each cluster at the first level. The second level is a synthesis of the clusters of the first level and the process continues up the program tree. The dependency of the network is followed in this process. The process is highly iterative with many tests. For example, in the new town design ADLC has isolated one cluster problem of five components. For each component five alternative solutions have been proposed. They know the outcome desired and the input requirements; they are searching for the system that passes the test of bringing congruity between input and output. It is a matter of test, try a new system combination by changing a single alternative, and test again, etc. Those combinations that prove satisfactory are kept for the next higher level of synthesis where the process starts again. This phase ends when ADLC has several proposals for the new town design.

Solution

Phase seven begins with several proposed solutions. With the number narrowed down to a workable level, each proposal can be tested in more detail. A high level of confidence must be developed in one proposal before it can be accepted as the solution and before large amounts of money can be committed to it. Usually no one proposed solution meets all requirements exactly. Therefore, deciding on a solution involves weighing the importance of the various specification requirements and then comparing system capabilities in terms of the weighted specifications. The decision thus hinges greatly on the priorities. During this evaluation and selection stage the design process again narrows and converges to a particular set of criteria that have been appropriately chosen to meet the demands of the problematic situation. Several solution proposals are presented at first to insure consideration of all possibilities to avoid the danger that merely a workable rather than the best solution will, ultimately, be chosen. The selection and evaluation of one best solution comes as a combination of effectiveness and practicability. Initial tests in this sequence will reveal a favorable solution which is proposed as the solution. This design concept can then be evaluated in more detail.

With the proposed solution narrowed down, all the attention and resources can be focused on gaining confidence in the proposal. Every aspect of the design proposal must be carefully assessed in terms of all of the criteria that have been defined and by now have been fully developed. The outcome from this sequence is a satisfactory design of the "new town" pattern.

Results

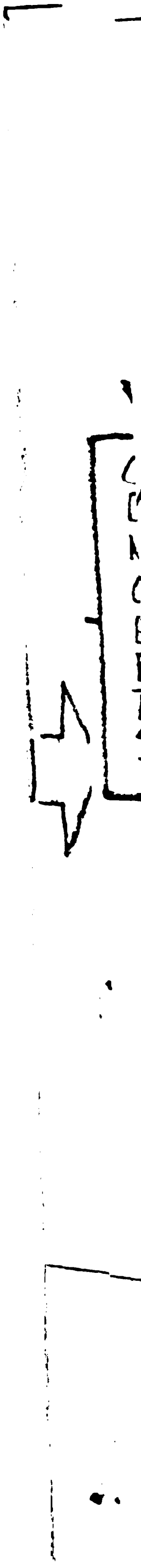
ADLC now has a spatial design for the new town form and pattern. What remains to be done is a program for implementation and to verify the results of the design. The program for construction-scheduling is carried on most extensively in the remaining steps in the planning activity. The ADLC designers, however, are interested in setting down a program that reflects functional sub-units of the community plan. They define what areas of the design should be constructed first, what community facilities will be needed from the start for a viable environment and what other sections can be constructed next. If the ADLC designers get to the detail of designing working drawings for such things as street systems, whater systems, and buildings then the working drawings would become part of the construction program. The actual scheduling of construction, the timing of material arrivals personnel schedule, and detailed construction sequence is not the work of the designer. Other members of the planning team have the expertise for this function. This work is carried out in the concluding phase of the planning.

Action

The program should point out the sequence in which construction should take place and the construction methods. If we have detailed "working drawings" of the town it is just a matter of having the construction specialists begin their phase. ADLC, however, was just concerned with designing the structure of the town, locating land uses and the basic pattern of town development. Specialists were given the detailed work to design such as the engineering system and the architecture. Construction schedules were worked out with an eye toward functional units being built at once. This will insure a usable environment from the start, while the remainder of the town develops over a fifteen year period. This means that scheduling must insure that commerical, industrial, and social facilities are included from the start, within financial feasibility. The orientation must be toward attracting the customer, but at the same time the construction of the whole town center, for example, can not be economically justified from the start. ADLC must carefully analyze the results as the project is implemented.

In this way any feedback may help to improve the design of the remainder of the project. Results must be measured against the goals that were defined for the outcome, in terms of implementing schedules and in terms of the rate of profit that was forecast. This feedback may indicate that the project plan and design need to be re-evaluated with an eye toward making changes in the as-yet-unfinished portion of the project.

Feedback must be evaluated by the design team. The feedback, however, comes not directly from the project results, but passes back to the design team through the planning process. The ADLC planners find sales are slow, for example, because adequate cultural facilities have not been included with construction of the first two neighborhoods. They find that the bicycle paths to the churches are not being used, and that several green strip areas are costly to maintain. The planners analyze their findings and pass this feedback information on to the designers along with new policy criteria. The designers take this new information and research their designing activities. The results are then incorporated in the areas yet to be constructed, as well as improving the areas where misfits exist. The design process continues to operate as long as the planning efforts feed new information. With



