CRITERIA FOR ENVIRONMENTAL DECISIONS

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PREFACE

Architecture developes from a fabric of contrasts. All the impingent and resultant areas of the environment, the directly measurable factors such as the atmospheric, haptic, sonic, as well as processes of experiential and creative nature are concerned.

Natural and scientific comprehension and experiential and creative processes suggest a philosophy for teaching and learning and for practising architecture. The development of a design concept is evaluated and criticized. An approach to the solution of environmental problems is predicted. This latter includes considerations of the pivotal position of environmental technologies. A paradigm shift is anticipated.

Acknowledgement is made of the debt owed Professor Henry Wright. His guidance and teachings provided the intellectual fundamentals, the inspiration, and the patience, to pursue and develope these concepts.

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CHAPTER 1

THE POTENTIAL OF NATURAL COMPREHENSION TO IMPROVE EFFICIENCY AND FIT IN CONTEMPORARY ARCHITECTURE

The architectural environment is composed of the related areas of technology, the social sciences, creativity, education, managerial philosophy, qualifying types of problem solving, and other inputs and resultants. This thesis contains thoughts indicating a philosophy for these expanding areas of architecture and environmental design.

Independent isolated information results in fragmentation and differentiation. This is the necessary first step toward dedifferentiation, the reversion to more generalized conditions and basic patterns.[1] Often this is preliminary to a major change, to a new environmental fabric. Ultimately therefore, the appreciation, usage, manufacture, analyzation and learning of architecture requires the insight which removes the problem from concern with singular, uncoordinated inputs.

Knowledge and technology develope, as does civilization, along a sine function curve. Syncretism and hence progress occurs at a level along the curve where means or tools available make understanding and syncretism possible. Familiarity through contact forms one basis for understanding and pursuant syncretism. The familiarity or experiential contact which occurs in vernacular civilizations developes a natural understanding. The factual data such as that accumulated in industrialized civilizations developes a scientific understanding.

Natural understanding or comprehension is primarily intuitive. It developes from an understanding of the physical world and depends on the normal and characteristic quality, strength, vigor, resilience, the fundamental characteristics of materials and processes. It is as though a controlling and creative agent or force were operating in something and determining its constitution and development. It is established by what appears to be a set of principles regulating the universe or at least observed in its operation. It is exemplified by builders, masons, thatchers, who develope their own forms in response to climatic conditions.

Scientific understanding or comprehension is primarily intellectual. A science is a branch of knowledge which is or can be made a specific object of study. It is accumulated or accepted knowledge that has been systematized and formulated with reference to the discovery of general truths or the operation of general laws. It is concerned with observation and classification of facts, with quantitative formulation, and especially with the establishment of verifiable general laws, chiefly by induction and hypothesis. Scientific comprehension is exemplified by the reconciliation of practical or utilitarian ends with specific laws.

Contact and communication, reflected in comprehension, increase with the development of earlier contact and communication. There comes a point along the curve of development where the complexity leads to misdirection in concept and to a loss of natural or natural/scientific comprehension. Here old methods and approaches to synthesis and invention, the source of efficiency and fit, become unsuitable and new ones need to be invented.

The vernacular architecture of primitive man very often resolves well very complex problems. The primitive troglodyte resided underground. Bernard Rudofsky comments on habitations they developed, "The dwellings are clean and free of vermin, warm in winter and cool in summer."[2] Relative to the amount of resources available vernacular architecture frequently has efficiency and fit which out performs the attempts of industrialized man. Through design mistakes and misuse of technology contemporary architecture is guilty of violating nature's laws and balance and of producing physical and aesthetic waste. Despite the stress placed on contemporary buildings by the very complex tecture in which they exist this can be avoided.

Differences in the efficiency and fit of primitive and industrialized architecture reflect the differences in contact and communication with process and materials between primitive and industrialized man. If we examine the development of vernacular products we note a wise use of available materials and a respect for natural principles. Natural knowledge developes from an understanding of the operation of the physical world, the result of long contact, a traditional learning process of observation and trial and error. Scientific knowledge is accumulated or accepted knowledge that has been systematized and formulated with reference to the discovery of general truths and the operation of general laws, laws which appear unique and definitive. The scientific abstraction of processes and materials from the fluctuating cycles of nature results in the loss of natural comprehension and the loss of confidence in intuitive feelings. To avoid this loss emphasis must be put on the relation which the scientific abstractions have with cyclic nature.

The definitions of heat and humidity, themselves scientific abstractions, are useful examples. They allude to processes of constant change. Yet contemporary man, when he thinks of heat, thinks of an abstracted specific thing called "heat." Heat is a measure of the relative hotness of a system. Melting ice is colder than steam but hotter than liquid air. Relative humidity is a measure of the relative amount of moisture in an air-water mixture with respect to the maximum amount of water vapor that mixture can support at that temperature and pressure. A change in the temperature without a change in the amount of moisture results in a change in the relative humidity of the mixture. A common factor in temperature and humidity is therefore their basic foundation in the concept of change. Solar radiation is also easily observed as being based on change. Not only does the position of the sun in the sky change continuously but the condition of the sky itself never is constant.

The development of scientifically abstracted constants presents laws which make computations and predictions possible. But it is a mistake to depend on those abstracted constants and to forget their fit in a flexible and moving texture. Although each law appears to be static and independent each was developed inductively from a great number of observations and each is an equating element. While design by vernacular people developes by long periods of sympathetic adjustment and natural comprehension contemporary designers frequently equate maximum and minimum contingencies without similar recognition of fabric. Recognition of cyclic fabric can provide a substitute experience for natural comprehension of the inputs and a broader base for application of the scientific rules. Viable, integrated methods of design may pursuantly provide computational, graphic, and electronic media solutions, may reverse the science induced dehumanization tendency, and may provide a coherent, total, more intuitive approach.

