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"Intelligent" Architecture: Cybernetic Theory and Architecture

Introduction

The paper discusses current descriptions of "mtell1gent" architecture and proposes the relevance of cybernetics in affording an alternative criteria for us conception and production. The recent appearance of what has been oted as a 'new genre in architecture' indudes buildings which have various levels of automated and computer controlled functions- 'robotic" infrastructures. Information Technology and Communication Systems have since the 1960's aided new conceptions of architecture and fuelled speculation concerning architecture's future development Contemporary, architectural discourse now includes artificial intelligence in the technological debate, contributing another dimension to the modern, *machine esthet«*. Current descriptions of "intelligent" architecture are consistent with a model of artifidal intelligence which has been generated by the predominance of the electronic, digital computer and the prevalent symbolic and logic driven descriptions to which it adheres. Consequently, the existing "intelligent" building is unable to achieve better performance over its initial, well defined specification and is incapable of interacting with the wortd as an autonomous entity. The cybernetic concept of an "intelligent" building demands some degree of epistemic autonomy *in* order to improve itself, a capacity which is only attainable through structural autonomy, as is the case with all biological systems. The development of "intelligent architecture" as an informationally open, organisationally dosed, cybernetic system is discussed in relation to existing extensions of "robotic" technologies in architecture. Interaction, a fundamental characteristic of intelligent, decisionally autonomous and unpredictable living systems was explored by cybernetician Gordon Pask (1928 - 1996). His work is compared here to the pre defined, receptor-effector devices currently in use in order to highlight the limits of existing adaptive machines and to suggest the relevance of his ideas in providing an alternative, human-centred design methodology.

Nfrrtefligent? Architecture?

At present, 'intelligent" architecture is a description of any structure in which some or all of the buildings services are automated. Services are such things as heating and ventilation systems, transportation in the form of lifts and escalators for circulation of people and products as well as security or safety mechanisms for efficient damage limitation in the event of theft, vandalism or fire. In a number of "intelligent" buildings, services are centrally controlled by an electronic, digital computer programmed to manage all functional requirements. The computer operates in communication with a number of other mechanisms such as thermostats and valves, necessitating the employment of transducers to convert the pneumatic signals of these and other devices to the computers digital signals and back again. The complexity of these hybrid systems, in conjunction with the large number of indiv1dual components needed, has proved to date to be expensively inefficient. In order to avoid the problems created when centralised, computer control breaks down (an apparently frequent occurrence), a network of ind1v1dually powered micro processors each carrying their own battery pack has been employed as an alternative method to monitor internal conditions and operate equipment in a building. Both methods involve digital transmission and reception of signals to a number of different 'point" and by a number of different means, involving experimentation with coaxial and fibre optic cable, telephone lines and microwave or radrewave links in order to facilitate faster and more precise information relay [1]

The implementation of elaborate servo-mechanisms as discrete, unitary elements housed *in* otherwise static, "dumb" structures or their utilisation as modular components of some infrastructural mechanism demonstrates the deficit in integrative design strategies to date. As a result the architectural question is currently in danger of being neglected in favour of a technical elaboration of its functional parts. The confusion made evident in architectural discourse by its uncritical adoption of the term "intelligent• in relation to buildings with a high technological investment reflects the differing criteria of a number of contributing scientific fields. This can be seen in the wide variety of terms used to demibe "smart" material systems and structures, terms such as adaptive, active, sensory, sensitive, metamorphic and intelligent. This diversity attests to the research communities struggle to define an appropriate set of criteria concerning the development of "smart"' science and technology in order to focus attention on the premise or defining pnnciples for "smart" as opposed to "intelligent" innovations. The emulation of the adaptive capacity and integrated, interactive characteristics of biological systems is commonly considered to be the ideal goal of this new discipline and one which emphasises a holistic or systemic philosophy. 'Smart" scientist Richard Gardiner has suggested that "It is in this way that our synthetic world will be guided by the same philosophy as our natural world." [2] He considers that "smart" innovation represents a physically realisable compliment to research in the area of complex, adaptive systems or Artificial Life (AL).

