

# Information Technology Foresight: The Future Application of the World Wide Web in Construction

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## Abstract

Information technology (IT) is fundamentally changing global construction business. The Internet, and more specifically the World Wide Web (WWW) will be key to this change. Forecasting technological change is notoriously difficult. This is becoming further exacerbated by the increasingly evident cycles of over-hype and disillusionment that new technologies and management paradigms face.

Science policy research has developed innovative forecasting methods to deal with such a problem. Key within these is the use of scenarios to describe the integrative effects of developments in parallel technologies and their socio-economic context.

This paper contains a detailed scenario of the way the WWW may be used in global construction in the year 2001. Analysis of the scenario causes key questions to be asked regarding the impact of technology development in construction. These questions are in need of urgent, serious consideration by: governments, senior construction executives, educators, students, researchers, recruiters, and new entrants to the industry.

The answers to these questions will help shape a key component of the research and innovation agenda for construction for what is left of this millennium.

**Keywords:** Technology Foresight, Construction IT, Internet, World Wide Web.

## Introduction

Information technology (IT) is in the process of fundamentally changing the construction industry world-wide. Numerous studies have pointed to the way that IT will impact upon construction and many countries are setting strategic plans to guide these fast moving developments (Department of Environment, 1995). A large number of major construction organisations are also looking to the way that IT can fundamentally change their businesses in the future. The current plans of Shimizu in Japan, Skanska in Sweden, YIT in Finland



and Laing and Alfred McAlpine in UK have recently been documented (Construct IT, 1997a) and a recent study has also documented examples of recent strategic IT exploitation by major construction firms (Construct IT, 1997b). Construction has traditionally been less strategic in its use of IT than other sectors (Betts, 1992).

All of these plans will be substantially affected by two major current trends in the IT world. One is the ability of all businesses and other organisations to deal with the impending millennium date change problem (Construct IT, 1997c). This simple technical issue is becoming a major business problem and will be the largest IT project that any construction organisation will have had to manage whilst being the only one with an immovable deadline. The second is the explosion in the Internet.

Both of these issues are being largely ignored at present by governments and companies in construction. The end of the next four years (1997-2001) will see a dramatically different IT world in construction than exists today. Our normal research practice of developing our views of the future incrementally from our current position are wholly inappropriate to our times.

This paper takes a different approach. Taking the issue of the World Wide Web, this paper attempts to explore the impact the technology will have on the sector by adopting the approach of technology foresight. This has become a common technique of science policy and corporate strategic planning that is beginning to be used in construction. The UK government, for instance, has recently concluded a major cross-sectoral technology foresight exercise which included a construction specific sectoral study (Office of Science and Technology, 1995).

Earlier attempts to speculate on the implications of IT in construction as technology foresight exercises have been made by a number of researchers (Froese and Waugh, 1991; Construction IT Forum, 1995; and Oliver and Betts, 1996).

### **Technology Forecasting**

The development of technologies must be planned strategically. In this way it is like the development of businesses. Planning for technology requires the following key assumptions to be made explicit (Bhalla, 1987).

- Technology is an integral part of business and its planning
- Key technologies require at least a 8 to 15 year time frame to develop, the time horizon of technology planning is significantly longer than that of business, Benton, (1973).
- Technology development goes through multiple stages, each requiring different skills and talents
- Technology builds on prior technology and science builds on prior science
- Technology forecasting is a viable concept
- The behaviour traits of technologists are different from those of businessmen.

Technology forecasts can be in the form of short, medium or long-term exercises. Short-term forecasts of usually a year or less, might typically deal with a single technology. Medium-term forecasts might cover a 2-10 year period as the key technologies are already known. An accurate and reliable view of this timeframe requires forecasts of rate of use

and adoption. Long-term forecasts cover 10-20 years which is a time horizon long enough for new technologies to emerge.

Technology forecasting methods assist in the following:

- Projecting rates of technology substitution
- Assisting in the management of technical and Research and Development programs
- Evaluating the present value of technology
- Identifying and evaluating new products and processes
- Analysing the value of new technologies to the organisation.
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### Technology Development

Historically it has been assumed that when the performance of a technology is plotted against time it takes the form of an 'S' curve. Initially the performance increases slowly, partly due to its lax management. In the first part of the middle range the technology is better understood and applied and the performance increases more rapidly, controlled by sales-oriented management. As the technology reaches its most well-developed stage, controlled management of the technology takes over. Then as the technology matures, performance increase tapers off and management takes on a resource-oriented, or planning role.