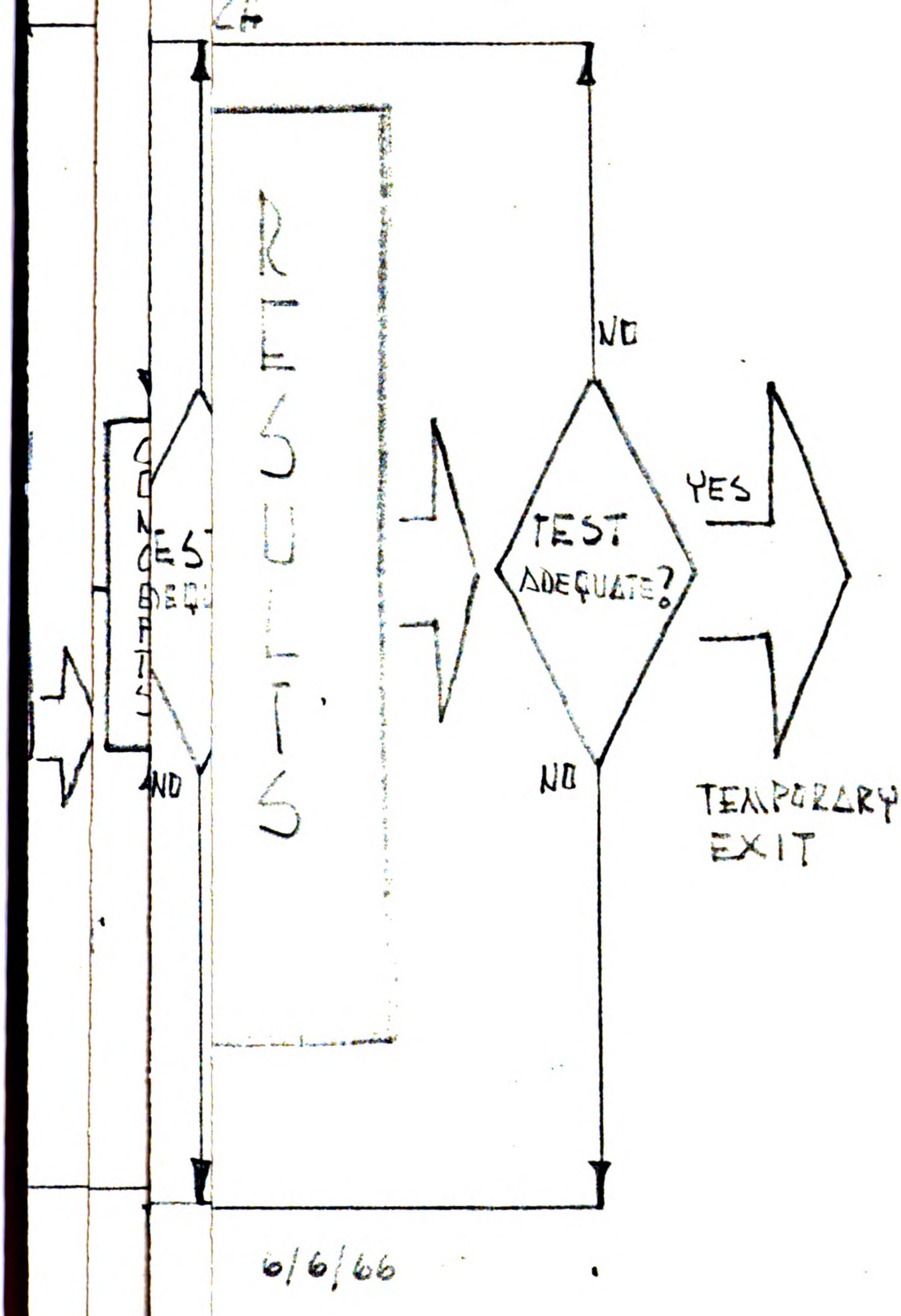


figure 27.

complete construction of the project ADLC terminates its responsibilities to its clients and the planning phase ends.

CHAPTER IV

THE SPATIAL CITY AS A SUBJECT FOR DESIGN

A. Philosophy of City

The discussion of problem-solving and design up to this point has made little reference to the city as a special category of design problem in a theoretical sense. The purpose of the chapter is to suggest the important features of the city as a design problem, pointing out the utility of the design model in the case of the urban situation. Figure 6 points out that the designer must work within the discipline of design but also within a philosophical framework with regard to the design subject. This philosophy is a systematic and consistent understanding of the city. The earlier discussion of the form-context model considered a part of the philosophy of a design discipline with its relevance to the urban complex. Even within this discussion certain philosophical concepts of the city had to be assumed. For example, the city was considered as a whole made up of parts. Such a philosophy postulates a city as a complex hierarchy, a structured whole of parts and not a monolith. As Gilbert Herbert states, "a philosophy is necessary for the town planner, because philosophy 'builds cathedrals before the workmen have moved a stone'."[1] It is not my objective here to describe a single full blown philosophy, but rather to suggest that a philosophy is needed by the designer and what a philosophy is by pointing out some of the approaches that have been described.

We can think of the city as a cultural artifact in considering the causal forces which produce it. Figure 28 is a highly simplified causal diagram. It suggests the causal chain that results in the urban structure. The cultural interaction of individuals in society gives rise to organized groups. These groups have a central set of meanings and values consistent within the group, which assume the form of law-norms that define the relationships of the interacting individuals toward one another, the outsiders, and the world at large. This interaction gives rise to a cultural structure. Each institution has its own meanings, values and goals which it attempts to maximize. Artifacts are the equipment that support the activities of the institution. The interaction of the institutions (norms, values, meanings, artifacts) with man as the agent, gives rise to the urban complex in its artifactual form.

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[1]Gilbert Herbert, "The Organic Analogy in Town Planning," J.A.I.P., Vol. 29, August 1963, p. 208.

Philosophical approaches to the city as a design subject seem generally to fall into two categories. Donald Foley[2] advises: the unitary approach and the adaptive approach. The unitary approach is primarily concerned with an end product or a design outcome. It deals with the whole city as a design subject, the process influenced by the early architectural heritage of planning. The design activity, using certain spatial design principles and standards, attempts to produce a spatial pattern for the future community. The future spatial pattern is the proposed goal. Stanley M. Sherman[3] identifies a number of methods within the general unitary approach. Table 4 lists these methods with very brief description of their central theme.

The adaptive approach identified by Foley focuses on process rather than product. The city is viewed as a complex interaction of functionally interdependent parts which evolve over time as they seek to adapt to their changing context. Emphasis is placed on defining the daily interactions and what forms are manifested. Design is aimed at development policies. This approach has a strong

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[2]Donald T. Foley, "An Approach to Metropolitan Spatial Structure," <u>Explorations into Urban Structure</u>, Webber, et. al. (Philadelphia: University of Pennsylvania Press, 1964).

[3]Stanley M. Sherman, "On Forming and Re-Forming Towns and Cities," <u>J.A.I.P.</u>, May 1963, pp. 134-143.

TABLE 4

DESIGN APPROACHES TO THE CITY*

1. The Aesthetic Approach - considers city solely as a work of art - what makes urban forms beautiful.

2. The Analytic Method - organizes physical forms of city according to some structure, Lynch-Image of City.

3. The Empirical Approach - trusts personal vision over historical theories and studies - relies on generalizing from personal background.

4. The Architectural Approach - relates interior and exterior arrangements, emphasizes buildings alone and overlooks the spaces and activities between buildings.

5. The Ordered Control Method - links design with human needs, with "design idea" a central force in organizing space, - Bacon.

6. The Economic Approach - proper design is justified because it will provide a greater return on investment - Gruen.

7. The Accumulative Approach - loose organization, less firm disciplinary base for greatest freedom of expression.

Source: Adapted from Sherman, op. cit., p. 134-143.

organic orientation where there are undertones of life - birth, growth, change, and ultimately death. The organic design being one which fosters the life process. In Table 5 Gilbert Herbert identifies some approaches within the organic philosophy.

In summary, with the organic philosophy, "the general . . .use of the word organic denotes constitutional, inherent, fundamental, structural: organized, systematic, coordinated: and it is used in such phrases as organic unity, or an organic whole."[4] Another organizing construct of importance within the adaptive approach that is closely related to the organic analogy is systems analysis. While this postulates along the lines of the organic, it generally is oriented away from the "natural" connotation. A system, in this method, is any group of interrelated or interacting components. In application to the city it considers the natural systems but emphasizes the man-made systems. "Systems theories suggest that the total functioning urban region can be understood or comprehended within a framework which takes into account both the characteristics of the many parts and the ways in which they are interconnected and interacting to make up the structure and operations of the total urban

[4]Gilbert Herbert, loc. cit., p. 200.