Intuitive comprehension as possessed by vernacular people is related to our ability to translate from one language to another. The concept was expressed by Marshall McLuhan:

> Language is a metaphor in the sense that it not only stores but translates experience from one mode into another. Money is a metaphor in the sense that it stores skill and labor and also translates one skill into another. But the principle of exchange and translation, or metaphor, is in our rational power to translate all our senses into one another.[3]

Observation and scanning depend on the ability of man to bring together many disparate elements, elements irrelevantly presented, and then to synthesize them into a resultant. The ability rests on psychological processes of differentiation and dedifferentiation. These processes have implications important to the learning, teaching, and practise of architecture.

A position taken by Louis de Broglie supports the thesis that whenever possible, necessary and useful isolation of quantities and formulae should occur in recognition of the processes of which they are part:

> Faithful to the Cartesian ideal, classical physics showed us the universe as being analogous to an immense mechanism which was capable of being described with complete precision by the localization of its parts in space and by their change in the course of time. . . . But such a conception rested on several implicit hypotheses which were admitted almost without our being aware of them. One of these hypotheses was that the framework of space and time in which we seem almost instinctively to localize all of our sensations is a perfectly rigid and fixed framework where each physical event can, in principle, be rigorously localized independently of all the dynamic processes which are going on around it.[4]

Implied is the necessity of developing the interrelationships between a multiplicity of factors. J. D. Young suggests the scope of human potential to react to and comprehend the varied range of factors concerned with in this study:

> The effect of stimulations, external or internal, is to break up the unison of action of some part or the whole of the brain. A speculative suggestion is that the disturbance in some way breaks the unity of the actual pattern that has been previously built up in the brain. The brain then selects those features from the input that tend to repair the model and to return the cells to their regular synchronous beating. I cannot pretend to be able to develope this idea of models in our brain in detail, but it has great possibilities in showing how we tend to fit ourselves to the world and the world to ourselves.[5]

The statement suggests that intuitive human and physical reactions can develope suppositions regarding the design of structures and the applications of environmental technologies. These technologies as well as the industrialization of man have evolved through the developments in science. The developments have been viewed as fragmentary. Science texts, definitions, and the attitude and objectives of practitioners have reflected that view:

> Those texts have, for example, often seemed to imply that the content of science is uniquely exemplified by the observations, laws, and theories described in their pages. Almost as regularly, the same books have been read as saying that scientific methods are simply the ones illustrated by the manipulative techniques used in gathering textbook data, together with the logical operations employed when relating those data to the textbook's theoretical generalizations. . . .[6]

Even though today historians of science are finding it more and more difficult to follow the development of science-by-accumulation[7] that concept is prevalent. It defines the antagonist in our argument.

The argument is that the presently defined scientific approach to the teaching of science and to the teaching of the scientific aspects of architecture divorces natural comprehension from realistic consideration in professional areas.

> Effective research scarcely begins before a scientific community thinks it has acquired firm answers to questions like the following: What are the fundamental entities of which the universe is composed? How do these interact with each other and with the senses? What questions may legitimately be asked about such entities and what techniques employed in seeking solutions. At least in the mature sciences, answers (or full substitutes for answers) to questions like these are firmly embedded in the educational initiation that prepares and licenses the student for professional practice. Because that education is both rigorous and rigid, these answers come to exert a deep hold on the scientific mind. That they can do so does much to account both for the peculiar efficiency of the normal research activity and for the direction in which it proceeds at any given time. When examining normal science . . . we shall want finally to describe that research as a strenuous and devoted attempt to force nature into the conceptual boxes supplied by professional education. Simultaneously, we shall wonder whether research could proceed without such boxes, . . .[8]

This describes the conflict between natural comprehension and scientific comprehension. The argument is not obvious or conclusive but neither are the answers which must be found. James Marston Fitch has said:

> Art and architecture, like man himself, are totally submerged in an exterior environment. Thus they can never be felt, perceived, experienced in anything less than multi dimensional totality. A change in one aspect or quality of the environment inevitably affects our responses to and perception of all the rest. The primary significance of a painting may indeed be visual; or of a concert, sonic; but perception of these art forms occurs in a situation of experiential totality. Recognition of this is crucial for aesthetic theory, above all for architectural aesthetics. Far from being based narrowly upon any single sense of perception like vision, architectural aesthetics actually derives from the body's total response to and perception of, its external physical environment. . . .[9]

The conceptual boxes supplied by professional education into which normal science forces the study of nature results in fragmentation and a rigid approach. It is the antithesis of the experiential totality which architecture demands. The experiential totality which is necessary for all architectural aesthetics can only be fully achieved by exposure to total situations. There can be no purely scientific substitutes.

When preliminary concepts for the production of objects are made by contemporary man the preliminary conceptualizations are attempts to simulate realistic conditions. Many of man's ideas are developed mentally in symbolic and pictorial or graphic forms. The simulation can be called design and although design is another conceptual box divorced from nature the act of designing can be given a natural bias.

Symbols are words and numbers and other signs arbitrarily attached to either physical objects or abstract concepts to enable man to communicate about his world. Scientific development has emphasized the use of symbols. Pictorial or graphic forms are also used by man to communicate about his world. They are purely a visual method and must be transformed into the symbolic method for purposes of oral communication. Under certain conditions however, they have decided advantages over the symbolic method:

> The appropriate use of graphical methods has many advantages in dealing with a variety of problems that arise in technological research fields. . . .
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> . . . .
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> It is recognized that numerical methods and the employment of computers have contributed a great deal to the work of both the engineer and the researcher. . . . Nevertheless we have quite often overlooked the appropriate use of graphical methods.[10]

Graphics is the development of the use of pictures and geometry for communication and for the solution of problems. Their value in representing accumulated data, for example, is fairly obvious in that an accurate drawing of a table is easier to understand than a word description of the same table. Further, if a problem has to be analyzed or solved there are two reasons why graphics are valuable. The first is that the juggling of equations is often little more than meaningless abracadabra to the casual practitioner. The mere setting up of a problem in graphical form, on the other hand, is illuminating and meaningful. The second reason lies with the question of accuracy. Since time, mass, and distance are all continuous in nature they are not susceptible of absolute accuracy and the graphical method is just as accurate as an algebraic one so long as its accuracy is held within the accuracy of the original data.[11] Note is made of the fact that:

