Some Speculation on the Future of Engineering the Environment".

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ABSTRACT

This paper outlines a 'futures study' which speculates on the possible impact of 'artificial intelligence' software on building design. Some thought provoking ideas are highlighted within a mu1ti-scenario analysis, which focuses on the nature of technology application by engineers, architects and designers, and specifically the who or what controls which function in a building to benefit the local and global environment of building occupants? It uses the following terms to conceptualise future design - anarchic buildings, cybernetic buildings, archionics engineering, infotecture, kinematic architecture and biotecture.

Introduction

A 'futures study' is based upon an analysis of today and prediction of the interrelationship of factors which might affect the situation and circumstances of tomorrow. Forecasting is too complex for 'reason' to cope with alone and intuition and imagination have to be part of the process. Also, a forecasting exercise is never totally accurate because the interrelationship of issues is highly complex and often a significant issue is missed out for the long term in the equation. However the value of a 'futures study' is in it being thought provoking - helping discussion, anticipation and planning for possible and probable opportunities and problems, and importantly to reconfigure thinking towards creative solutions to problems.

The framework of the study focuses on the notion that the design and the operation of buildings can be automatic - done FOR people; or, cybernetic - done WITH people; or anarchic - done BY people. At a

basic level for example, the control design of lighting within a building today can allow direct control by people, or, personal use of adjustable timers, or, be done with simple automation technology. The control scenario could '1owever change under the influence of microprocessor systems with artificial:"intelligence (ai) software, which can recognise patterns in data and make informed and .apparently' intelligent decisions using the data. Such systems can monitor a building's environment, both inside and outside, and make decisions about the state of a building with reference to the local environmental circumstances and even global environmental demands. The main question to ask is: with what criteria are decisions to be made?

A Multiple Scenario Analysis: Contexts

Speculation in this multiple scenario forecasting exercise is done in three contexts, each with their own set of relationships in the building design process and circumstances of building use. These focus upon relationships between clients, building design expertise, the users of the buildings, the nature of design strategies, building control designs and the use of "ai" technology using microprocessor systems. An overview of these contexts is given below followed by key concepts used and a summary of each forecasting scenario for the short, medium and long term.

1. Anarchic Buildings: design and building control is much the some as today.

In this scenario the design of buildings does not alter radically from today and developments are ad-hoc, they do not interfere with the status quo - the professional roles of building designers, the relationships between designers, their clients and building users. Buildings are designed with the local environment in mind.

2. Cybernetic Buildings: design and control with people.

More people are involved in the design process, and building occupants have some authority over building control systems. Building control systems and building design are cybernetic in this scenario - systems, professional designers and other specialists work together with building occupants. The quality of designs is defined by consensus. The rather limited definitions of cost effectiveness of a design apply far less under pressure of environmental requirements of a global nature. Building occupants make informed decisions on the control of building systems, which include broad environmental criteria.

3. **Automatic Buildings: design and control by computers.**

Fewer people are involved in the design process, and building occupants have little authority in the building design process or systems in use within a building. Building control systems have an automatic nature in response to economic and environmental requirements.

Concepts
The speculation uses phenomena perceived by the author as important 'change agents' and described with terms below.

a. Intelligent Building - the embodiment of computer software within a building enables a more complex level of thinking to be stored in the design. The 'intelligent' building using 'ai' technology can learn about the effectiveness of its systems from the operation of a building. It can alleviate the need for designers to anticipate design situation, for example, the local environmental conditions within buildings at a particular time of day. A building may adapt itself to environmental and other requirements in an evolutionary way. It can be its own craftsperson - re-designing itself according to prevailing developments and circumstances!

b. Archionics engineering - the term 'archionics' is used for the integrative application of a range of new technologies, such as microprocessor-based 'ai' mechatronics control technology, information systems and telecommunications technology within building services and systems. Archionics engineering transgresses the design practices of the different professions and trades in the building industry and integrates them within 'intelligent' buildings. The analogy is made with avionics engineering in the aviation industry - the design of an aircraft's control and information systems.

c. Cyber-Control Systems - the word 'cyber' is of Greek origin and means 'to steer' or 'guide'. The term cyber-control is used for a system incorporating software referred to as 'expert' - it can guide its user to make intelligent and informed decisions and actions. Cyber-control is not a strong current paradigm today as a human-displacement and replacement one pervades in engineering - a robot culture. The participation of users in the system design of "intelligent" buildings takes two forms: during the design process - in consultation and discussion, and through re-programming systems in use.