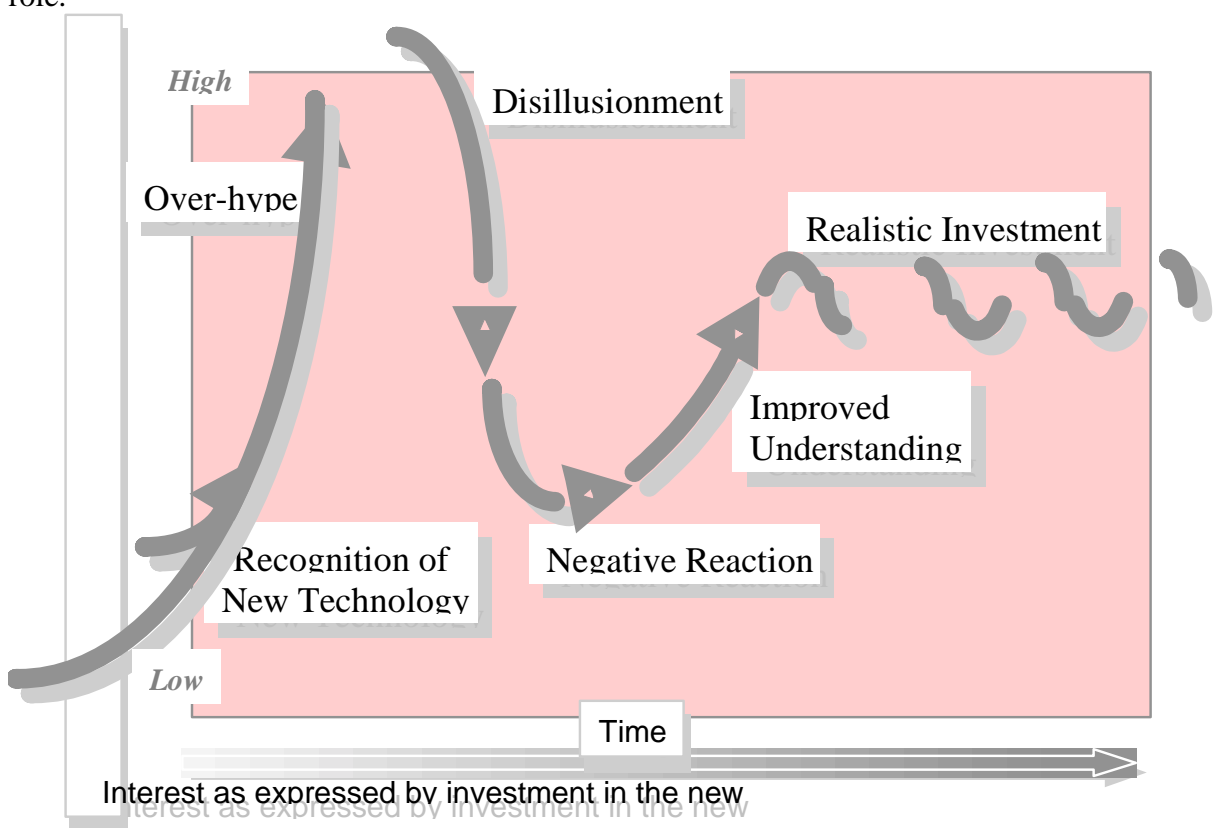


Fig. 1. The Reaction of Industry and Research to New Technological Innovation  
(Source: Brandon and Betts, Construct IT 1997c)

With regard to new technologies and the place of research and innovation, current thinking is that a more sophisticated pattern of technology development applies.

Brandon and Betts (Construct IT 1997a) advocate a more wildly fluctuating pattern of interest by industry in new technology as depicted in Fig. 1. The danger with this pattern is that the link between industry and research is subject to a failure for research and industry interest to coincide. Brandon has argued the importance of this view with regard to Expert Systems (Brandon, 1991). The implications of this to the way that construction is currently viewing the World Wide Web are key. The research community, IT industry and businesses generally have become consumed with the Web's future impact. Construction organisations are generally sceptical of the Web and some still restrict access to it to their staff. It is, as yet, unproven as a serious business technology in construction in the eyes of construction companies. We need some way of illustrating what a realistic expectation might be of the way the web will impact construction processes to assist companies to plan for its use strategically.

### **Technology Forecasting Methods**

There are many widely used technology forecasting methods. These can be classed into four major categories.

1. Surveillance
2. Projective
3. Normative
4. Integrative

Surveillance methods involve the search and evaluation of information. They are based on two basic observations.

- ♦ Most successful innovations go through similar stages of developments.
- ♦ There is a large time scale between each stage of development.

Projective techniques are based on the concept that the past is an indication of the future. It assumes that as long as socio-economic forces of the past do not change significantly, past patterns of change will continue in the future.

Normative Techniques are based on the assumption that future technology developments will be driven by socio-economic needs. Therefore if one can identify the future needs of society one can forecast the technological needs of the future.

Integrative techniques: The first three categories of technology forecasting methodologies involve the projection of developments in a single technology or a small group of technologies. It is obvious that technical developments take place in an interactive environment, where a development in one technology can trigger or accelerate advance in other technologies. Thus forecasts about the future must not only take other technical and non-technical developments into account, but must also specify these relationships. The development of the web is a perfect example of an interactive environment. The technology of the web is old and simple. Its current dynamism comes from the way it is linking with other types of IT and the social and economic forces engineering its expansion.