TABLE 5

ORGANIC APPROACHES TO THE CITY*

1. The Cosmological Analogy - relates to that fundamental aspect of organic theory which is conceived with universal problems of inherent order and meaning.

2. The Nature Analogy - the organic is equated with the natural - is related to living and growing, and these processes of the natural scene.

3. The Systematic Analogy - finds inspiration in an analogy with the normal systematic functions of aminal and plant life - hence the C.B.D. is likened to the heart or nerve center.

4. The Ecological Analogy - concerned with the structure of the city itself as a physical entity, but with the nature of the urban community as it is affected by the city, - concerned with the problem of symbiosis, the problem of the influence of environment upon man's relations to his fellow man.

5. The Cellular Analogy - this analogy arises partly from the consideration of the form of society as organic, and partly from the consideration of the structure of natural organisms as cellular.

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*Source: Gilbert Herbert, op. cit., pp. 198-209.

region."[5] Table 6 lists the features of the unitary and adaptive approaches as identified by Foley.

B. Understanding Urban Structure

One of the key principles of problem-solving theory which Alexander describes in his form-context model is to break the problem situation into its parts. To be effective, the designer must recognize the pattern of the problem so as not to cut across its structure and deal with parts of little utility. Execution of this principle in design entails not only a structure of the problem subject, but also a structure of the design process. We have been most directly concerned with the process and less with its theoretical substantive content. To make clear how these techniques are necessary and useful in the design process, however, a brief description of several techniques might prove worthwhile. Each of the approaches is formulated within a philsosphical construct and is developed to aid the designer in understanding and designing the urban pattern in a symbolic

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[5] Stewart D. Marquis, "The Urban-Regional Ecosystem: An Operational Research and Planning Approach," (Lansing: Michigan State University, 1965) Mimeograph.

TABLE G. - D. FOLEY, OP. CIT., 59

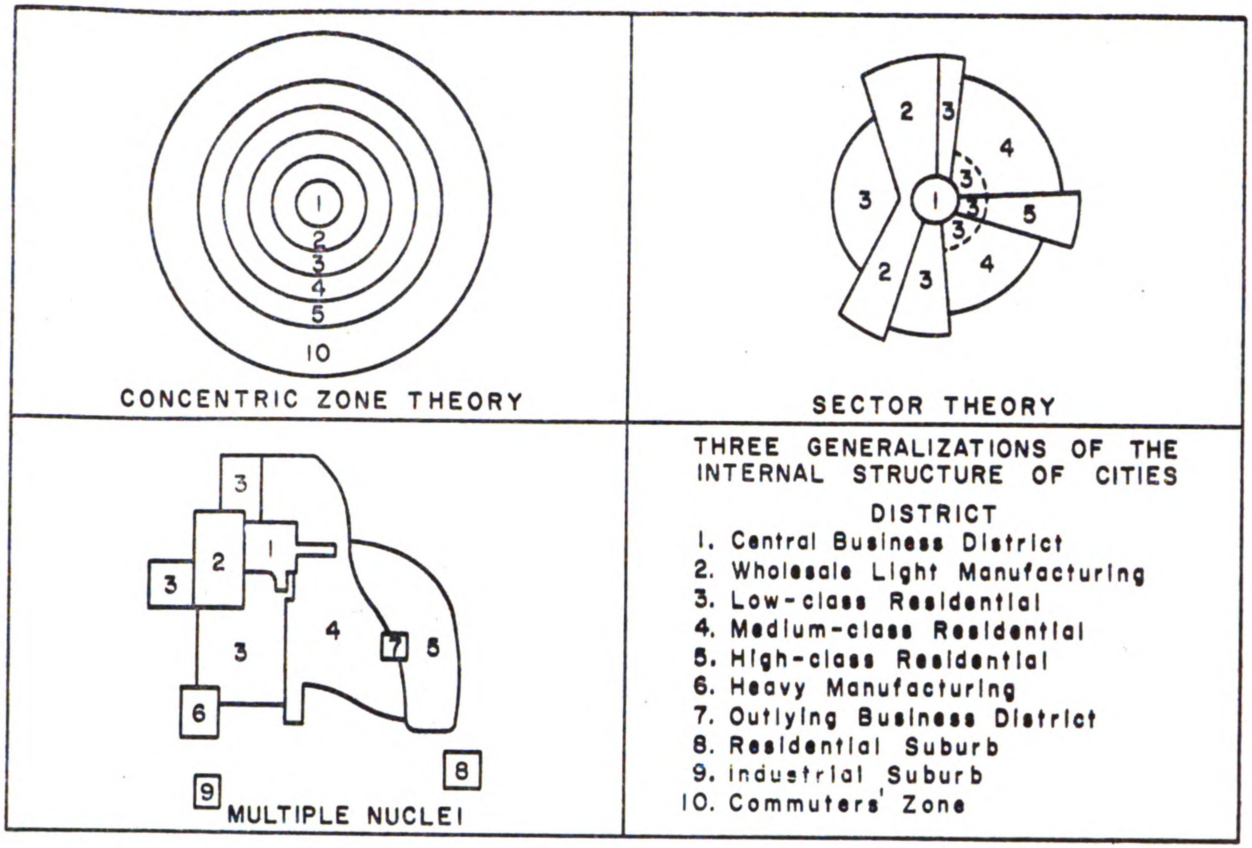
Nature of the Characteristic	Unitary Approach	Adaptive Approach
1) The plan toward which planning works	Long-range locational physical plan: the portrayal of a metropolitan spatial form for the future as desirable goal.	Policies and proposals constituting courses of action, to influence metropolitan development.
2) Substantive focus	Locational pattern of activities and the physical characteristics of the metropolis, taking into account social and economic goals, and including controls to ensure that development will accord with desired character.	Social economy of the metropolis, including opportunities and standards for living, cultural and business activities, etc.; the public and private decision making mechanisms by which development takes place.
3) Methodology	Intuitive, synthetic-political; aggregative; strong design influence; focus on product.	Empirical-analytic-economic; disaggregative; social science influence; focus on process.
4) Underlying assumption as to the basis for community solidarity	Solidarity results from consensus: a normative view of what is desirable.	Functional integration: solidarity results from the integration of diverse parts and viewpoints.
5) Assumptions regarding the political economy	Necessarily strong and fairly centralized role for government in the mix as between local and nonlocal subject to considerable variation; market decisions important but to be kept under control.	Decentralization; pluralistic political economy, with market-type decisions very important; governmental responsibility to provide leadership regarding prime-mover developments and to ensure working of economy in public interest.
6) Assumptions as to knowledge about the future	Precise knowledge irrelevant; strong design commitment and political leadership can provide self-fulfilling prophecy.	In view of complexity of the present and the essential unknowability of the long-range future, focus is on the near future and the directions of influence, subject to successive adaptation as the future unfolds.
7) Implicit aesthetics of spatial arrangement	Articulation: the designation of centers, the strong demarcation of circulation channels and internal boundaries, the clear bounding of the community so as to distinguish between city and country. Preferably treating designs as though they were reasonably final, with implication that disturbing overgrowth should be prevented.	Fluidity and interpenetration: the acceptance of growth, no single, final design; latitude for experiment and unpredictable change. A spatial plan can at best provide sound communication and transportation systems, a system of public spaces and community facilities, and a modular-type framework within which further development can proceed.