> . . . graphical methods like natural phenomena are continuous in character and thus can have an absolute symbolic correspondence to such phenomena, while numbers, being discontinuous in nature, cannot. Thus if you draw a line and call one end of it "time zero" and the other "10 hr" the line symbolically corresponds absolutely to the stretch of 10 hr, for it is continuous like time. However, as soon as you attempt to convert this into numerical symbolism, whether you divide into hours, minutes, seconds, or thousandths of seconds, the continuous nature is lost and you must proceed by jumps, however small. Thus graphical methods are much more natural--i.e., like nature--. . . .[12]

From the overview and image given in the previous pages of the characteristics of natural and scientific comprehension, of vernacular and industrialized man and their products, of experiential contact and of the science induced fragmentation, and finally of algebraic and graphic potentialities, the path to efficiency and fit becomes more clearly directed. Exposure to properly oriented experiential awareness and to the expressions of scientific knowledge, both seen in contact with nature, would produce an interplay from which the occurances associated with architecture would surrender to interpretation and development.

For example, data such as temperature-humidity and radiation exchange data can be perceived as establishing a cyclic fabric independent of quantitative values. Such an approach generalizes the study, diverting interest from concern with quantities and placing it on the movements and the interrelations between factors.

Most of the free energy inputs affecting man's macro situation is solar radiation. Part of this radiated energy is reradiated or reflected back into the atmosphere. The net radiation is the difference between incoming and outgoing radiation. For example, it is estimated that at Lincoln, Nebraska, Latitude 40N, Longitude 97W, 35% of the incoming radiation striking a free water body is reradiated back into the atmosphere.[13] Net radiation amounts accumulated vary at any one location and throughout the day and year. This is caused by the movement of the earth around the sun, the variable length of time from sunrise to sunset, the variable azimuth and elevation of the sun, by changing atmospheric conditions, and by other factors. The net radiation is available for mechanical processes such as heating, evaporation, and biological growth. As the potential of acqueous and biological reception for this energy decreases more energy is transposed into heat. The process is a cycling balance of temperature and humidity rise and fall, of absorption and storage followed by release of energy and moisture. These are the dynamic process vernacular man experienced and which scientific observers have defined and to which they have given a static connotation.

Each building acts and reacts as a computer: energy exchanges continuously occur. Consciousness of these reactions, the movements occurring between exterior factors and interior resultants should be understood and then reflected in design concepts. The contemporary designer, an anomaly when viewed against the vernacular development, produces his concepts with relatively little feedback; his conceptions may not be responsive to the total environment.

New methods and understanding will make the integration of the conflicting natural and scientific factors a more realistic probability. They will make the option available for designers to consciously choose on a firm basis of prediction what adjustments he wishes to make: architectural, e.g., the amount of glass to be used; planning, e.g., the siting and the orientation; technological, e.g., the temperature control and air distribution systems. The desired results, physiological, psychological, functional, will then be more sensitively approached. Natural comprehension, joined with scientific comprehension will viably effect decision making.

The development may require a change in the perception and evaluation of familiar views. Members of the professions who have been prepared to reorientate themselves may find more validity in the concept. Thomas S. Kuhn in speaking of the scientific profession has said:

> . . . when . . . the profession can no longer evade anomalies that subvert the existing traditions of scientific practise--then begin the

> extraordinary investigations that lead the profession at last to a new set of commitments, a new basis for the practice of science.[14]

These concepts are equally relevant to the profession of architecture. The integration in architecture of aesthetic sensitivity and scientific and technical facility would assure that the effect of the development would be broad. As Kuhn suggests, new theories, however special their range of application, are never just an increment to what is already known. Their assimilation requires the reconstruction of prior theories.[15]

Two probable developments which will encourage such reconstruction in the profession of architecture are cited. The first is the present logical necessity for broad extension of natural comprehension in architecture education and practise. This will be discussed in Chapter 2. The second is the compounding in the sciences of new techniques for evaluation and integration such as that described by P. H. H. Bishop:

> Selection of materials depends on many factors, but some aspects of selection can be made easier by the use of "figures of merit." These are simple functions of material properties, and although their use has been confined mainly to aircraft design, they have many wider applications when structural and thermal requirements occur simultaneously. Frequently they provide direct comparison of cost, weight and heat losses for the same project constructed from different materials. They may have many applications to instrument design when there is an interplay of weight, thermal and electrical requirements. For the materials specialist they indicate which properties should be improved.[16]

Expansion and application of this latter idea will be presented in Chapter 3.

CHAPTER 2

THE EDUCATIONAL IMPLICATIONS OF NATURAL COMPREHENSION

The development seen as presently occurring in architecture, the necessity for natural comprehension and the compounding of new scientific techniques for evaluation and integration reflect the observations of Marshall McLuhan:

> Our extended senses, tools, technologies, through the ages, have been closed systems incapable of interplay or collective awareness. Now, in the electric age, the very instantaneous nature of co-existence among our technological instruments has created a crisis quite new in human history. Our extended faculties and senses now constitute a single field of experience which demands that they become collectively conscious. Our technologies, like our senses demand an interplay and ratio that makes rational co-existence possible.[17]

Experiential, natural comprehension is a fundamental requirement if this interplay is to occur. Education should provide ability to reconcile apparently conflicting sources of influence. To accomplish this the position of the student must be clarified, i.e., the type of education aimed at him must be directed to enable him to fulfill his future role. The situation portends the necessity for flexibility and creativity, and calls for the stimulating of ideas in all areas of concern. What ideas are stimulated is not particularly important provided they are consciously related to the objective of the stimulation; the presentation of ideas can be somewhat random if the student perceives the objective. What is important is the attitude of mind that is established. The question of how we learn is deeply involved. Particularly in a situation such as the present "electric age" where the multiplicity of factual data inundates us is it important to provide this direction or attitude. Numerous educators, among them Hutchins, Rogers, and Friesen,[18] point out that the derivation of the word education is from the Latin educere, "to lead forth, to draw forth, as something latent, bring out, elicit."