The technology to construct "robotic" (bionic) environments already exists or is in an advanced stage of development but there is nothing as yet that challenges our concept of self - who or what we are in current examples of so called "intelligent" or "smart" buildings. These structures can not anticipate our changing, individual, human needs or communicate with us in a relational context. Robotl< processes are fixed, and unambiguous as are "smart" materials and structures. The 'receptor· effector' devices currently employed in the built environment react only within pre defined perameters, optimising there performance within given percept and action categones. Such systems improve upon their initial designs by altering their decision functions contingent upon evaluation of past performance, they have decisional capacity but no "decisional autonomy." Robotic tasks are necessarily definable, distinct, predictable; they evince reason in their behaviour and one need not look beyond a robots behaviourto determine its intention ... there is nothing about 'robotic-ness" that entails mindfulness" [3]. The modernist conception *of dwelling* as a "machine for living' has not yet made a convincing translation to a late twentieth century conception of dwelling as "living machine."

A Cybernetic Approach: the Work of Gordon Pask

The hybridisation of architecture into an "intelligent, living machine" represents an opportunity for collaborative discou~e which demands a meta language for its conception and a trans - disciplinary, design strategy. The limitations affecting contemporary machine learning suggests the need for more inductive approaches to artifidal intelligence and Cybernetics is proposed as affording a more cohesive and design orientated approach than is currently available.

The "intimate relationship" of cybernetics and architecture that cybemeudan Gordon Pask advocated some thirty years ago, anticipates the increasing importance of human machine interaction in facili·tating new psychological and physical environments. He influenced a generation of architects through his consultancy at the Architectural Association in London from 1961 - 93, the most notable being Cedric Price and the "Fun Palace" project as well as individuals such as Peter Cook and Ron Herron formers, founding members of "Archigram~Pask daimed that cybemetrcs and architecture shared a common philosophy of operational research . These terms had been previously outlined by Stafford Beer who observed that "architects were essentially system desiqners who would need to take an increasing account of the orqanisational system properties of development, communication and control" [4]. The cybernetic conception of archrterture expressed by Paskin relation to Beer's initial comments implies a broader conception of architectural design as "esthetic communication: He proposed that cybernetics may be seen to be advanced as a new theoreucal basis for 'intelligent" architecture and as a metalanguage for its critical discussion. John Frazer has summarised his own version of a cybernetic architecture inspired by Pask's theory as having" ... an open relationship with the environment, in both a metabolic and socio economic sense. It will maintain stability with the environment by neqative feedback interactions and promote evolution in its employment of posmve feedback. It will conserve information while using the processes of autopoiesis, autocatalysis and emergent behaviour to generate new forms and structures ... Not a static picture of being, but a dynamic picture of becorning and unfolding - a direct analogy with a description of the natural wortd." [5]

During the penod 1 gso-58, Pask constructed a number of electrochemical devices having emergent, sensory caoabhues. His intention was to construct a machine that would create its own "relevance critena" by evolving its own sensors 'to be able to choose, independent of the designer those aspects of the external environmem to which it would react." [6] Unlike any other existing and well defined machine, the device was envisaged as being able to adaptively construct its own perceptual categories and create its own means of interacting with the environment. A number of assemblages were built as a course of experiments in finding an appropriate medium for self-organisation to occur. By passing current through an array of platinum electrodes immersed in a container of metal-salt solutions such as ferrous sulphate, Pask was able to form dendritic metallic threads which could be manipulated in their structural growth. Fluctuation in conductance was aligned with particular environmental disturbance in order to direct thread structure growth, promoting emergent sensory awareness by rewarding the systems development through variation in energy supply. In 1958, Pask succeeded in developing a working device which demonstrated that ferrous threads could be adaptively grown to become sensitive to sound and magnetic fields. We have made an ear and we have made a magnetic receptor ... The training procedure takes approximately half a day and once having got the ability to recognise sound at all, the ability to recognise and discriminate two sounds comes more rapidly... : [7]. The capacity ofthe assemblage to interact with the wortd, to classify the apparent state of the wortd based on this interaction ... to make measurements, to draw distinctions to form concepts by physically evolving its own observables" is described by Peter (ariani as being a significant an unique contribution to the field of artificial intelligence. [8]

Pask believed that humans are essentially 'leaming machines" (systems), and that this "need to learn" impels us to seek out novel experience. This is found in events or configurations which engender uncertainty or ambiguity, necessitating abstraction and conceptualisation in an attempt to interpret "the new" in relation to an existing body of experience -- knowledge. The propensity to explore, discover and explain our environment involves social communication and cooperative interaction with each other in creating requisite novelty and variety resulting in the development of, what Pask refers to as, "aesthetically potent environments': Such environments are perceived by Pask to arise from both the production and appreciation of Art in its many manifestations. It is considered to facilitate a

dynamic information structure in which we are able to learn and to interpret at various levels of abstraction Depending on the sense modality (medium) used, different levels of interaction do occur but are perceived by Pask to be generally dependent upon adaptation on the part of the viewer, reader or listener"our internal representation of a painting, (play or musical piece) ... does respond and engage us in an internal ronversation'wuh that part of our mind responsible for immediate awareness" (9) ... does respond and engage us in an internal"conversation"with that part of our mind responsibsentations or discourses and affords greater ambiguity and indeterminacy."It may in addition respond to a man, engage him in conversation and adapt its characteristics to the prevailing mode of discourse" (10).