DISTINGUISHING CHARACTERISTICS of THE UNITARY AND ADAPTIVE APPROACHES TO URBAN DESIGN way, Present methods, however, are regarded as fragmentary, ambiguous, insignificant at the urban scale and generally inadequate.

The conventional land use classification system is one method of representing the urban pattern in a manageable form. At first glance land use appears to be a simple and unequivocal concept. It is concerned with the surface utilization of land with a division of all land into two major categories, developed and vacant. Developed land is usually divided into two sub-categories, those privately and those publicly developed. While the first division establishes its category according to the criterion of purpose, the second introduces a completely different criterion - ownership. Other criteria appear in the third subdivision. Privately developed land is subdivided generally into six subcategories: single, two, and multi-family residential, commercial, and light and heavy industry. The terms residential, commercial, and industrial denote the purpose or function of a piece of land. But the difference of the three residential categories refers not to different functions, but to different types of structure and density. However, in the division of industry into light and heavy, the criterion is neither purpose nor structure nor ownership.

Getting into the publicly developed land we find a mixed bag. To carry on further would only reveal more of the inconsistancies and glaring contradictions. Attempts have been made to improve this system. Several planners, including Rapkin and Mitchell, suggest four criteria relevant to the classification of land use: (1) buildings or other improvements on the land; (2) occupants or users of land; (3) major purpose of occupancy of land; (4) kind of activities on the land. Certain design standards are used along with this system to facilitate general spatial arrangements.

Another system of a more generalized nature attempts to describe the internal structure of the city. There are three classical models, the concentric ring theory by Burgess, the sector theory by Hoyt and the multiple nuclei theory by Ulman and Harris. The first theory is a generalization for all cities, the second and third varies from city to city. The utility of these models is in explaining the existing urban pattern at the urban scale, as the product of certain underlying forces. This technique is of little direct value as a design approach and is greatly simplified. Figure 29 illustrates the three theories.



Source: Chauncy D. Harris and Edward L. Ullman, "The Nature of Cities," The Annals, November, 1945, p. 13.

GENERALIZATIONS of INTERNAL STRUCTURE of CITIES

FIGURE 29

The neighborhood unit concept is another model used to analyze and to design indentifiable "natural" neighborhoods. These space units emerge because of certain interacting economic, physical, and social elements. In analysis, attempts are made to identify the center, usually a community center that often includes a school, store, and/or a church; the exterior boundaries that restrict daily movement such as major streets, natural physical barriers, and land use barriers; and physical-social homogeneity. As a design technique certain design principles and standards have developed as to area and population,size, location, internal service radius and street patterns. The concept is closely related to the organic cellular approach. The neighborhood idea continues to bring forth both staunch defenders and opponents. Figure 30 illustrates the theory as defined by Stein and Perry.

There have been recent attempts at developing more useful techniques to deal with the urban structure as a design subject. Albert Z. Guttenberg[6] considers the urban structure, identifying some of the critical elements and relationships. His model is based on the principle that urban structure is a result of a community effort to

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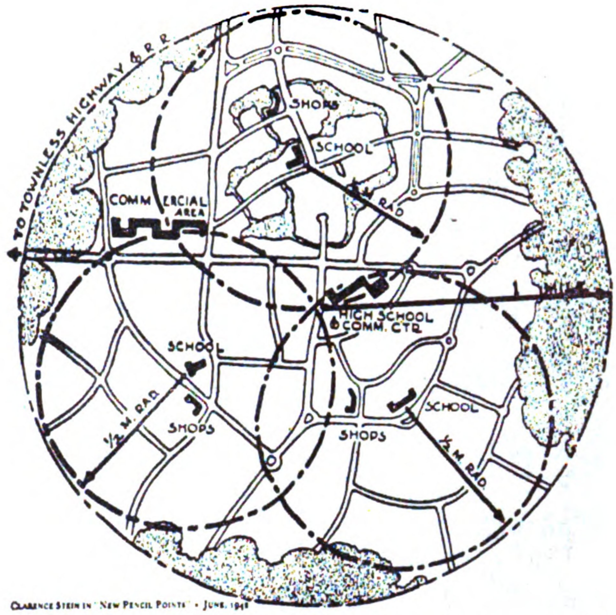
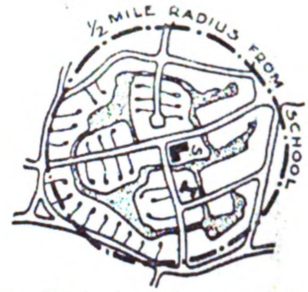
[6] Albert Guttenberg, "Urban Structure and Urban Growth," J.A.I.P., Vol. 26, May 1960, pp. 104-110.

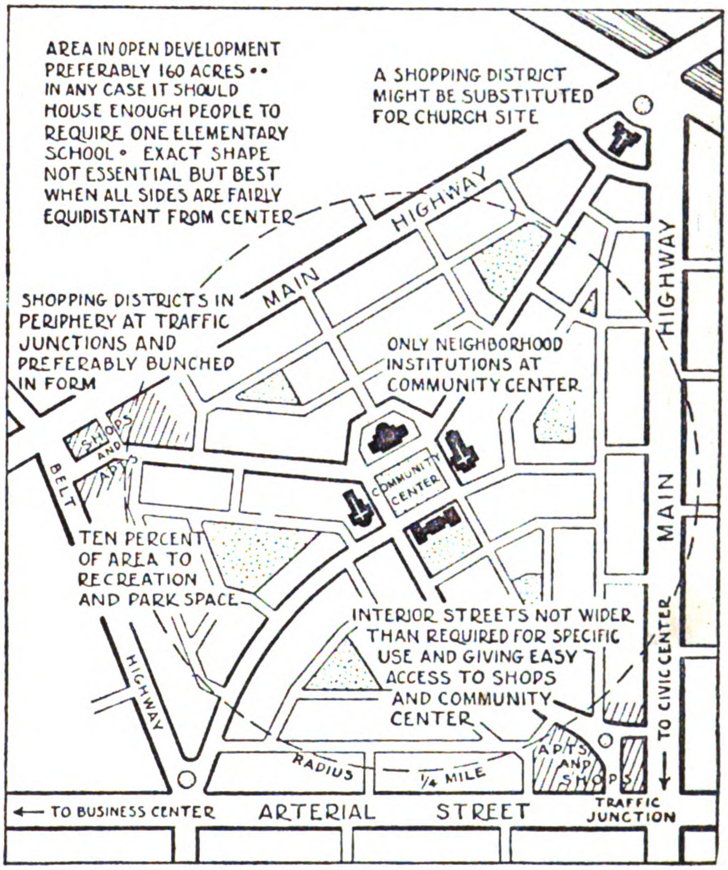




Clarence Stein's determinations of the proper areas to be included in the Neighborhood Unit.

