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The Rational Systematic Approach: A Necessity for the Future of Design

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Introduction: Instability and Architecture

One of the distinguishing features of the second half of the 20th century is the rapidity with which crises and contradictions or unbalances explode in every field: natural resources, environment, overpopulation, etc.

Fortunately, architecture and related fields have not been immune. The inadequacy of traditional design methods therefore has been exposed dramatically in its lack of rational methods and its incapacity to meet the conditions which the design of objects demand. Just as clearly has been revealed the obsolescence of the renaissance designer, capable of filling in a masterpiece all the requirements of society, while adhering to perfectly technological capabilities.

But, as every revolution in history is followed immediately by its antithetical condition before its beneficial effects can be felt in a balanced situation, thus rationalizations of the design process increased until the opposite extreme of pragmatism was reached, attempting to delegate all the design functions to machines, computers, techniques of gaming and simulation, and so forth.

Every university has in fact its architectural machine, with people devoting time and energies to its operation; but a redimensioning of the collective madness is taking place, and behavioral scientists, sociologists . . . and architects are called into the design process. However, the need for a more systematic approach to design and the use of sophisticated tools definitely have been affirmed.

Universality of General System Theory Concepts

The results of the application of systematic design techniques to private practice will say whether the solutions are up to the intentions; I feel that reasons to be confident do exist.

The whole universe is organized systematically, as demonstrated by Ludvig Von Bertalannfy, who affirms that its parts are in continuous interaction, so that "the prototype of their description is a set of simultaneous differential equations." [1] But he also admits that it is dubious whether elaborate "mathematical models can always be applied to concrete cases," even if the proof of the systematic nature of the problem does exist.

But he strongly establishes the necessity of conceiving problems as a series of components, locked inside of connective systems which are reproducible as a network of logical relationships. It is consequent, therefore, to state that a process of designing objects related to the whole system must adapt itself to the complex nature of the problems, constantly considering the modification of the whole system, when any one of the variables undergoes modification.

Theoretically this is possible, with a sophisticated technique, if the system is a closed one, that is if the system is subject to modifications as a consequence of internal relations between its own parts, through feed-back loops or by other cybernetic principles. But what if the system is an open one, that is, if the system is subject to the influence of external elements which can alter its equilibrium?

An example would be the study and design of a rational master plan for a new town (such as it happened in Reston, Va.), providing a balanced mixture of housing for different income levels; in such cases the exogenous element which has frustrated the intention of the planners has been the ostracism exercised by the wealthier families (settled first), against the introduction of a more modest strata of the population. Other examples would be the highly sophisticated systems for water resources, crime control, and so forth, prepared for the State of California during Gov. Brown's mandate, which proved fallacious because the unexpected development of the war in Vietnam became the external disturbing element with which the systems could not cope.

Not for this, however, should system analysis as a tool be underevaluated; it represents still the most rational way to overcome the inadequacies of partial solutions, often in contrast with each other, because the interdisciplinary connections are neglected, if not totally ignored.

Different directions presently are being followed, in the attempt to overcome the danger of incongruence between model and reality. I would categorize them into three main groups of studies:

First is that concerned with the logic of systems. This falls within the definition of general system theory, or more specifically, of cybernetics, information, science, operations research, and so forth.

The second group of studies addresses itself to the refinement of empirical methods which represent systems, such as formal models (generally mathematical) capable of adaptation to variations of reality. Many of these are nonlinear, differential expressions, and are computer-manipulated, according to the principles of the theory of automata, graph theory, control theory, and so forth. The intrinsic characteristics of the models are investigated (Rapoport, Bronowsky, Mesarovich), while practical applications also are formulated (Forrester, H. R. Hamilton).[2] All of the encouraging results tend to produce models which are more descriptive than operative; in other words, a guideline for action is provided, but synthetical action still is quite undetermined.

It is difficult to say whether these studies will reach a point where the limit of error will enable the model to be considered as a means for forecasting and as an abstraction for design, but I think that their empiric character is limited intrinsically.

From a Means for Analysis to a Means for Action (Synthesis)

I suppose that Christopher Alexander made the same consideration when he progressed from his mathematical formulation of the Indian village to a "system of generating principles, which can be readily transformed according to circumstances, but which never fail to convey their essentials."[3]

This very well could be the broad definition of what I consider to be the third direction for the research of systematic design processes which are accessible to designers on a large scale and which particularly permit the introduction of variables, taking into account values of judgement. This means that the ultimate product in the form of a spatial and physical system for design can be reached starting from conceptual expressions and formal models, manipulated with the techniques and possibly the direct contributions of mathematicians, system analysts, computer experts and behavioral scientists. The introduction of patterns, as defined by C. Alexander,[4] furthermore intends to overcome the quantitative limitations of formality, by introducing "the relationships required to prescribe some features . . . to solve a problem which will occur" in the spatial structure to be designed. "Rather like a grammar," in the same way as the "English grammar is a set of generating principles" to make up sentences. To put it in another way, a set of patterns can be assimilated to a design strategy, based on the reconstruction of the conditions and constraints which the design has to face. This complete reconstruction is in fact the main difference from the plethora of exclusively formal (mathematical) models, particularly since it does imply the contribution of disciplines which have unquantifiable parameters. At the same time its concrete quality and deterministic nature contribute to the liberation of architecture from the archaic myths which for too long have surrounded the creative or design process.

