THE ARCHITECTURAL RELEVANCE OF CYBERNETICS

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It is easy to argue that cybernetics is relevant to architecture in the same way that it is relevant to a host of other professions; medicine, engineering or law. PERT programming, for example, is unequivocally a 'cybernetic' technique and is the commonest-implied in construction scheduling. Computer assisted design is a 'cybernetic' method and there are several instances of its application to architecture (for example, the CDC's planning scheme in which the designer uses a display to represent the disposition of structural modules on a grid and in which the computer summarizes the cost-effort consequences of a proposed layout). Of these cases the first (PERT programming) is a valuable but quite trivial application of cybernetics; the second is likely to have a far-reaching influence upon architectural design. But neither of them demonstrate more than a fortuitous bond between cybernetics and architecture. If we leave the matter at this level, then architects dive into a cybernetic bog of tricks and draw out those which seem the most intriguing, but the perfectly reasonable thing to do, of course. But cybernetics and architecture really enjoy a much more intimate relationship; they share a common philosophy of architecture in the sense that Stafford Beer has shown it to be the philosophy of operational research.

The argument rests upon the idea that architects are the first and foremost system designers who have been faced with designing for nearly 50 years or so, to take an increasing interest in the organizational (i.e., non-parallel) system properties of development, communication and control. Design problems were coped with as they cropped up, but for some time it has been evident that an underpinning and unifying theory is required. Cybernetics is a discipline which fills the bill insofar as the abstract concepts of cybernetics can be interpreted in architectural terms (and, where appropriate, integrated with real architectural systems), to form a theory of architectural cybernetics, the cybernetic theory of architecture.

Historical roots

In or before the early 1800's 'pure' architecture existed as an abstraction from the art a building. Its rules were essentially condensed statements of what could be looked at as building at work on a site, and by looking at buildings constructed during different periods and in different places. Architects added a layer of historical and aesthetic sensitivity to their discipline and created new structures with stability and style. On the whole, their structures were judged, within 'pure' architecture, according to these canons.

Even in those days, of course, architects were asked to solve problems entailing the regulation and accommodation of human beings; hence, to design with a sense, their brief was quite narrow. The problems could all be solved by the judicious application of pure architectural rules. The form of the artifact (house, college or theatre) was largely determined by the needs of the time and place (designating, for example, its acceptable whole part relationships) and by the conventions of society or the individual practitioner. Speaking technically, there was well accepted communication media for conveying instructions, directives and ideas (style manuals and so on). Further, there was a metalanguage for talking about these instructions, directives and ideas, for comparing them, criticizing them and evaluating them (as in statements of stability or style). Indeed, when impressed by his systemic qualities and the way in which they may satisfy the architect's purpose to the occupant. Two of them still exist in practical form. Even in its forbidding reformation it was a remarkable structure. Since these data were not used in the prefabricated building it also counts as a piece of system data at the time of its construction.

Architectural functionalism and mutualism

A structure exists chiefly to perform certain functions, for example, to shelter its occupants or to provide them with services. At this level, a 'functional' building is a meaningful entity because a 'decorative' building; it is an austere structure. Stripped of its humanistic content, the whole is a functional building and humanistic content is achieved by the functions, after all, are performed for human beings or human societies. It follows that a building cannot be viewed simply in isolation. It is only meaningful as a human environment. It perpetually interacts with its inhabitants and on the other hand controlling their behaival. In other words structures make sense as parts of larger systems that include human components and the architect is primarily concerned with these larger systems: they (not just the bricks and mortar parts) are what architecture is about. Thus, the new architectural 'mutualism' meaning mutually is determined by the relations between structures and men or societies.

One consequence of functionalism and mutualism is a shift of emphasis towards the form (rather than the material constitution) of structures; materials and methods come into prominence quite late in the design process. Another consequence is that architects are required to design with a dynamic rather than static mind-set. Clearly, the mind-set of the designer is dynamic. But it is equally true (though less obvious) that the structural part must be imaged as continually adjusting its human inhabitants.