In the upper-right diagram the elementary school is the center of the unit and within a one-half mile radius of all residents in the neighborhood. A small shopping center for daily needs is located near the school. Most residential streets are suggested as cul-de-sac or "dead-end" roads to eliminate through traffic, and park space flows through the neighborhood in a manner reminiscent of the Radburn plan.

The upper-left diagram shows the grouping of three neighborhood units served by a high school and one or two major commercial centers, the radius for walking distance to these facilities being one mile.



The Neighborhood Unit
as seen by
Clarence A. Perry

Perry was one of the first to give some consideration to the physical form of the neighborhood unit. It is substantially the same as that in the diagram by Stein but suggests that the maximum radius for walking distance from the home to the community center should be only one-quarter mile. Accepting the practice which was then, and still is, generally prevalent, shopping areas are situated at intersecting traffic streets on the outside corners rather than at the center of the unit.

Source: Arthur B. Gallion and Simon Eisner, The Urban Pattern (Princeton, New Jersey: D. Van Nostrand Company, Inc., Copyright 1950), p. 279.

THE NEIGHBORHOOD UNIT CONCEPT

figure 30.

overcome distance between residents and required facilities. The elements of structure are identified, the mutual influences of urban structure and urban growth are considered, and there is an effort made to demonstrate the dynamic interdependency of various urban structural phenomena by analyzing the effects of a change in transportation efficiency. The major functional parts that are identified are the distributed facility, the undistributed facility, and the transportation element. It is recognized that certain facilities can be distributed throughout the area in close physical proximity to their users while other facilities can be distributed only in the sense of being made accessible through the transportation system. The model is based on a simple relationship which the author advises is yet largely hypothetical.

The last substantive technique to consider is being developed by Kevin Lynch.[7] This method has evolved over the last few years and still remains untested, as the author

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[7]Kevin Lynch, "A Classification System for the Analysis of the Urban Pattern," unpublished paper prepared for the Seminar on Urban Spatial Structure of the Joint Center for Urban Studies of M.I.T. and Harvard University, 1961. See also Lynch and Rodwin, "A Theory of Urban Form," J.A.I.P., Vol. 24, 1958, pp. 201-213.

admits. Lynch was motivated to define this system because he feels that present methods are not very useful. His proposed system begins with the assumption that the urban pattern is the distribution of two things: the activities of people and the physical facilities for those activities. In designing his model Lynch has considered the following essential criteria:

> (1) that each category of data be simple and generalized, so that we can express and analyze city form with economy of effort;
>
> (2) that each category be unambiguous, and its data obtainable and comparable;
>
> (3) that no significant features of urban pattern be excluded;
>
> (4) that categories be easy to relate to one another, and yet be independent and separable, allowing a flexible application to urban pattern of any type;
>
> (5) that the system as a whole be orderly and compact. Probably this last is an aesthetic motive, but none the less an important one.[8]

Lynch describes a classification system that attempts to deal with the varied effects of different physical forms, and of location of human activities in relation to physical forms. Justice cannot be rendered to this work in a brief description. Perhaps it would be most useful to summarize the model as Lynch does. He identifies the substantive elements of the city and summarizes the total system as follows:

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[8]Lynch, loc. cit., p. 12.

"A. The subject matter, the spatial pattern of human activity in a physical setting:
   1. Activity
      a. Localized activity
      b. Flow
   2. Physical facilities
      a. Adapted space
      b. Flow system

B. For any item of subject matter, the following may be specified at any one point in the region:
   1. Characteristic of that point alone:
      a. Type
      b. Intensity
   2. Specified for the point, but due to type or intensity at other points:
      a. Grain or gradient
      b. Potential

C. Once any of these items have been specified for all points, the data may be expressed:
   1. As a statistical distribution
      a. Total quantity
      b. Percent composition
      c. Measures of centrality

   or:

   2. As a spatial distribution in either two or three dimensions which may be expressed verbally, mathematically, or graphically as abstractions emphasizing the following features:
      a. Total distributions of standard units or of a continuous variable
      b. Focal patterns
      c. Network patterns
      d. District patterns"[9]

Figure 31 illustrates a system of notation devised by Lynch to analyze urban patterns using his classification system with regard to human objectives. The appearance of a goal in the top diagonal (shaded squares) indicates