The multiplicity of factors coexisting, particularly in a profession as far ranging and interdisciplinary as architecture, prohibits conscious predetermination of the limitations of what the student is exposed to. An undisciplined approach is not supported. The objective is always made clear. Reliance is then put on the free, associating ability of the mind to creatively synthesize factors which seem to be in disparity. Anton Ehrenzweig has commented on synthesis:

> It is difficult, if not impossible, to describe the exact functioning of syncretism which is so far removed from direct introspection. We can assume that complex unconscious scanning goes on. It balances one distortion against the other and extracts a common denominator or fulcrum from them that is somehow discounted.[19]

The operation of the facility to synthesize is not a concern here. It is however, one of the phenomena which makes natural comprehension possible and it gives some validity to the support of a broad ranging education for architecture.

Frequently this synthesis is dependent on factual, scientifically developed disciplines. The student can be trained in these disciplines and from these he can then determine his objective. One of the difficulties encountered is the inability of the student to see that his education is an adventure. The freedom to let happen and the process of self discovery are integral. Creative simulation and generation by going through processes developes an understanding in the student of what he is doing.

> The ideal system might set teachers and students forever in orbit in a kind of perpetual motion. . . . So obviously we must start with some sort of process or activity that is in itself creative and keeps people lively and stimulated. From such a process will flow a kind of vitality that motivates both teacher and student. Without motivation education suffers.

> Whitehead wrote about "inert" education and suggested that--say Latin and Logic--must be brought to life. By this I believe he meant not by sugar coated pills or classroom acrobatics but by making learning happen in the entire learning system of the student--mental, nervous, muscular. Dewey and many others knew this empirically some time ago. Today neurological research confirms this: it shows that the only real learning is experience that changes the learner; and such neural change basically comes from self generated action or activity or thought.[20]

When discussing the implimentation of natural comprehension in architecture education and the process involved, the intended scope and direction of that education must be known. In 1966 Nathan March Pussey said:

> The curricula of the early schools were shaped by the conditions of those times. They were compounded of concerns of engineers and interests of individuals trained in the French Beaux Arts tradition who thought of themselves primarily as artists. The aim was to impart at least a modicum of basic knowledge of structural engineering together with considerable familiarity with the earlier historical styles of architecture. . . . We have learned that a building can no longer be thought of, if it ever properly could, as an entity in itself, or even only with reference to its immediate setting. . . . No building project can be undertaken today without careful thought for the purpose it is to serve. . . . Men with the broadest kind of education are now needed in the profession, and a more advanced kind of professional education must be devised to provide them. . . .[21]

The new direction and interplay should be based on experiential study and on integral advances in science and technology such as "figures of merit" and will depend on experiencing the processes of generation and simulation and of creative synthesis. Education must relate the student to the world as a whole. Today's consumers, like vernacular people, are much more conscious of the various valid determinates than are formal designers. Many of these designers don't understand the objectives of what they are doing. Vernacular people have experienced the processes and developed valid expressions of their environment such as the teepee and igloo.

Education aimed at natural knowledge cannot substitute for vernacular experience. This is not the level of education supported here nor is a return to the crafts. Education aimed at natural knowledge can motivate and nourish a creative approach as well as cultivate a far more realistic, from the standpoint of the designer, study of the sciences and technologies and their applications. The objective should be progressive, first to master the basic inputs of nature, and then their compounds. This can inherently entail comparative analysis and provide the most viable approach to the twentieth century. Comparative analysis is a form of self criticism and can push toward quality and efficiency and fit. The eventual goals are intelligence and wisdom and impartiality, the ability to judge and make decisions.

With respect to this the question has arisen: Is the goal of architecture an idylic environment or a committment to the idylic?[22] Amos Chang has pointed out two vital problems, the human quality of the physical environment and the harmony and unity of different buildings. Physical manifestations may be manipulated. Intangible is beyond the power of man, usually unseen and unappreciated.[23] Architecture is the expression of feelings through ordered space environment. Ordered space means different things to different people; the social psychologist and the architect look at things differently. The physical manifestations therefore become even more weighty.[24] This implies the need for flexibility and comparison.

The contemporary climate or Zeitgeist very closely resembles an age of genius: there are very great potentialities. The average student is breaking out of tradition but he needs a handle, an attitude of mind.

Every design begins with thinking about what the design ought to be and includes planning, the initial concept, the alternatives. Every design should be honest, analyzing the good and the bad, what is right and what is wrong. Every design has restricting tolerances, too much, too little. Too much agreement leaves a homogenized boredom, whereas contrast can develope vitality. This concept, vividly expressed by Marcel Breuer, may provide the handle:

> . . . The real impact of any work is the extent to which it unifies contrasting notions--the opposite points of view. I mean unifies, and not compromises. This is what the Spaniards express so well with their motto from the bull fight: Sol y Sombra, sun and shadow. Half the seats in the bull ring face the sun, the other half is in the shadow. They made a proverb out of it--"sun and shadow." For them, their whole life--its contrasts, its tensions, its excitement, its beauty--all this is contained in the proverb, sol y sombra.[25]

Today's students may have opportunity to become more sensitive to this feel than the present professionals. They may put into action the highest objectives of architecture. As Amos Chang commented:

> . . . overemphasis on the product of design is formalism, classical or modern. The new trend of design to emphasize process, on the other hand, is by nature morphological: complex and complicated yet complete and comprehensible interaction of human behavior and physical function.[26]

The student must face these new processes aware that the implimentation of any process or system creates its own problems. If we have to walk between two places a road will help direct us. It will also tell us where we must walk. To have no plan leads to chaos while a system carries with it the risk of dehumanization, forcing people to act with a minimum of initiative and sponteneity.[27] As the world continues to change the point of view of the student must continue to change with it. He must, however, continue to see architecture in its environment as the vernacular people saw it. Natural comprehension in juxtaposition with contemporary processes can then continue to play its role and vicariously relate the student to vernacular experience. A great deal of learning can occur by this type of interplay and develop an awareness of means, and not an awareness of only application of means.