This notion is embodied in *Musicolour Machine*, which Pask constructed together with fellow student T. Robin McKinnon Wood at Cambridge University Built and performing by *1953,Musicolour\'* interactive program elicited attention (input) by interjecting in live, musical performance with responsive displays of coloured lights. By inducing human response n was able to incorporate variation in to the musical interpretation learning to "listen effective\(,n order to respond and participate. The learning capabilities of *Musicolour* involved an anti inertia program which in the absence of input, or if given a repetitive input became"bored" and directed its attention to the potentially novel. In this way the machine was"designed to entrain the performer and to couple him into the system." [11] Converse participation was enabled at various levels of interaction e.g. performers could accentuate properties of the music by reinforcing audio visual correlations in the process of improvising new musical compositions. The dose, co-operative rapport that this engendered between the human and the machine was demonstrated at a number of public events between 1953 and 1957. The significance of *Mus1colour* is not only in its achievement as a technically proficient, adaptive system but more pertinently m its particular ability to genuinely participate in the creative process. It's capacity to and "ad lib." (to improvise) was so effective that it lost its distinction as a detached entity in many of the participating musician's conceptions during such performances. [12]

Colloquy of Mobiles was a socially orientated, interactive environment, designed by Pask on 1967 It consisted of a set of suspended, communicating entities able to emit and recognise several different colours and time modulations of light and a number of different tones and time modulations of sound. The community of five mobiles, run asynchronously in parallel interacted with each other via a conversational strategy involving a complex auditory and visual language existing at several different levels. The syntax of the interpretation depended upon rules built into each mobile's program so that different levels of communication occurred in which each mobile retained a certain individuality. Male mobiles were assigned as having two"drives," or goal-orientations and in order to facilitate these goals the male mobile had to elicit the co operation of a female, rotating in territorial competition with other males in the search for a willing participant. Receptor and effector devices were triggered by sound and light signals involving complicated correlations consisting of temporal delays or extensions as each mobile selectively reinforced particular communications with each other and apparently at will. The intriguing nature of the mobitc community elicited considerable curiosity from human participants who were introduced into the envuonrnent. Interpretation of the system involved a number of individual gambits which usually entailed attempts to synchronise certain co-respondents so that a pattern of communication or what may be alluded to as a "conversation" was achieved. [13]

Condusion

Pask's work involving the construction of adaptive systems involved the development of a number of elaborate programmes in order to regulate learning, innovative processes, and perception in individuals and groups. This work represents a substantial contribution to ideas of self-organisation in models of mentation as well as insights concerning the activity of sodological systems finding its apotheosis ,n Pasf.'s'Conversation Iheory"It is in essence a theory of interaction in which psychological *(P)* and machine individuals (MJ participate, creating in the process, a conceptual domain in which new perceptions evolve. Pask believed that" from this mutual accord there could emerge a metamorphosis, a transformation both of the human mind and of the nature of computing ... : [14] This conception ls apparent in the interactive environments perceived by Pask as places with which the inhabitant cooperates and in which she can externalise her mental processes. In this way the "living machine" will elicit our interest as well as simply answering our questions.Mutual adaptation is emphasised as compared to mere reaction, providing a model for"Intelligent Architecture"which supersedes current descriptions of"dumb" structures housing intelligent components i.e., human beings. Pask contended that many human activities *are* symbolic in character and by using visual, verbal or tactile symbols man perpetually"talks" with his surroundings.The proposition that a structures may be designed to foster a pleasurable and productive"dialogue"is described in part by the interaction exhibited in *Musidour* and *Colloquy* in furnishing such an environment. This interactive process can be refined and extended with the aid of developing technologies in offering new mediums of communication.As suggested by Pask the relationship between the individual and the environment is an information processing system and ll we are going to design for this situation then we must deal with the system as a whole.

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