Architectural holism

Once a rudimentary version of the functional-mutualistic hypothesis has been accepted, it becomes clear that any single system is questionable. Most human/structure systems rely upon other systems to which they are coupled via the human components. By hypothesis, there are organizational wholes which cannot be meaningfully dissected into paradigms, yet this is not the case of society. Holism is of several types:

- A functionally interpreted building can only be usefully considered in the context of a city (not just the building considered in isolation).
- A functionally interpreted structure, either a building or an entire city, can only be meaningfully conceived in the context of its technological extension, i.e., its growth and development.
- A functionally interpreted structure exists as part of an intention, i.e., as one product of a plan.
- An architectural theory can be applied to a system of norms by transforming the system into a series of constraints which are to be regulated in the development of various tributaries and which render this

1 Very similar comments apply to engineering, since there are many 'architectural' design objects, for example, the bridge designer. The situation is quite different in engineering, where the impact of cybernetics is not great because a relatively small body of engineering theory and explanatory theory is already there at the beginning. Cybernetic concepts came along as new innovations. Moreover, whilst all architects design systems that interact closely with human beings and societal components, most engineers (the exceptions to the exceptions) are not forced to do so. The human interaction is a part of difficulties which can only be overcome by cybernetic thinking.

2 The difference between inductive and deductive reasoning is arbitrary and depends upon the emphasis of the problem. For example, a new technology is often paired with a new technology. The example of a new technology is arbitrary and depends upon the emphasis of the problem. For example, a new technology is often paired with a new technology. The example of a new technology is arbitrary and depends upon the emphasis of the problem. For example, a new technology is often paired with a new technology. The example of a new technology is arbitrary and depends upon the emphasis of the problem. For example, a new technology is often paired with a new technology. The example of a new technology is arbitrary and depends upon the emphasis of the problem. For example, a new technology is often paired with a new technology. The example of a new technology is arbitrary and depends upon the emphasis of the problem. For example, a new technology is often paired with a new technology. The example of a new technology is arbitrary and depends upon the emphasis of the problem. For example, a new technology is often paired with a new technology. The example of a new technology is arbitrary and depends upon the emphasis of the problem. For example, a new technology is often paired with a new technology.
behaviour homeostatic rather than divergent. Hence, the architect is responsible for building conventions and shaping the development of traditions (this comment simply elevates the idea that a building controls its inhabitants to a higher level of organization).

Evolutionary ideas in architecture
Systems, notably cities, grow and develop and, in general, evolve. Clearly, this concept is contingent upon the functionalist/mutualist hypothesis (without which it is difficult to see in what sense the system itself does grow) though the dependency is often unstated. An immediate practical consequence of the evolutionary point of view is that architectural designs should have rules for evolution built into them if their growth is to be healthy rather than cancerous. In other words, a responsible architect must be concerned with evolutionary properties; he cannot merely stand back and observe evolution as something that happens to his structures. The evolutionary thesis is closely related to holism, type c, but it is a carefully specialized version of c as manifest in the work of the Japanese.

Symbolic environments in architecture
Many human activities are symbolic in character. Using visual, verbal or tactile symbols, man ‘talks with’ his surroundings. These consist in other men, information systems such as libraries, computers or works of art and also, of course, the structures around him. Buildings have always been classified as works of art. The novel sub-theory is that structures may be designed (as well as intuited) to foster a productive and pleasurable dialogue. This way of thinking is most clearly manifest in connection with the literary art forms, notably surrealism which relies upon a variety (novelty) producing juxtaposition of releasers and supernormal stimuli (evoking inbuilt emotive responses) within a thematic matrix. At the architectural level, this type of design appears in the vegetable surrealism of some of the Art Nouveau. But it reaches maturity in Gaudí’s work, especially the Parque Güell (right) which, at a symbolic level, is one of the most cybernetic structures in existence. As you explore the piece, statements are made in terms of releasers, your exploration is guided by specially contrived feedback, and variety (surprise value) is introduced at appropriate points to make you explore.

It is interesting that Gaudí’s work is often contrasted with functionalism. Systemically it is functionalism pure and simple, though it is aimed at satisfying only the symbolic and informational needs of man.4

The machinery of architectural production
Just as a functionally interpreted building constitutes a system, so also the construction of this building is a system. The new techniques developed in the last century and the general mechanisation of production facilities led to sub-theories concerned with the achievement of forms (the most important centred around the Bauhaus) and these, in turn, restricted the forms that could be produced.