d. Kinematic Buildings - the local climatic environment of a building is constantly changing, as does the organisational function within it. The term 'kinematic building' is used for buildings incorporating

mechatronics technology which enables dynamic form. For examples, in a kinematic building at a simple level solar heat collectors follow the path of the sun across the sky, and at a more complex level windows may have a complex control function as super environmental filters, where light, heat, air, and noise might be filtered by intelligent and dynamic membranes, and operate like the iris of an eye. The architecture of kinematic buildings is more like visual music rather than a collection of visual harmonies frozen in space. Opportunities for creative kinetic architecture abound with the incorporation of mechatronics technology. A building could be as physically responsive as a plant to its environment.

e. Infotecture - the term represents the design of information in the widest sense, and the design of artifacts from an informational point of view rather than the perspective of material form. Information is becoming a significant building component. Infotecture is an analogy made with architecture. It is the concept of the structural design of information ""_ere at one extreme there is the dimension of culture and aesthetics and at the other extreme the design of 'mundane' practical problems; from incorporating the spirit of the age in a design to efficient sewers. 'Infotects' will increasingly take a role across all types of design.

SCENARIO I: Anarchic Buildings

Short term: We are seeing in the early 1990s consideration of the use of "ai" technology in buildings. However, there are difficulties in its application in building control and management caused by inadequate availability of appropriate software packages.

*1994+ :*The popularity of multi-disciplinary design practices is growing as they can offer a complete design service for buildings. Computer aided design and simulation techniques are increasingly used on a growing number of complex and ever more demanding '"intelligent" building' contracts. Information on the operation of the more sophisticated buildings is increasingly demanded in by building managers. Low cost domestic microprocessor control systems are gaining popularity.

However there is inertia of clients to use "ai" control systems in their buildings. There is a need for powerful low cost systems and design case-studies on "ai" use in buildings which demonstrate its potential. The application of 'ai' control systems is not cost effective enough to achieve the substantial savings in energy required to pay for the investment. Buildings continue to be a substantial cause of greenhouse gas emission through energy use.

Long Term : After years of scepticism about the usefulness of "ai" control systems promises were beginning to be fulfilled. Large multidisciplinary design practices use their economies of scale to offer research and development of "intelligent" building designs. Specialist design professionals are given authority in certain areas of design activity. Energy audit consultants and environmental consultants are contributing more and more to building design helping designers to cope with the rising complexity of the "intelligent" building, and demands of ever tightening environmental legislation. Architects are increasingly frustrated by these developments, especially by the influence of creative 'infotects' on building form.

A new discipline called 'archionics engineering' develops from the integration of skills of building services, communications and systems engineering, with mechatronics technology. It has a similar relationship in the building industry as avionics has within the aircraft industry. The expansion of the overseas construction markets results in an export industry for design know-how for 'intelligent' buildings. Architects develop sophisticated design concepts for the "intelligent" building with new virtual reality interactive building simulation design systems. Energy use in buildings begins to fall.

SCENARIO 2: Cybernetic Buildings:

Short term: There is a reluctance by architects to set the pace with new 'ai' building control systems and new kinds of design consultants begin to be commissioned by clients.

*1994+ :*Predicated changes in the global climate require a significant reduction of energy use to slow down green house gas accumulation in the atmosphere. Also, the social impact of much architecture for mass housing had to be improved, and design responsibility had to be diffused along with accountability for design decisions because of new professional liability laws. New international legislation is introduced for 'greenhouse gas' emissions, and increased democratic planning of the built environment. The specialised consultancies established in the 1990's develop rapidly after deregulation of the profession of architecture. They 'design and build' using democratic Design Forums multi-disciplinary and multi-interest group meetings for designing" and managing buildings.

Designs increasingly assist building occupants to control their own environment by incorporating programmable "ai" control systems. New multi-media computer displays with interactive - graphics for simulation and visualisation of building operations enable people to understand sophisticated building design and control concepts.

"Do-it-yourself' building design is increasingly possible, where building regulations and design knowledge are incorporated in "ai - expert" system software. Many building components incorporate sensors and become "smart structures". These allow buildings to behave very responsively to new requirements of building occupants and environmental needs. Thus "design for change" philosophies of architecture are encouraged.