Rationalization of the Design Process

The main problem in rationalizing a design process, therefore, is to produce systems capable of being translated directly into spatial organizations. In order to indicate how this correspondence can be accomplished, it is important to introduce the concept of the "performance" of a system, and to consider basically the possibility of developing performance evaluation techniques as follows:

—It is assumed that the design problem can be spelled out formally in a set of spatial requirements.

—Performance levels of the system (or of its parts) must be expressed in a measurable form.

—Performance levels should be liable to maximization; this will be possible to the extent that the parameters used in the definition and evaluation of the levels can be optimized. (Parameters, of course, may be non-spatial conditions and may be modified as the "design growth process takes place through time.") [7]

Interdisciplinary Character of the Systems Approach

The above considerations indicate that whether the design is to be expressed in the form of a pattern language or in a detailed plan of a site or of a building, the solutions must satisfy the assumptions of a scale for the evaluation of the parameters, such as behavioral response, psychological reaction to form, social relations as a consequence of spatial organizations, functional characteristics, and so on.

These statements might suggest establishing a rigid series of rules for design, but actually they are only the stimuli for a search for a way to incorporate objectively into the design the element of human needs of every sort, other than only by an act of faith in the "humanity" of the designer.

While strongly supporting the quest for a systematic design approach, I have also tried to indicate some of the risks connected with a blind confidence in the model construction and operation techniques, as well as pointing out some directions for further investigation. These ideas are meant to break the limits of compartmentalization of disciplines, and to recognize the objective goals of a design process capable of establishing a direct relationship between multi-variable form-generating functions and the product of the design itself. I also have made a reference to the recent work by C. Alexander, because I think that his work shows the need for a real interdisciplinary process, leading to a comprehensive and harmonious design. These qualities can be only the expression of a design team, in terms of systems performances or required standards.

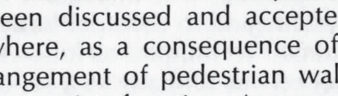
New Dimensions for Creative Expression

Because of the very complexity of the design process and of the need for an interdisciplinary team approach, no attempt will be made here to give an exhaustive example of "how to design." Rather the emphasis remains on theoretical values, from which may be extracted indications for basic methodological choices. Already it has been mentioned that the use of performance characteristics would allow overcoming the *impasse* caused by the difficulty of passing from an analytical representation of systematic requirements to their synthesis into a spatial design. The tendency to tear things apart and to express them by means of numbers and formulas must be matched by the ability to put the pieces together into a physical form, creating objects from concepts.

From Performance Levels to Design

I shall now refer to a hypothetical situation where the problem is to design a multi-functional urban space, the goals and purpose of which already may have been discussed and accepted. Assume that the designer has progressed to where, as a consequence of other considerations, he is considering the arrangement of pedestrian walkways and open spaces as a pre-eminent form-generating function. Assume as well that an exhaustive analysis of the possible behavior-environment interface has been produced by social scientists, expressed in a formal model. The designer then establishes the performance levels that his space must meet in order to comply with the requirements. He is able to suggest what the users ought to want from his design, as well as how they can go about getting what they want. In other words, he would be able to undertake a synthetic act which would distinguish his creative activity from a statistical investigation and from obscure, abstract interpretations. For the same reason, the resulting design is liable to reconsideration by the behavioral scientist who contributed to the definition of the parameters for the performance specifications, thus enabling the whole process to be verified. Again, this is not the place to codify how the verification should take place, but it can be indicated that it could be in the form of an efficiency test, to determine the correspondence or dissonances between the parameters originally established and those which are identifiable as controlling the design.

Returning to the case of multiple choices for the design of pedestrian paths in the urban space, the following schematic arrangement of cybernetic loops in the design process indicates where and how the evaluation of parameters determines the choice of the performance levels, coherent with the established utility values (u) of the alternative possible directions (x).



U = Utility indicator
U² = random Utility indicator
Ux = Utility function
Ux² = random Utility function

Plx = Performance level

u² = random parameter utility value

In fact, if p(Ux) = p(x) − p(Uy) is a verified condition, meaning that the probability of selecting a path coherent with the established parameter value (u) of the Utility function (Ux) corresponds to the probability of selecting any one of the possible multiple alternatives p(x), provided that the limit of the negative Utility function p(Uy) is kept close to zero with the constant verification of (u). Which condition can be expressed by saying that the limit of p(Uy) must tend to zero when (y), negative parameter, increases.