The widening brief
As a result of these, essentially cybernetic, sub-theoretical developments, many architects wanted to design systems but, on the whole, they were expected to design buildings. To a large extent this is still (quite reasonably) true. All the same, there is a sense in which the brief given to an architect has widened during the last decades. In part this is due to a state of problems for which no conventional solution exists (structures connected with aerospace developments, industry, research, entertainment, the use of oceans, etc.). Here, the architect is in much the same position as his Victorian predecessor when asked to build a railway station. In part, however, the constraints have been relaxed because of the greater prevalence of system orientated thinking amongst clients and public sponsors. It is, nowadays, legitimate to enter the design process much earlier, even for a conventional project. For
example, it is quite commonplace to design (or at least plan to) cities as a whole with provision for their evolution. A University need not be conceived as a set of buildings around a courtyard with living accommodation and lecture theatre. The educational system might, in certain circumstances, be spatially distributed rather than localised. In any case, architects are perhaps encouraged to anticipate trends such as the development of educational technology and to provide for their impact upon whatever structure is erected. By way of an example of this, some of the solution phrases into the picture at the time when a higher educational system is being contemplated, without commitment to whether or not it is called a university. The project, by Jean Littlewood and Cedric Price, was an early entry project of this type in the field of entertainment and it is not difficult to find examples in areas ranging from exhibition design to factory architecture.

The point I wish to establish is that nowadays there is a demand for system oriented thinking whereas, in the past, there was only a more or less exotic desire for it. Because of this demand, it is worth while exploring the isolated subtheories together by forming a generalization of the common constellations. As we have already argued, the common constituents are the notions of control theory and cybernetic systems. Hence the generalization is no more nor less than abstract cybernetics interpreted as an overall architectural theory. It would be premature to suggest that the necessary interplay between the disciplines is complete. But a creditable start has been made by a number of people; in particular, those with whom I have personal contact, Christopher Alexander, Niall McLearn, and students and ex-students from the AA School of Architecture and from Newcastle.

Status of the new theory

In common with the pure architecture of the 1960s, cybernetics was to have a major influence on the design of the times. But the cybernetic theory is more than an extension of 'pure' architecture. As we noted somewhat earlier, pure architecture was descriptive (a taxonomy of buildings and methods) and did not concern itself with the preparation of plans (or indeed the preparation of plans) but it did little to predict or explain. In contrast, the cybernetic theory has an appreciable predictive power. For example, the urban development of our own times is the result of the analysis of the conditions of organizing system (a formal statement of 'Evolutionary ideas in architecture') and in these terms it is possible to predict the extent to which the growth of a city will be chaotic or ordered (by the degree of predictability of data for prediction is unavailable we can, at least, pose and test rational hypothesis. Much the same comments apply to predictions in which time is not of primary significance, in predicting the influence of spatial and normative constraints upon the stability of a (functionally interpreted) structure.

The cybernetic theory can also claim some explanatory power. It is possible to mimic certain aspects of architectural design by artificial intelligence computer programs (provided, incidentally, that the program is able to learn about and experiment in the language of architecture, i.e. by exploring plans, material specifications, condensed versions of clients' comments, etc.). Such programs are clearly of value in their own right. They are not, however, intended as intelligent extensions of the tool-like programs mentioned at the outset. Further, they offer a means for integrating the structural system (the 'machinery of production') with the ongoing design process since it is quite easy to embody the constraints of current technology in a special part of the simulation. However, I believe these programs are of great importance as evidencing our theoretical knowledge of what architecture is about. Insofar as the program can be written, the cybernetic theory is explanatory.

Speculations

It seems likely that rapid advances will be made in at least five areas guided by the cybernetic theory of architecture.

1. Various computer-assisted (or even computer-directed) design procedures will be developed into useful instruments.

2. In different disciplines (notably social anthropology, psychology, sociology, ecology and economics) will be unified with the concepts of architecture to yield an adequately broad view of such entities as "the social system," which can lead to changes in human behaviour.

3. There will be a proper and systematic formulation of the sense in which architecture acts as a social control (i.e. the germ of an idea, mentioned under Huxley and elsewhere).

4. The high point of functionalism is the concept of a house as a 'machine for living in.' But the bias is towards a machine that acts as a tool serving the inhabitant. This notion will I believe, be replaced by the concept of an environment with which the inhabitant cooperates and in which he can externalize his mental processes, i.e. mutualism will be emphasized as compared with mere functionality. For example, the machine for living in will relieve the inhabitant of the need to store information in memory and the need to perform calculations as well as helping out with more obvious hillian functions such as heating and washing up dishes. Further, it will elicit his interest as well as simply answering his enquiries.