Long Term: More emphasis in architecture is placed upon the design of organisational form in the built environment and less as material form. The design process increasingly takes place in a local context where users of buildings design their own environment. Organisationally, buildings are communications nodes, and travel of building occupants between in the build environment is substituted by the use of sophisticated broadband multi-media telecommunications systems. For example, tele-cottages are conceptually designed as part of city centre offices even though geographically miles apart.

Cyber - control systems assist and guide users in building control, and new control possibilities are suggested by the systems linked to information centres on local and global climatic conditions.

SCENARIO 3: Automatic Buildings.

Short term: Developments of knowledge-based 'expert' systems present many promises for the future. however they pose some threats for the professional status quo. Building management systems provide benefits for building operation but also threaten the freedom of action and privacy of building occupants.

*1994 + :*Initially, architects dominate the changes in design practice during upheavals due to new technology, and again take on the functions of other specialist disciplines in building design, which developed over the past few decades. Computer software was used to reassert the architects role in building projects.

Buildings become increasingly 'intelligent'- they incorporate software which enables certain design tasks to be done by the building itself when in use. For example, building services and systems can automatically respond according to predetermined design criteria in software on recognition of changes in patterns of occupancy, and internal and external environmental changes.

An elite group of computer literate architects are commissioned to write "intelligent" building design software. This becomes part of a new discipline called "infotecture", which affects much of the role of the traditional design professions in building design, in a way analogous to how crafts and professions were affected by automation of manufacturing processes. Building control designs of 'infotects' are sold 'off the peg' by information brokers, and then customised.

Long Term: Design and construction is now more integrated by the use of industrialised "smart" building modules. They are designed to facilitate planned maintenance of buildings and recycling of building components. These developments give rise to an elite of infotects and the lowering of the skill required to assemble buildings through sophisticated modularity of building components. In some instances a free design service is offered if clients use a particular manufacturer's "smart" construction system for their buildings

Infotecture also gives rise to building designs which give dynamic sensory stimulus to building occupants. They use innovative technologies which influence a person's brain. and senses directly - such as controlled release of trace chemicals in air conditioning, mood generating images, sensorial forms, and subliminal audiovisual messages for autosuggestions Communications ring mains around buildings allow networking of office coffee machines to washrooms and air conditioners, which in the guise of security systems also monitor the health of office workers and adjust ingredients to maximise productivity of building occupants.

The efficiency of 'smart' building modules cannot however match new biotechnology. Architects design with genetic knowledge and organic building technology self-replicating and self-regulating. Biotecture has arrived and buildings are truly in harmony with the natural environment - reversing the greenhouse effect by releasing oxygen and absorbing carbon dioxide. New city rain forests are created.

Conclusion

The time has perhaps come to question many basic assumptions underlying designing and for some entrepreneurial thinking. There is an opportunity today to influence the course of events for the benefit of both the local and the global climatic environment. Moreover the nettle must be grasped soon because climatic changes may accelerate and together with the rapid growth of 'ai' control technology mean that there is little time to examine cultural, political, social and design implications before attitudes and

infrastructures are established, which may effectively preclude the adoption of alternatives. The gauge of railway tracks followed the width of cart axles - try changing the railway gauge today!

The design of the environmentally healthy build environment requires discussion as to what is a desirable future for building occupants as well as environmental requirements and costs. But whether engineering the environment will be both innovative and 'carefully' designed is dependent on the imagination and motivations of engineers, architects and design specialists.

Conjectures about possible futures, and discussions about possible opportunities are a desirable first step to choosing a direction to go. Any strategy for change is formulated by making observations about today and assessing what they might mean for tomorrow. The anticipation of possibilities for the application of new technology requires not only knowledge of what it can do, but also what people may do with the technology under the most probable circumstances. Any new technology merely opens the door to opportunities, and whether clients and designers walk, or are pushed, into a particular future depends on their motivation, individual requirements, and awareness of the threats and opportunities.

The potential change in the global environment is the greatest threat to all. There is an opportunity to use advanced 'control technology' for the benefit to both the environment and building occupants.

The potential application of 'ai' technology through archionics engineering for kinetic architecture will present many exciting new opportunities for building form along with responsibilities for the welfare of both people and the environment.

What is your guess for the future?

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