Primary emphasis must be placed on introspective investigation. The position of environmental technology can be presented in the undulating fabric of a building. In this context relative humidity, for example, generally the cause of much confusion in the study of heating and cooling systems, can become a viable factor. In this same context human reactions to movement from cool to warm, from one surface underfoot to another, can be vicariously felt. The placement of insulating materials over windows can be felt to produce immediately noticeable changes, both visual and thermal. Insolation can be seen as affecting a design concept. Sun heat can be imagined warming a floor and unbalancing heating and cooling arrangements.

Visual material can aid introspective investigation by presenting the concept behind natural integrated fabrics. It can stir ideas and encourage discussion. Graphs can make meaningful violations of expectations as well as conformity to rules. They thereby present comparative evaluations of spaces designed by the architect and engineer and show failure to meet physical standards.

The comparative factor in architecture can also be aided by the use of numbers. They give you a firm basis for conceptual thinking. Developing scientific methods such as figures of merit will provide the tools. Since resistence is the only thing affecting heat flow quick methods of calculation by desk top computers will develope. Comparisons will provide visualization of the contrasts, the major question in architecture, a question of comparative level. Thought will occur in annual terms. Rationalization will be toward a whole: contrast between detail and building; contrast in the nature of tasks; contrast in the speed of perception and the accuracy of perception.

There is not much potential left for technology unless it is applied with conscious invention. There is a need to direct efforts towards better management of present potentials. We must look at the problem and build accordingly. We must ask questions: are there other types of solutions; is there opportunity to interfere with established rules; does the problem solving method employed preclude the answer?

It is important moreover that architecture join with other disciplines to break down barriers between subject matter fields. Educational methods, conferences and group discussion, can dissolve issues caused by discipline conflicts and technical and professional jargon. Certain ideas can be absorbed by exposure. New concepts need no longer be looked at as unviolatable dogmas but as something with which to work.

The entire problem of architectural development must be looked at creatively, in a sense, divorced from tradition. Science by accumulation is being questioned; scientific laws are limiting. The dichotomy is between the collection and analyzation of parts and the ability to express new thoughts and to understand entirely new expressions of thought within the framework of an instituted language. If we are to understand how language is used or acquired we must abstract for both separate and comparative study the inputs to that language.

CHAPTER 3

NATURAL COMPREHENSION AND ENVIRONMENTAL DECISIONS

Flexible and creative attitudes toward environmental design based on natural comprehension were anticipated and supported by studies of climatic conditions and their resultant effects on architecture. These studies established a basis for both natural and natural/scientific comprehension. The studies did not entail a quantitative analysis of temperature - humidity and radiation amounts nor of the mechanics of transmission, conduction, or convection involved. This was the crucial point pertinent to these studies. They were oriented at demonstrating the cyclic fabric developed by the inputs and resultants.

The study entailed analyzation of a year long compilation of indoor - outdoor temperature - humidity and radiation exchange data. The data was compiled in a glass faced, enclosed, stairwell, tabulated, and pursuantly graphed and computerized in increments of two, eight, and twenty-four hours, as well as in weekly and solar period divisions.[28] The data was organized to provide a logical breakdown reflecting continuous movements in nature. Line graphs of single and composite inputs were drawn based on this data. Careful study and observation of these graphs revealed the cycles affecting single components and the interaction occurring between components, between two indoor components, for example, indoor temperature and indoor relative humidity, as well as between indoor and outdoor components, for example, indoor temperature and outdoor temperature. The latter complex graphs, revealing interactions between components, were most significant and provided visual substantiation of occurrances felt and intellectually assumed to exist but not previously revealed to the writer in a definitive demonstration. The graphs also revealed some violations of expectations. The fabric shown, an interrelationship between a variety of components, was studied in detail.

The data covered a continuous 365 day period. As the significance of the undulating nature of the data appeared the mechanics of ordering the data to enhance comprehension became instrumental. Breakdown of the data into solar period averages, for example, was a significant aid in observation of seasonal changes. Particular attention was given to insolation and its resultants. Eventually the data was also studied on eight hour divisions representing midday, evening and morning conditions. The interrelationships revealed by this method were of energy interchanges which occurred in temperature and humidity factors during periods of increased energy supply, i.e., during midday hours, in comparison with the energy interchanges which occurred in periods of increased energy release, i.e., during evening hours. Of particular significance were developments which revealed the role which the skin or membrane of the structure played: the lag between exterior energy availability and interior reaction; the energy blotting effect which the materials and structure appeared to possess; the effects, both daily and seasonal, of the proportionally large amounts of south facing glass.

The data was analyzed by computer. This provided a more directly communicable symbolic interpretation: the relationships between phases of the data expressed in percentage the sequence of steps which occurred between factors during various incremental divisions.

The most significant reaction to these studies was an awareness and comprehension of the interrelationships integral with the climatic environment and their resultants in architecture, and the ability to vicariously experience the occurrance via graphic and computer data.

This awareness and comprehension instigated thoughts regarding the relevance of the comparative factor in architecture and the compounding in the science of new technologies for evaluation and integration.

One significance of the graph and computer studies lies with the fact that they proved that it is impossible to anticipate with certainty or accuracy what is going to happen in a structure, that many of the rules established by the scientific professions don't work with precision, that taking exact measurements or doing exact calculations isn't particularly necessary or useful for the architect. Wise approximations are close enough. The complex fabric and number of variables concerned is at the source of this situation. An analogy presented by Henry Wright concerns a carpenter who was observed cutting wood strips. After each strip was cut he placed it next to the one previously cut. After going through the procedure a dozen times he set a second row over the previously cut row and manually patted the stack to determine his accuracy. He not only gained an accumulation of which he could take an overall measurement against which to check his precision but he also developed an intuitive reaction to the size and nature of the strip.[29] The analogy applies to the graph and computer data. The results they showed can be thought of in the same manner as the carpentry. The individual quantities recorded and graphed and computerized varied irratically and without explanation from hour to hour and day to day but in the overview provided not only an understanding, an opportunity for checking against norms and their accumulative agreement with the rules, but also to react intuitively to their complex texture or fabric.