At this point the problem is reduced to the formulation of the mathematical expressions of the various symbols indicated in the scheme, which, as stated before, can be done by means of differential, non-linear equations (to allow the introduction of the time factor and to absorb the influence of external influences in an open system).

The performance levels then very likely will have a mathematical formulation, directly reproducible into the spatial structure of the required design.

Conclusions

The reference to a practical detail of a more complex situation has been made in order to illustrate how it is possible to analyze design in systematic terms, as well as to endorse the universality of the more rational methodologies. Moreover, it has enabled me to indicate some important practical and ethical considerations.

In fact, less has been done in practice to implement interdisciplinary team design than is indicated by the favorable consensus in theoretical terms. Therefore it is legitimate to ask why there are so few and sporadic examples of interdisciplinary teamwork (the English new towns, for instance) with almost no advantage derived from these rare experiences. The answer may be that political and economic circumstances are the insurmountable impediment; but I would like to argue that little is being done to educate the people who should promote the idea. In other words, the universities and schools of architecture are not commited unequivocally to implementing interdisciplinary team activities.

More specifically, the schools should offer specialized curricula which would provide professionals with specific expertise, preparing them to make a unique contribution to a team, following a pattern suggested at the educational level.

As to the criticism that more specialized curricula would restrict professional perspectives and create second-grade architects, it can be argued that on the contrary such preparation would represent a requalification of the profession. Rather than limiting to those few who have comprehensive capabilities, it would enable many people who have different abilities to deal with form and inventive situations, to devote themselves to systems analysis for design, or to model construction and computer programming for design, or to any other complementary activity. They might be considered design technologists, instead of being frustrated architects.

This is not to say that some schools are not moving in this direction, but that they are few and in most cases they offer only one or two choices of relatively comprehensive design courses, like the design of a VSTOL airport, or of transportation infrastructures. All schools should offer as many alternative choices of specialization within the more general discipline of architecture as the availability of interdisciplinary contributions in the academical institution may allow. This would require a flexible curricula, contributions from other departments which may focus on architectural issues, as well as enlightened and careful planning of the overall program. There should be a series of different academic and professional qualifications, requiring professional recognition of new degrees. The present licensing examinations for the profession of architecture may have corresponding alternatives in related fields of practice. This would be a way of enabling those architects who have different abilities from the traditional ones and who, without a license, already accept a secondary role in the profession, to be fully recognized as specialists in concurrent design disciplines, allowing them to give their indispensable contributions as architects with mathematical or systems simulation majors. These distributions of tasks are already a fact in the world of industry, and even in fields which are increasingly related to architecture: meaningful examples are provided by the previously mentioned case studies of Forrester on urban dynamics and by Hamilton and others on the River Basin region.[5]

Another warning should accompany this concern that architects may presume to be knowledgeable across the whole spectrum of humanities and sciences: it is the concern lest experts in non-visual matters should assume full design capabilities. More simplistic than the architect presuming universal capability would be the programmer supposing that machines alone can supply perfect solutions, say to the traffic problems of a city or to the design of the infrastructures. In other words, limitations of technological tools constantly should be made clear when applied to specific situations and when sophisticated techniques are used for design purposes. For example, it would be an oversimplification to think that the simulation of a complete urban situation could be just as exhaustive in terms of forecasting probabilities as, for instance, it might be for anticipating the production operation of a factory. Complexity of relationships, the sort of behavioral factors which were discussed previously, the impossibility of verifying the validity of the model, and more generally the non-applicability of the principles of consequentiality all require the mediation of spatial decisions at a creative level.

This brings me to the conclusion that, on the one hand the design discipline may benefit greatly from the increased lateral inputs, while on the other the architectural competence itself will be increasingly evaluated. The architect may regain the confidence he deserves as the formal interpreter of the many social, economic, and technological requirements, acquiring a share of power which he now does not possess but which he once had when he considered himself to be no more than a shaper of space, while actually he was deeply influencing his society and its civilization.

Footnotes

1. Ludvig Von Bartalannfy, *General System Theory*. New York: G. Braziller, 1968.
2. M. D. Mesarovich, "New Directions in General Theory of Systems." In *Systems and Computer Science*, J. F. Hart (Ed.). Toronto: University of Toronto Press, 1967. See also A. Rapoport, *Fights, Games, and Debates*. Ann Arbor: University of Michigan Press, 1960.
3. C. Alexander, S. Ishikawa, and M. Silverstein, *A Pattern Language Which Generates Multi-Service Centers*. Berkeley: Center for Environmental Structures, 1968.
4. C. Alexander. See also *Houses Generated by Patterns*. Berkeley: Center for Environmental Structures, 1969.
5. Jay W. Forrester, *Urban Dynamics*. Cambridge: M.I.T. Press, 1969. See also H. R. Hamilton and others, *Systems Simulation for Regional Analysis, An Application to Rivers Basin Planning*. Cambridge: M.I.T. Press, 1969.