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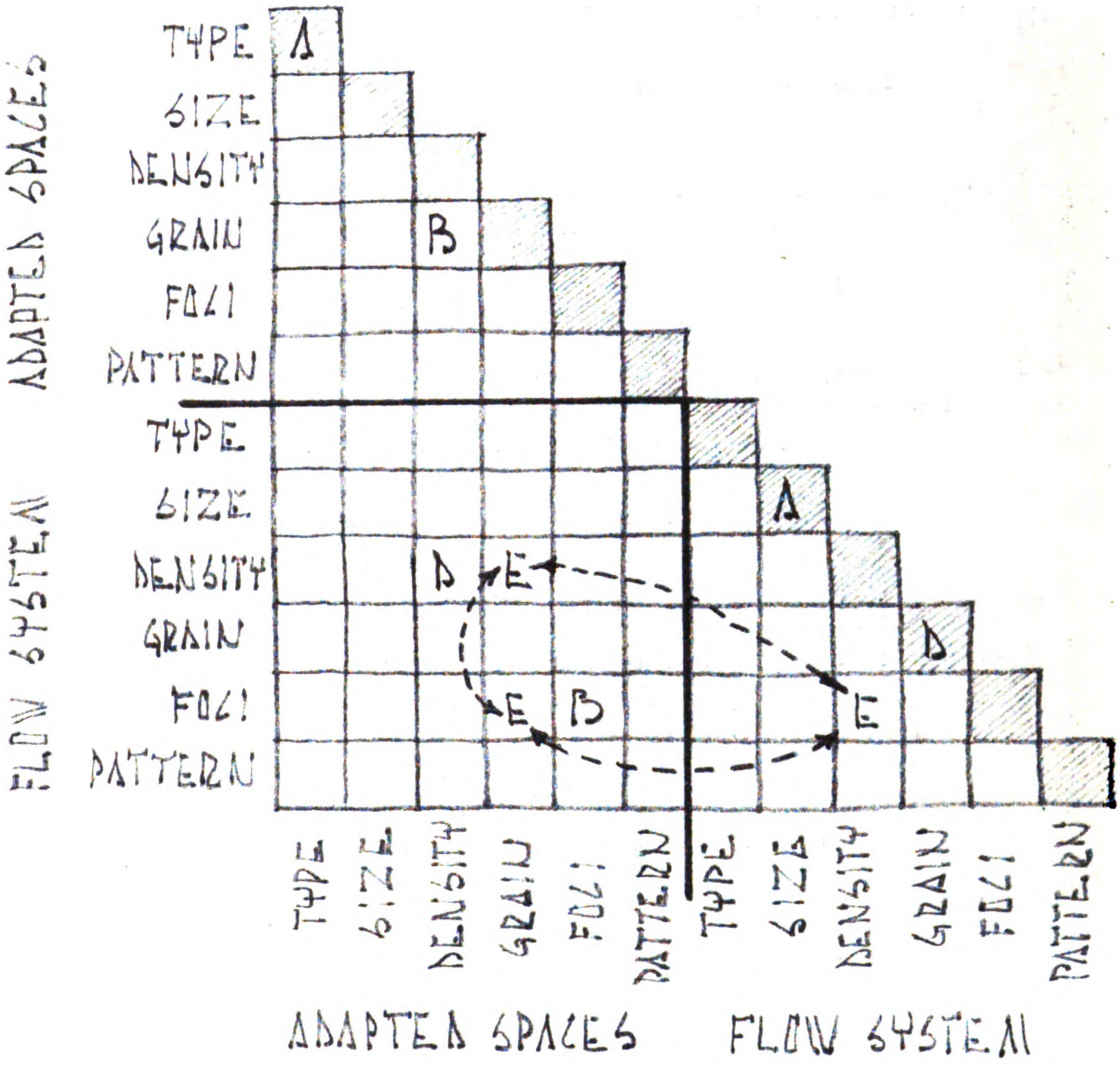
[9] Lynch, _loc_. _cit_., pp. 7-8.

ACHIEVEMENT OF GOAL IS INFLUENCED BY:
A-(1)space type;(2)flow system size.
B-(space, density, and grain combined;(2)focal organization of space and flow system combined.
C-(1)space, size, and flow system pattern combined.
D-(1)grain of flow system;(2)density of space and flow system combined.
E-(1)grain of space, and density and focal organization of flow system all combined.



SOURCE: SEE FOOTNOTE 9

SYSTEM of NOTATION FOR RELATIONSHIP of GOALS TO FORM

Figure 31.

that it relates to a single "form quality" at a time. If the goal is located in one of the other squares it means that it is influenced by a pair of "form qualities" that must be considered together. The goal E that is shown is influenced by three "form qualities" and must be connected in a triangle on this two dimensional notation system. If the system were three dimensional, then E would appear in only one square. A very complex notation system of this sort would be needed with a goal that had many interacting form variables.

C. The Structure of a Problem

In closing this chapter a number of important conclusions need to be made. Most significantly it must be recognized that the structure of a problem situation is defined by two quite different things in terms of moving to a solution. Both the discipline of the design process, as well as the substantive technique used within the design discipline strongly affect the understanding and solution of a problem. The substantive content is closely related to the philosophical construct that is used to bring a structured order to the design subject. In the case of urban design the philosophy presents to the designer an intellectual construct which permits him to break the city into workable parts in a logical consistent manner and therefore amplify his capacity to design for the city. Only recently has there been much research in this area.

There is then, of course, the design discipline as a factor, which was dealt with at some length in this paper. The discipline gives structure to the problem-solving activities. In this way, it too breaks a whole into its simpler parts -- in this case the solution search process. The components of the problem-solving process represent subproblems, or problems in their own right. By being able to concentrate on simpler problems once again the designer's capacity is amplified. The design process is the plan that points out the subproblems and the sequences in which they should be dealt with while moving to a solution. To make the design model applicable to the city it would require incorporating a substantive theory into the design discipline that it outlines, but this is a subject for further investigation, at another time.

CHAPTER V

CONCLUSIONS

There appears to be a significant need for better design theory when it comes to the design of the urban spatial pattern. Recent planning literature has begun to hint at the need for a new perspective scale of design with reference to the urban complex. With this new perspective, the inadequacies of present design methods are recognized by a small group within the planning profession. In an effort to break away from the strong influence in its early history of the architectural design techniques, the planning profession in recent years has been making energetic advances in other directions. The result is that little research has been oriented to developing new design methods.

The preceding represents an attempt to point out the significance of design in adapting to the complexities of the urban environment, to examine problem-solving theory and the advances in engineering processes as a foundation in building a design model, to suggest the peculiarities of the city as a design subject, and to develop a procedural, systematic framework relevant to the design of cities.

In Chapter I it was suggested that both planning and designing are the behavior of man whereby he adapts to his evolving environment. The growing complexity between the interaction of man and his environment has made it necessary for him to improve his adaptive methods. Special classes formed in society, with their body of rules, to make the important adaptive decisions. In the planning field great strides are being made today in improving its methods of decision. New decision theory, new information processing techniques, and new models of the urban community are being developed. Urban design, however, remains totally inadequate to deal with the design of the urban environment and in its present form cannot adapt the new advances in the field for its use.

A design perspective of problem-solving is established in the investigation in Chapter II. A problem proves to be a complex and perplexing situation that must be examined closely before a solution search can begin. The major problem-solving procedural elements are examined for their relevance to a design discipline. The design process, as represented in the model, is composed of a series of procedural steps; moving from establishing needs to finding a solution. Each sequence is composed of six basic creative processes aimed toward a particular outcome for that sequence. Each sequence outcome is a component of the design solution. In this sense the model is a framework or a plan of the activities that need to be carried out, in a particular sequence, in finding a solution.

Many features of the design process are represented diagrammatically in the model. There has been particular emphasis placed on the importance of defining a complete statement of the problem situation. One of the most frequent shortcomings in design is to move too quickly in the process to solving the problem before an adequate understanding of the problematic situation has been attained. Subsequently, the design model divides equally between problem search and solution search. The problem search phase has analytic operations as its overriding movement. The goal of this movement is the decomposition of the problem situation. This decomposition becomes the program for the solution search. The solution search has synthetic operations as its overriding movement. Its objective is the combining of solutions to the problem parts into a unified solution of the problem.