The study personified the reconciling of two opposing ideas. On the one hand vernacular man relied on his intuition and on natural comprehension.

On the other hand twentieth century man has become reliant upon the truth of his scientific knowledge. Both of these ideas were believed in by the writer, and are by many others, as being accurate and as having merit. The study undertaken enabled personal in-depth understanding of and confidence in the significance of the subtle and far ranging ramifications of integration for both design and education.

Although certain specific observations made of the graphic and the computer printout material was significant in that it described adherence to expected rules and therefore can be a learning experience as a vivid demonstration of those rules, its value in this study was in its dichotomous information and the pursuant need to reconcile two opposing factors. This type of development can stimulate ideas in all areas of architecture and can be the lever into the split plaguing architecture, the conflict between science and nature, the physical and the aesthetic.

Much of the potential significance of this study is not yet understood. Many of its more detailed aspects, e.g., radiant and conductive transmission, enthalpy and relative humidity, absorption of heat and moisture by materials and the time lag involved, the relation of all factors to the cyclic fabric, will require further study. In its present state the study has provided a philosophy for design development.

An overview of the entire cycle in conjunction with developments such as the figures of merit and the use of computers has provided thoughts on the possibility or probability of a paradigm shift occurring in the perception of design. Materials and technologies, both in their aesthetic capacities as space definers and establishers of mood and character and in their functional capacity to intervene in behalf of man became much more mutable in their potential. Designers may learn to enclose volumes of space in total recognition of the complex results of the integration they produce.

CHAPTER 4

CONCLUDING INDICATIONS

The significance and importance of natural comprehension in environmental decisions were verified by a study of vernacular achievements as well as by consideration of industrialized developments of the last few years.

There is much to learn from untutored builders fitting into but not overpowering the environment. Good architecture is the result of rare good sense in the handling of practical problems. The humanness of this architecture brings response and testifies to the aspirations of the people who evolved it. Primitive man helped shape his environment and therefore never tired of it. He attempted many solutions that anticipate our technology, prefabrication, standardization of building components, flexible and movable structures. Durability and versatility are characteristics. There is a balance between unity and diversity.

To show moreover that natural comprehension is significant for the 20th century the following brief description of office landscaping is given and a design question is raised. The development is based on ideas about office work organization based on analysis of thought and communication processes. Many management consultants realize that the physical planning of offices is a significant factor in the kind of organization structure that can exist within them. Realities of physical space, wall, doors, and desk locations, for example, can override organization charts and directives in establishing what will really happen in an office. The concept is based on computer analyzation of the communication which occurs, basically, who works with whom. It is seriously questioned here whether the type of fluid occurrance can be analyzed accurately enough to provide improved design criteria and most pointedly it is questioned whether the design guides put forth to act as guides for landscape development critically affect humanness. The implications are severe. The impingment upon the architectural scene of systems or holistic approaches may complicate even more the interconnected systems in which people operate. If we knew through and through just how these complicated systems really work in every detail, then it might be feasible to be "ecological." But, in fact, the holistic ecologist can also be ignorant of the remote effects of his holistic ecology. And so the ecological approach can, in itself, begin to produce more harm than good by tying the possibility of natural comprehension, natural reactions, and natural spontaneity.

FOOTNOTES

FOOTNOTES

[1] Anton Ehrenzweig, The Hidden Order of Art (London: Weidenfeld and Nicholson, 1967), p. 16.

[2] Bernard Rudofsky, Architecture Without Architects (Garden City, New York: Doubleday & Co., Inc., 1964), Caption No. 17.

[3] Marshall McLuhan, The Gutenberg Galaxy (Toronto: University of Toronto Press, 1962), p. 5.

[4] Louis de Broglie, The Revolution in Physics (New York: Noonday Press, 1953), pp. 5-6.

[5] J. D. Young, Doubt and Certainty in Science (Oxford: Oxford University Press, 1961), p. 4.

[6] Thomas S. Kuhn, The Structure of Scientific Revolutions (Chicago: University of Chicago Press, 1961), p. 1.

[7] Ibid., p. 2.

[8] Ibid., pp. 4-5.

[9] James Marston Fitch, "The Aesthetics of Function," Annals of the New York Academy of Sciences, 128:706, September, 1965.

[10] A. S. Levens, Graphical Methods in Research (New York: John Wiley & Sons, 1965), pp. v-vi.

[11] John T. Rule and Earle F. Watts, Engineering Graphics (New York: McGraw Hill Book Co., Inc., 1951), pp. xiii-xiv.

[12] Ibid., p. xv.

[13] R. J. Banks, "Net Radiation Measurement" (a short report made available through Kansas State University, 1968).

[14] Thomas S. Kuhn, The Structure of Scientific Revolutions (Chicago: University of Chicago Press, 1962), p. 6.

[15] Ibid., p. 7.

[16] S. D. Probert and D. R. Hub (eds.), Thermal Insulation (New York: Elsevier Publishing Co., 1968), p. 110.

[17] Marshall McLuhan, The Gutenberg Galaxy (Toronto: University of Toronto Press, 1962), p. 15.

[18]Walter S. Friesen, "Toward Community In Higher Education" (An address delivered to the staff and participants of the NDEA Institute for Higher Education Student Personnel Workers, Michigan State University, July, 1967.)

[18]Carl R. Rogers, On Becoming a Person (New York: Houghton Miffen Co., 1961).

[18]Robert M. Hutchins, The Learning Society (New York: Frederick A. Praeger, 1968).

[19]Anton Ehrenzweig, The Hidden Order of Art (London: Weidenfeld and Nicholson, 1967), p. 9.

[20]Benjamin Thompson, "Let's Make It Real," Architectural Record, 139:108, January, 1966.