5. Gaudi (intentionally or not) achieved a dialogue between his environment and its inhabitants. He did this by utilizing physically static structures (the dynamic processes depending upon the movement of people or shifts in their attention). The dialogue can be refined and expanded with the use of dynamic techniques which allow us to use the same pattern in terms of a reactive environment. If, in addition, the environment is malleable and adaptive the results can be very potent indeed. I have experimented along these lines myself but the work of Broday and his group at the environmental ecology laboratory is a project on a much more impressive scale. As a broad statement of what computer controls the visual and tactile properties of environmental materials (which are available in sufficient diversity for most architectural purposes). These materials contain sensors, transducers, visual as well as the visual as well as control circuitry which return messages to the computer at several levels of complexity. In the absence of a human inhabitant, the feedback leads to stabilization with respect to certain environmental invariables (for example, a body of material shall maintain mechanical stability and occupy a prescribed value), and to a search process in which the material actively looks for signs of a human being in contact with it. If there is a human being in the environment, computer, material and all, engages him in dialogue and, within wide limits, is able to learn about and enter into his visual and tactile patterns. This is thus one sense in which the reactive environment is a controller and another in which it is controlled by its inhabitants.

A single cybernetic design paradigm

In the context of a reactive and adaptive environment, architectural design takes place in several interdependent stages.

1. Specification of the purpose or goal of the system (i.e. the system and its inhabitants).

2. At least it should be minimized that the goal may be and nearly always will be underspecified, i.e. the architect will not know more of the purpose of the system than he really knows the purpose of the system and his students (who design architecture) are bound up with everything from engine organization to molecular biology, the discipline of biology is already highly abstract and theoretical in itself. In this sense I take the point for engineering in the development of the theory of systems. Further, the controller is no longer a pure mixture of catalyst, reactant and memory but is also, as the case and as the probability, a controller and other which are present, that is embodied in the systems (control systems) which he designs.16

16 Clearly, in other respects, it would be uncomfortable to live in.

1 The impact of cybernetics upon architecture is considerable just as because the theory does have much more predictive power than the pure architecture had. Cybernetics, did relatively little to alter the shape of biology, but they have been a very influential theory. Since the two concepts are bound up with everything from enzyme organization to molecular biology, the discipline of biology, is already highly abstract and theoretical in itself. I made the same point for engineering in the development of the theory of systems.

14 I have the work of Neopropast's group (see p. 500-514) cited above, less than others are exemplary.

16 For example, the control of the major project and the motorcontrol system, A comment, a case history and a plan in Computer Architecture. The idea was that the machine could be put into the body as a system. Partly this at stage and partly in it above, the architect determines what properties will be relevant in the man environment dialogue.

18 Specifications of what the environment will learn about and how it will adapt.

19 Choice of a plan for adaptation and development, in case the goal of the system is underspecified (as in i) the plan will chiefly consist in a number of evolutionary principles.

20 Of course, this paradigm applies to systems which adapt other than short time intervals (minutes or hours). In contrast, the adaptation in a project, such as the Fun Palace project, was to place over much longer time intervals (for instance, a 4-hourly to a 1-hourly cycle formed part of the proposal). Depending upon the time constraints and the degree of flexibility required, it is more or less convenient to use a computer (for example, the work is much more economic to programme by a flexible office procedure). But exactly the same principles are involved.

21 Urban planning usually extends over time periods of years or decades, as currently conceived, the plan is quite an inflexible specification. However, the argument just presented suggests that it need not be inflexible and that urban development could, perhaps with advantage, be governed by a process that in the dialogue of a reactive environment (physical contact with the inhabitants giving place to an awareness of their preferences and predictions; the inflexible plan to the environment computing machine). If so, the same design paradigm applies, since in all the cases so far considered the primary decisions are system in character, and the people who inhabit it. The glove fits, almost perfectly in the case when the designer uses a computer as his assistant. In other words, the relation 'controller/controlled entity' is pervasively in his case, instead of being the result of either by 'designer/system being designed' or by 'systemic environment/inhabitants' or by 'urban plan/city'. But notice the trick by the designer is controlling the construction of control systems and consequently design is control of control, i.e. the designer does much the same job as his system, but he operates at a higher level in the organizational hierarchy. Further, the design goal is nearly always underspecified and the controller is no longer the authoritative apparatus which this purely technical name commonly brings to mind. In contrast, the controller is an old mixture of catalyst, control and memory and arbiter. These, I believe, are the dispositional a designer should bring to bear upon his work (when he produces a computer) and this are the qualities he should embed in the systems (control systems) which he designs.16