The design model as it stands now is strongly reflective of the perspective of problem-solving. As was mentioned in the text, important additions could be made to the model if decision theory or information processing theory were to be incorporated as a part of the discipline. If the model were to be described at a higher level of complexity, important substantive decisions could make it more relevant to the urban situation.

Having dealt at length on the discipline of design, the importance of substantive theory was made clear in an effort to show how the design model could handle the urban case. A philosophy of the city becomes a necessity which the designer must define for himself. This intellectual construct helps him to organize the milieu of the city into understandable form. The purpose of a philosophy of the subject of design is to find a meaningful structure or pattern in the problem subject. Solving a complex design problem reflects both the structure of the discipline of design and the functional structure of the design subject.

The design model is greatly oriented to the functional characteristics of the urban elements. The substantive methods used within the operation of the model should reflect this orientation. Systems theory would be most relevant from this standpoint since it deals with the functional parts or systems in the urban region. The objective of the problem search phase was a complete decomposition of the problem into a dependency network in terms of the possible functional misfits in the urban form. The systems theory would provide an organizational framework to decompose the complex urban form into its elemental functional requirements.

On a whole, little research has been done aimed at improving substantive design methods that would have significant relevance in the design model. The work of Guttenberg, Lynch, and Rodwin stand out in this area. Alexander and Schlager have done notable work in design discipline and applications of the computer to design.

Despite its inadequacies at this point, the model has utility. Unfortunately, the evaluation of its utility would require its use in a complex example. The model as it stands here is only the basic framework, even though it points out the sequential processes. If a problem were to be executed in some detail, using the rationale of the model, its value might become more apparent. This was not feasible in the scope of this work. I can suggest, however, several places where the model may have utility. The model could be nested in the comprehensive planning process that deals with the urban community. In other words, it could become an intimate part of what is called the the master planning process. This relationship was suggested in the description in the text of the new town project. The model could have use in designing on the project scale, where the complexity warranted it. Projects, such as large renewal areas and large subdivisions, where extensive planning and designing is necessary and where many people are involved in the project, would find the framework of the model useful in carrying out their design work.

A final utility, which I wish to suggest, is as a teaching tool. This, perhaps more than anything else, has motivated me in this effort. Teaching design seems to be an extremely difficult task. I have seen this task from both the perspective of the student and teacher. Design for centuries was "learned," in some mystical way, only after years of rubbing elbows with the master. Much the same method exists in many schools today with the studio critic method, greatly influenced by the beaux-arts tradition. I remember only too clearly my years struggling with design in architectural school waiting for lightning to strike so I could finally become one of the members of the priestly cult of designers. As I look back now, I can readily see the significance that the design model would have in learning about design and how to design. The model doesn't do away with the need for artistic creativity; in fact the opposite may be true since it brings design in the open, where the designer can't hide behind an arbitrary grand concept. There are logical processes and sequences in design that when crystalized can be meaningful teaching tools. It is possible to point out the kind of activities within each sequence and at what point in the process they should be executed, while at the same time having a perspective of the whole process.

To recapitulate, the planning profession is in need of improved design methods for the urban scale. The model has answered a few questions toward that end. Perhaps just as importantly, at least for me, is the insights that have been gained that are yet to be explored.

APPENDIX A

Problem-Solving Context

The following summary information is mainly the work of Frank E. Williams, Jack W. Taylor, and Bernard B. Goldner.

TABLE 7

THE NATURE AND SKILL OF PROBLEM-SOLVING DEPENDENCY*

1. Varied activities and speculation.
2. Change of one's actions when either searching for adequate ways to find an obvious solution or in applying the chosen solution.
3. Planning and organizing for a decision.
4. Perserverance.
5. Upset or disorder as contrasted with routine accomplishment.
6. Flexibility of thinking and creating when conditions favor variable approaches.

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*Source: Williams, op. cit., p. 67.

TABLE 8

TRAITS IMPORTANT TO THE PROBLEM-SOLVER*

1. Something _accomplished_, a new response.
2. _Novel combinations_ of parts of things, idea, or experiences brought together in a new relationship.
3. _Usefulness_ for problem-solver or group.
4. _Incubation_ or the necessity of purposely laying the problem aside to await creative responces.
5. _Universality of creativity_.
6. _Flexibility_ in shifting from general to problem particulars.

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*Source: Williams, _op_. _cit_., Chapter II.

TABLE 9

PERSONALITY BLOCKS WHICH HINDER CREATIVE PROBLEM-SOLVING*

Perceptual

1. mental rigidity - inability to overcome preconceived set or "groove thinking."
2. functional fixation - object having one function not seen as suitable for quite a different function.
3. habit - seeing problems as always seen before.
4. failure to see the problem in true perspective - unable to differentiate between symptoms of the problem and the problem itself.
5. misdirected judgement - inability to turn judicial functions on or off at will - particularly in divergent thinking stage.

Emotional

1. prejudice - fixed attitude, "closed mind."
2. fear - of failure, ridicule, being different.
3. anxiety - unresolved fear, state of apprehension, insecurity.

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*Source: Williams, op. cit., Chapter IV and Taylor, How to Create New Ideas (Englewood Cliffs: Prentice-Hall, Inc., 1961).

4. jealousy - feeling of deprivation, envious.

5. over-motivation - time and pressures force concentration on only the "obvious."

6. misdirected tension - unrelieved upset, abnormal control of tension.

7. negativism - refusal to follow suggestions or consider anyone else's point of view.

TABLE 10

CULTURAL FACTORS THAT WARP CREATIVITY*

1. uneasiness - social and personal pressures from a materialistic society.
2. complacency - emphasis on pleasure and profit.
3. mediocrity - behavior acceptable toward the mean or average.
4. group systems - personal security within a group emphasized over individual initiative.
5. conformity and dependence - stability oriented to fit a definite pattern.
6. change: resistance to or high value on - main - training status quo versus formal orientation.
7. authority domination - stress on documentation.
8. demand for action - achievement orientation.

---

*Source: Williams, op. cit., Chapter IV and Taylor, op. cit.

TABLE 11

ATTITUDES AND ABILITIES ESSENTIAL

TO THE CREATIVE PROBLEM*

Solving Process

1. problem sensitivity - skill of recognizing needs, goals, and improvements in the environment.

   knowledge
   keen observation
   inquiring mind
   sensitive to surroundings
   enthusiasm
   questioning attitude
   involvement in problem

2. fluency of ideas - quantitative fertility of mental and verbal expression.

   good vocabulary
   vivid imagination
   copious flow of ideas
   mental imagery
   self-confidence
   deferred judgement
   intellectual competence

3. flexibility - skill for having a variety of different thoughts and ideas.

   rapid adjustment to new situations
   knowing when to pursue or when to abandon alternative solutions
   ability to shift between convergent and divergent thinking

4. originality - skill for constructing unconventional mental patterns and to see new combinations.