[21]Nathan M. Pusey, "The Needed New Man in Architecture," American Institute of Architects Journal, 46:80, September, 1966.

[22]Opinion expressed by Herbert H. Swinburn in an informal address on the topic ("A Systems Approach to the Design Process in Architecture"), Kansas State University, 1969.

[23]Opinion expressed by Dr. Amos Chang during an informal address given at Rock Springs, Kansas, September, 1968.

[24]Ibid.

[25]Marcel Breuer, Sun and Shadow (New York: Dodd Mead, 1955), p. 32.

[26]Chang, op. cit.

[27]Paul Goodman, "Decentralizing our Inefficient Organizations," Environment/Planning and Design, 8:21, January-February, 1970.

[28]Further descriptions of the graph and computer material appear in the Appendix to this Thesis, and in a report "Climate Interchanges with Architecture" by the same writer, at Kansas State University.

[29]Opinion expressed by Professor Henry Wright during informal discussion at Kansas State University, 1970.

APPENDIX

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Interior-exterior temperature-humidity and radiation exchange data was collected at Manhattan, Kansas, Latitude 39N, Longitude 97W. The data was considered independent of its quantitative values. This is an essential aspect of the approach taken, diverting interest from concern with quantities and placing it upon periodic movements, interrelations between factors and the implications involved. The movements, interrelations, and processes would vary with a change in locale and product but analogous cycles would occur under the changed conditions. They reflect natural laws.

A cyclic fabric was observed and recorded during a year long continuous study of Emergency Stairwell No. 4 of the Student Union Building, Kansas State University, Manhattan, Kansas. The interior space was an 18 foot by 8 foot by 45 foot high rectangular volume enclosed on the two narrow dimensions by monolithic bearing walls and on the North 18 foot by 45 foot dimension by the abutting Student Union Building. The South 18 foot by 45 foot dimension was an area of 810 square feet of double glass. The space contained approximately 450 cubic feet of concrete and masonry in fire stair construction. The space had no mechanical means of temperature or humidity control. The abutting Student Union Building was maintained at constant or near constant median temperature and humidity levels throughout the year and therefore was considered to have had a marginal blotting effect, affecting the year long internal conditions of the stairwell volume minimally and contributing little to their winter or summer fluctuation.

Due particularly to its large area of glass and its orientation the mechanically unmodified interior volume was subjected to large amounts of natural heat energy by processes of radiant transmission and conduction. The nature of its construction and materials, the massiveness of its enclosing side walls and enclosed stair construction, its proportionally tall and narrow composition, in combination with other factors, sharpened the processes of interior-exterior temperature-humidity and radiation exchange. Recognition of this expanded the concepts of this thesis beyond concern with solely the comprehension of the processes of energy interchange to concern also with the design implications of those energy interchanges, to concern with the composition and proportion of materials, orientation, and other related factors.

Where scientific analysis is a norm it is expedient to measure the variation in separate components of fabrics. Records of such components were made for the year, October, 1965, to October, 1966, of exterior conditions, temperature and relative humidity and insolation, by the University Weather Station, Manhattan, Kansas, and of resultant interior conditions, temperature and relative humidity, by a twenty-four hour recorder in Stairwell No. 4. These were put into tabular form with a two hour increment division. Averages, both for twenty-four hour intervals and for seven day intervals were compiled. This data provided the information from which the graphic and computer analyzations discussed in the following pages and reported on elsewhere developed. Line graphs representing the year long record of twenty-four hour averages of single climate factors, temperature, relative humidity, and insolation, and the resultant interior factors, temperature and relative humidity, were drawn. Careful study of these graphs supported the anticipation that with directed and conscientious study inputs and their resultants can be vicariously experienced.

Based on this confidence line graphs were also drawn of multiple factors, the relation between indoor temperature and relative humidity, outdoor temperature and relative humidity, indoor and outdoor temperature, indoor and outdoor relative humidity. All of these were studied in relation to insolation. A certain level of comprehension developed.

As the study developed, the mechanics of procedure became instrumental. The two hour increment divisions of the data were partitioned and averaged into eight solar period sections making the visualization process simpler while keeping the data in contact with the movement of its sources. The movement, the sequence personified by the changing position of the sun in the sky and by the changes in season, was stressed. Graphs of interior and exterior temperature and relative humidity and their interactions were based on these solar period intervals and resulted in a more comprehensive view of the annual cycling interactions.

Changes in inputs and resultants occur not only on the basis of twenty-four hour intervals but also on the basis of smaller intervals; that is, changes can be recognized between the experience and recall of one complete day and the next complete day or between the experience and recall of one complete season and the next complete season, and changes can also be recognized with equal intensity between the experience and recall of one eight hour morning and the next eight hour morning or between the experience and recall of the mornings in winter and the mornings in summer. The tabulated data was therefore averaged for the three sections of the day, noon to eight P.M., eight to four A.M., four A.M. to noon. Graphs for these three eight hour increment averages were drawn in divisions representing the eight solar periods. These visualizations provided dramatic insight into the environmental fluctuations characteristic of particular portions of the twenty-four hour cycle as well as of the seasonal cycles.

The format of the graphical presentation and the attitude and visualization ability of the reviewer, ability designers depend on, is fundamental to the value of such study. The process resulted in visualizations of the movement of climatic factors and their resultants, of the interchanges reflecting the characteristics of the skin of the structure, but even more importantly, in confidence that although visualization is difficult intuitive comprehension emerges.

There are limitations to the scope and effectiveness of the process of natural comprehension. Variety in the characteristics of factors, different qualities with different bases of measurement such as, for example, temperature, a measurement of heat in degrees fahrenheit, and humidity, a measurement of moisture in percentage, or different environmental contexts such as indoor and outdoor, complicates the processes occurring and in various combinations reach a point where visualization becomes difficult or impossible; e.g., it is more difficult to visualize the different processes occurring between indoor temperature and outdoor relative humidity than between indoor and outdoor temperature.

