# Impact of Innovative Technology upon the Construction Industry

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Buildings combine a very wide range of technologies. On the one hand computer based technology and robots can be employed, but there is a wide spectrum of trades which require craftsmanship and basic manual labour. Traditionally building has been viewed as a low technology industry, but this view obscures the complexity of tasks being performed and ignores the dramatic changes that have taken place during the last few decades. High technology industries tend to be characterised by manufacturing processes that use technology intensive capital equipment, such as computers and robots. The difficulty is that few processes in the site based activities in the building industry can be subjected to such simplifications for organisation and control. However, a building is the product of many inputs from consultants, contractors and manufacturers throughout the design, construction and operative stages of producing and occupying a building. Gann (1991) believes the two main reasons why Japanese contractors enjoy a much more powerful role in development of technologies than their counterparts in the rest of the world are firstly because contractors have not remained passive while firms from electronics and telecommunications sectors have introduced new technologies. There are many examples where construction corporations have diversified from their traditional roles as general contractors to move up market and become developers and engineering constructors. This could only be done, however, by proving their technological expertise to potential clients. Secondly, large construction corporations in Japan collaborate with large electronic companies in order to develop information network system infrastructures for buildings and to establish network engineering methods, taking into account building use (Kennaway 1991).

Employment of technology in buildings should not be an end in itself, but is only justified if it can help in meeting the rising expectations of clients and the demands by occupants for a better quality human environment, as well as improved building performance overall. Technology can also help to make buildings more flexible and adaptable for users.

Construction is often characterised by the limits of time, money and manpower. There is, however, the need to recognise that the relationship between design, installation and construction, commissioning, maintenance and appraisal in use is essential if buildings are to respond to the needs of people and investment is not to be wasted. Innovative technology recognises that the management of the process, the manufacture of the components, the assembling of the components and the maintenance of buildings are key activities which are all equally important.

Technological innovation needs to be seen as a spectrum across history. It is important that engineers and architects appreciate the ingenuity with which man has adapted buildings to climate throughout the world over several millennia. Buildings need to be designed to have a very low energy consumption, not only because of the finite nonrenewable fossil fuel reserves on the earth, but also because fossil fuel burning contributes to about fifty percent of the greenhouse effect. Throughout history there are many innovative passive design solutions which produce high quality environments with low energy expenditure. Today we need to meet the technical, social and economic demands of our society by using technology to blend with the lessons from history and so produce a high quality product which is durable over time. Technology offers an opportunity for buildings to become more dynamic. The fluid nature of buildings is naturally defined by the flows of people, information, light and air within and across the building envelope. Transmission of information represents knowledge highways throughout the building, and the spacing of people can be varied to give different distances for private as well as social communication.

Much of the recent research on sick buildings shows that fresh air, natural light, some degree of personal control, a sense of aesthetics and some link with the outside world are the main concerns of most people working and living in buildings. The balance of man-made things and those of nature should allow spiritual values to be felt; buildings can be emotive and sensual too because their interiors and finishes awaken our senses of touch, vision and hearing.

In planning buildings it is essential to bear in mind the social changes which are continually taking place. Technology has been viewed at various stages in civilisation as leading to future progress but it must also give the opportunity for individuals to explore and not usurp their creativity. It must also help in solving health and environmental issues which have become a major responsibility for the construction industry today. In planning technological innovation there is a need to use wider avenues of information than in the past covering technical, social and economic issues. For example, the International Research Institute on Social Change (Nelson 1989) carries out annual surveys in twelve European countries, North America, Brazil, Argentina and Japan about social development. Socio-cultural mapping helps to understand how peoples priorities and needs are changing.

Probably the greatest avenues of technological change will continue to occur in material science; information technology with the evolution of the biochip; superconductivity switching devices; optical information transfer systems and the development of measurement sensors which will enable many of the invisible aspects of environmental controls, such as radiant and convective heat transfer, to be measured and visualized more easily.

With the evolution of lightweight materials, surface coatings and selective layers for glass, materials which change their properties as the environment alters, photochromic glass, holographic glass walls, a family of dynamic building adaptive envelopes is being created. These horizons are providing an exciting future for the construction industry. The dynamic structures will mean that there will be a much greater integration between building services and the building fabric. It can also be expected there will be a much greater modernization of components as one off designing specific for use is replaced by flexible servicing with short life plug-in components which can be frequently replaced. Ultimately, with the provision of adaptive envelopes conventional heating, ventilation and airconditioning apparatus should disappear as multi-layered building envelopes incorporate data and environmental sensitive devices.

Communication systems now use attribute addressing where each controller is given attributes which may be confined to a particular floor or a part of the floor in a large building; the controller will handle the data from all of the environmental variables. Sophisticated information systems mean that cabling throughout a building is becoming much more complex, so cable management like access, fire safety and maintenance has to be considered at the early stages in the design process.

The use of fibre optics is causing a revolution in lighting and expanding communication systems markets. With their low attenuation signals can be transmitted over several kilometres with very low error rates; there is very little cross-talk and no electrical interference so that the cables can be installed alongside power lines. Currently, data transmission rates are in the order of ten megabytes per second, but it is already envisaged that rates of one hundred megabytes per second will be feasible in the not too distant future; laser driven fibres can achieve one thousand megabytes per second.

Universal cabling systems bring another dimension into building by which data and voice signal transmission become analogous to fluid flow in ventilation and heating systems. The band-width possibilities of fibre optics means that video conferencing, drawing graphics and other communications will be accommodated easily in a fully comprehensive fibre optic transmission system. The light pipe is another exciting advancement which means that sunlight or daylight can be channelled into virtually any area of a building.

It is envisaged that most superstructures will become component assemblies. Cast insitu concrete is still a versatile material and will be developed to compete in terms of cost and speed of erection with structural steel and precast concrete. Traditional craft skills may well be largely replaced by skills in fixing techniques. Increasingly mechanisation will alleviate on site skills shortages by most of the work being done in factories capable of responding economically to the variability of demand for building.

The scope for participation by the client in the design process is already a reality. With the aid of large visual displays, which may occupy whole walls in designers offices, clients will be able to play with alternative strategies and study different layouts of rooms for their new buildings and see realistic representations of its appearance and environmental quality using information technology techniques. Having made a choice they will be able to be advised almost immediately about the performance, cost and completion date of the selected design. Client requirements in the form of outline designs, building performance, standards, costs and times are likely then to be transmitted electronically from the local computer aided design system, which may be anywhere in the world, to the production office of a multinational construction company, which in turn can make the detailed production plan.

Innovative technology requires the ability to plan for the short, medium and long term future. Croome (1991) describes evidence concerning short termism. Investment in British research requires a return which is almost three times that of an equivalent Japanese programme. The average required rates of return over the period 1977 - 88 showed payoffs of 7.6% for Japan, 14.3% for Germany, 15.6% for USA but a surprising 24.8% for the UK. Requirements for high rates of return on capital preclude many investment opportunities and stifle growth. Dividend yields of 3.5 - 5% in the UK and the USA compare with a world average of about 2.5%. There seems to be a fundamental conflict between the short-term perceptions of financial institutions in the UK and the USA and the need for society as a whole to design and plan for posterity. Long term vision is not restricted in Japan and most of Western Europe as it is in the UK.

For too long the words building construction engineering and architecture have moved uncomfortably together and yet distinctions between aesthetics, form and function are arbitrary to say the least. Human thought and life need the stimulus of proactive and reactive forces to give them creative movement. Innovative technology can be used not only to achieve technical and economic performance, but also to contribution towards the sensitivity and the emotional effects of the built environment, besides meeting social needs.

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