---

*Source: Williams, *op. cit.*, Chapter IV and Goldner, *The Strategy of Creative Thinking* (Englewood Cliffs: Prentice-Hall, Inc., 1962).

constructive discontent
power of association
application of the principles of analysis
  and synthesis

TABLE 12

ENVIRONMENTAL AND CULTURAL FACTORS WHICH STIMULATE CREATIVITY*

Environmental

1. permissive atmosphere - freedom of expression, custom and and conventions that encourage original thinking.
2. positive attitude - receptivity to ideas that anything is possible and can be done.
3. combine group collaboration with individual ideation - power of free association coupled with self reflective meditation.
4. motivation - stimulation of surrounding atmosphere which encourages creative abilities.

Cultural

1. democratic tradition - mutual acceptance of the individual opposed to domination of many by a few.
2. man against nature - man's insatiable need to modify environment and control nature.
3. readiness for innovation - tune for acceptance condition - conditioned impetus followed by continued momentum.
4. competition - stimulation of the free enterprise system for survival by purposeful innovation.

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*Source: Williams, *op. cit.*, Chapter IV.

5. communications - mass media keeps all better informed about common experiences.
6. growing acceptance of the aesthetic side of life - creativity movements, active participation in creative endeavor.

APPENDIX B

TABLE 13

OPERATIONAL TECHNIQUES FOR USE IN THE IDEATION STAGE OF A CREATIVE PROBLEM-SOLVING METHOD*

Brainstorming: An intentionally uninhibited conference type group approach. Four ground rules are observed:

1. Judicial thinking must be withheld until ideation is carried out.
2. "Free wheeling" is welcomed.
3. Quantity of ideas is wanted.
4. Combination and improvement of ideas are sought.

The objective is to produce the greatest possible number of alternative ideas for later evaluation and development.

Gordon Technique: A variation of brainstorming with these main features:

1. The chairman leads a general discussion of a subject which is central to the problem to be solved.
2. The chairman does not reveal the specific problem-assignment to the group until he feels that the group is getting close to a satisfactory solution.
3. The group has a free discussion, with the chairman only questioning and guiding and occasionally supplying problem related information.

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*Source: Taylor, *op. cit.*, Chapters 5 and 6.

4. When the group seems close to a good solution(s), the chairman reveals the specific problem whereupon the principle behind the solution is crystallized, and the group then develops the idea in detail.

The objective usually is to produce one best idea and to carry it through to testing, verification, development, and production in final form.

Attribute Listing: A technique used principally for improving tangible things. Procedure:

1. Choose some object to improve.
2. List the parts of the object.
3. List the essential, basic qualities, features or attributes of the object and its parts.
4. Systematically change or modify the attributes.

The objective is to better satisfy the original purpose of the object, or to fulfill a new need with it.

Input-Output Technique: A method for solving dynamic system design problems. Procedure:

1. Specify the input - the power or force going into the system.
2. Specify the output - the corresponding action/ reaction sought.
3. Define the limiting requirements or specifications.
4. Bridge the gap between input and output - find ways to make the input produce the desired output within the specified limitations.

The objective is to produce a number of possible solutions which can then be tested, evaluated and developed.

Free Association: A method of stimulating the imagination to some constructive purpose. Procedure:

1. Jot down a symbol - word, sketch, number, picture -- which is related in some key way to some important aspect of the problem or subject under consideration.
2. Jot down another symbol suggested by the first one.
3. Continue as in step two - ad lib - until ideas emerge.

The objective generally is to produce a quantity of intangible ideas, such as designs and so on.

Forced Relationship: A method which has essentially the same basic purpose as Free Association, but which attempts to force associations. Procedure:

1. Isolate the elements of the problem at hand.
2. Find the relationships between/among these elements. (similarities - differences - analogies - cause and effect)
3. Record the relationships in organized fashion.
4. Analyze the record of relationships - to find the patterns (a basic idea) present. Develop new ideas from these patterns.

Edisonian Method: An approach consisting principally of performing a virtually endless number of trial-and-error experiments. A "last ditch" approach, to be resorted to only

1. When other, more systematic methods have completely failed to produce the desired results; and/or

2. When one is knowingly and necessarily delving into the unknown, into areas of basic research.

Morphological Analysis: A comprehensive way to list and examine all of the possible combinations that might be useful in solving some given problem. Procedure:

1. State your problem as broadly and generally as possible.
2. Define the independent variables present in the problem - as broadly and completely as possible.
3. Enter the variables as the axes of a mophological chart - or make a permutational listing.

The objective is to find all of the possible combinations - for subsequent testing, verification, modification, evaluation and development.

Pack Corp Scientific Approaches: This method is scientific in the sense of being orderly, systematic, organized and thorough.

1. Pick a Problem. Define the problem. Specify your objective.
2. Get Knowledge. Observe; explore; experiment. "Get the facts."
3. Organize Knowledge. Put your information in understandable form.
4. Refine Knowledge. Screen it for relationships and principles.
5. Digest. Let your conscious mind relax; put your subconscious to work.
6. Produce Ideas. Ad lib, or; concentrate anew until ideas emerge.

7. <u>Rework Ideas</u>. Check ideas for flaws. Rework them, improve them.
8. <u>Put Ideas to Work</u>. Decide, Sell, Apply. Teach. Follow-up.
9. <u>Repeat the Process</u> - until it becomes a natural habit.

The objective is an organized structure to compel free, imaginative, "artistic" consideration of problems.

TABLE 14

EVALUATIVE CRITERIA FOR JUDGING THE VALUE OF PROBLEM SOLUTION IDEAS*

U. S. Air Force "Key Criteria."

1. Is it Suitable? Will this solution do the job? Will it remedy the problem situation completely or only partially? Is it a permanent or a stop-gap solution?

2. Is it Feasible? Will it work in actual practice? Can we afford this approach? How much will it cost?

3. Is it Acceptable? Will the customers go along with the changes required by this plan? Are we trying to drive a tack with a sledge hammer?

U. S. Navy Criteria Listing.

1. Will it increase production - or improve quality?
2. Is it a more efficient utilization of manpower?
3. Does it improve methods of operation, maintenance or construction?
4. Is it an improvement over the present tools?
5. Does it improve safety?
6. Does it prevent waste or conserve materials?
7. Does it reduce costs?
8. Will it improve working conditions?
9. Will the public understand?
10. Can this reduce time and/or effort in getting to, or being used by, the customer.

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*Source: Williams, op. cit., Chapter 6.

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