Terms with little relevance to the sensitivity of man, terms which disturb man's contact with nature also limit the comprehension process. Enthalpy is such a term. It is used in lieu of total heat or heat content. It is expressed in btu/lb. It is a useful term from a scientific or engineering approach to architecture and environmental technology. But although it relates to natural factors, temperature, humidity, and atmospheric pressure, man does not react physically to the enthapy concept. It has no experiential connotations. It is on a different level of comprehension. Graphs of enthalpy factors, factors derived from calculations with input and resultant data, present little meaningful comprehension.

The limitations of the graphic approach included also the difficulty of communicating verbally the comprehension achieved.

These limitations however do not reduce the validity of its objective, natural comprehension. To eventually bring the problem of architecture design and environmental technology to a higher level of efficiency and fit new approaches to the visualization process will develope.

Graphic visualization proved viable enough to give insight into reciprocal environmental fluctuations and pursuantly provided suppositions for an approach to the design of structures and integrated environmental technologies. The supposition developed consciously and unconsciously in response to the recognized potentials and limitations of the number and complex interrelations of factors and the limitations of their communication.

Communication of data such as the concerned data is dependent on the use of symbols to represent the concepts. Symbols develope tendencies for divorce from nature and cycles. This is the dichotomy faced by the twentieth century. Symbols however can be used in recognition of cycles such as those displayed by the graphs, and in recognition of inbalances in temperature, humidity, insolation, materials, orientation, and architecture design.

The strongest awareness which developed out of the work toward natural comprehension was the notion of the integrated cyclic fabric. Despite the concentrated effort required to interpret the graphs and despite the limitations of that approach the conviction of its validity persisted. A method of developing a viable, natural comprehension eliminating the two principle limitations, i.e., the quantity of interrelations involved and the difficult task of communicating the observations made, was an outgrowth of the concepts of the integrated cyclic fabric and of those limitations, quantity and communication.

Both the advantages and the limitations of the graph led to use of the computer, making possible analyzation of large numbers of interrelationships and their conversion into a more directly symbolic notation. The graphs had established strong recognition of the cycles. The computer is able to recognize positive and negative relationships. This faculty was used to determine the relationship between phases of the data and to express those relationships in terms of percentages: the computer was used to determine the sequence of steps, expressed in %, which occurred between for example, indoor temperature and humidity in the winter, in the summer, between indoor temperature and outdoor temperature at noon, at eight P.M., at four A.M.

These concepts synthesized into thoughts of computer application. It is carefully pointed out here that however valid the suppositions are that the computer is a feasible tool its importance is seen only in light of the concept of the cyclic fabric of nature as instigator.

The computer was programmed to resolve the following: In what % of increments from period "a" to period "b" do factors "x" and "y" both move in positive directions, i.e., in increase agreement (IIA), both move in negative directions, i.e., in decrease agreement (IDA), move in opposite directions, i.e., in disagreement (IDS). Span increments include daily, solar period, yearly sections. Factors include indoor and outdoor temperature, indoor and outdoor relative humidity. Time segments include twenty-four, eight, and two hour periods.

The computer study was based on the objective of obtaining a numerical visualization reflecting the movements which occurred between inputs and resultants. It was an interpretation of the same data and increment division from which the graphic material evolve. It provided a picture of the response characteristics of the building fabric.

The objective was not to determine the quantitive results in mechanical interchanges but to observe the movements occurring. The computer study determined, for instance, the seasonal difference in the manner in which the exterior conditions and the interior resultants occurred and indicated the degree of synchronism between factors during different periods of the day and of the year.

Each building acts and reacts as a computer: energy exchanges continuously occur. Consciousness of these reactions, the movements occurring between exterior factors and interior resultants, was instrumental from this stage on.

The contemporary designer developes his concepts without benefit of a minimum of feedback; his conceptions may or may not be responsive to the total environment. The graphs and computerized material expressed the significant differences which occurred, for instance, between summer and winter, and the sequential picture established by the percentages of IIA, IDA, and IDS. With this information the designer is aided in judging the speed and intensity with which a proposed building will react and pursuantly in evolving semi-intuitive or natural/scientific adjustment.

This method of determining a picture of a building's reactions to its environment can develope through a mathematical model or formula of the proposed design, materials, orientation, combined with feed-in of the anticipated environmental conditions. This mathematical model can be evolved through application of Figures of Merit or similar developments.

Since the objective is not a mathematical statement of the quantities of the inputs and resultants but rather a picture of resultants the feedout must be adjusted to produce graphic and symbolic material similar to that previously discussed. The option is available for the designer then to choose what adjustment he wishes to make: architectural, e.g., the amount of glass; siting, e.g., the orientation; technological, e.g., the heating and air distribution system. The desired result, physiological, psychological, and functional, can be more sensitively approached.

This entire development is primarily significant for its design potential. Natural comprehension viably effects decision making. The major asset of the development is seen to be the integration the designer would achieve between structure, technology, aesthetics. The development may require a change in the perception and evaluation of familiar data. Members of the concerned professions who have been prepared to reorientate themselves may find more validity in the concept.

If the development is not feasible as a contemporary approach in the established profession it is most viable as a teaching experience, as a motivator for developing facility with and concern for total integration as well as for some of the concerns of design which today appear irrelevant and divorced. It is a method of assurring the student's total recognition of the integrated quality of nature and structure.

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CRITERIA FOR ENVIRONMENTAL DECISIONS

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AN ABSTRACT OF A MASTER'S THESIS

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This thesis recognizes the relevance of natural comprehension in the teaching and learning and practise of architecture and environmental technology. All the impingent and resultant areas of the environment, the directly measurable factors such as the atmospheric, haptic, and sonic, as well as processes of experiential and creative nature are concerned. Discriminately restricted data are studied by graphic and computer methods and illustrate the cyclic fabrics in nature and in architecture and the role which technology should perform as an outgrowth of these fabrics.

Natural comprehension and experiential and creative processes suggest a philosophy for teaching and learning and practising architecture. The scientific development of a design concept is evaluated and criticized on the implications of the philosophy and an approach to the solution of environmental problems is predicted. A paradigm shift is anticipated.