## **Integrative Forecasting Techniques**

There are three types of integrative techniques:

1. Cross-Impact Analysis
2. Mathematical Models
3. Scenarios

Cross-impact analysis addresses influences on future trends explicitly by mathematical formulae. By cross-impacting the probability of a trend happening with another the likelihood of a compounded probability of a trend occurring can be discovered. This process can continue cross-impacting many factors. Mathematical models can consider many more factors than might otherwise be possible.

Of all the integrative techniques the most applicable to this paper's framework is that of Scenarios. This method examines and presents the interaction between projections of a number of technical and non-technical factors to combine them into an integrated description of the future. Since a scenario paints a multifaceted portrait of the future, it allows more consideration of "real world" situations and adds both breadth and depth to decisions about future operations. Moreover because of its "story orientation", it often allows the organisation to consider alternative futures in a serious but non-threatening manner.

The key to successful technology forecasting involves an appreciation of the holistic environment in which technology operates and consists of social, political, economic, environmental, ecological, technological and competitive forces.

Porter's Competitive Advantage of Nations, (1990) also recommends the corporate use of scenarios because they:

- 1) allow a firm to move away from dangerous single point forecasts of the future in instances when the future cannot be predicted.
- 2) encourage managers to make their assumptions explicit. He also recommends the use of **industry scenarios** rather than just a single business forecast.

We therefore seek in this paper to apply scenario-building as a technology-forecasting technique. In doing so we hope to assist construction companies in their strategic planning for technology development. In particular, development related to the future use of the WWW in construction.

## **The World Wide Web**

In January 1993 there were only 50 known Web Servers in existence (Surfas and Chandler 1996); now we are increasingly seeing **http://www.** as the strange start of a new form of address somewhere in many organisation's information messages. In a Business Review Weekly cover story Andy Grove, the CEO of Intel Corporation, was cited as stating that by the end of the decade, consumers will spend more time in front of a PC than watching television (Plunkett 1996). Grove sees the Internet as clearly emerging as the new mass

media. Governments are investing heavily in web service offerings and the major banks see electronic service provision through the net as the way of the future. This begs the question: How will the web technology affect the construction industry? A further interesting question that needs to be addressed is, given widespread access and use of the www, how can the construction industry adapt to maximise its potential value?

In 1997 the Construction Industry's use of the web is very limited. Anecdotal evidence suggests that many construction professionals can not imagine how the web could affect their working lives and conditions. To assist in reaching the step of imagining preferred futures it is necessary to develop a scenario that can be examined, analysed and explored. In this way, research can be undertaken using speculation, vision building and analysis. It is intended that this paper starts the process by providing some guidance as to where the web may be leading us in the near future and how we can use the web intelligently. A detailed scenario is presented to indicate how it may be used in the year 2001. It illustrates how the WWW could be used in monitoring and progress review of projects.

### **Scenario**

Sonya hated wasting time. With a full time job managing the construction of a billion dollar retail complex and managing to raise two young children, even with child care facilities and home help, she was left with little free time. She had, like many, thought that the crazy time-drought of the 90's would change with the turn of a new century. For many it didn't improve, though things changed around the margins. One positive change had been significant advances in the use of information technology.

One huge waste of time in the past had been project control meetings. The idea was fine - monitoring plans to control time, cost, resources and quality. The trouble was that the meetings took up to three hours to complete, much of their purpose was flawed given that on her project over 50 people would have needed to attend. The main functions of such meetings had been to inform all of current progress, expose and discuss looming problems, address specific problems, and get the team to gain a shared understanding of the project's management direction. Generally in the past these meetings had been a boring, tedious and time wasting shambles; however well managed.

Enter the information management technologies of the new millennium, well actually much of it was available in the late 90's, but few made use of it. In the second half of the 90's video conferencing was starting to take off with a very small number of companies. The idea was that instead of spending a lot of money ( a renewable resource) and a lot more of key employees time (a NON-REWABLE resource), key team members could be linked by video conference also linked to shared software. This allowed them to save travel time and cost, solve problems on-site through the site team setting up a video link through which all views of the problem could be investigated on-site. Not only could the trouble shooters solve the immediate problem, but all pertinent documentation and data bases could be updated on the spot. Various options affecting time could be investigated using the project planning system. Cost options could be tested against the budget. All this could be undertaken on-line as part of the video conference. By the time the year 2000 loomed large, this was undertaken on the net using very inexpensive software and hardware.

This was a great change from the complete breakdown that was threatening the company just two years earlier. The millennium date change problem had placed this, and many other corporate systems, under great threat. The response with some of the old functional systems had been to recode. With project planning, recognising its mission-critical nature for the future, a bolder response was made. A new, fully web-based, system with newly designed, year-2000 compliance had turned a problem into an opportunity from which the company's projects were now benefiting.

With problem solving addressed in this way another major anachronistic function of project control meetings was review of progress so that all key project team members could be aware of current progress. This was seen, at the end of the 90's as a prime area of information for placing on the net. On more and more projects, intranet sites were being established with live links to contract project summary information with links to detailed levels of information accessible through password control.

Typically the project time section of a project control document would indicate the agreed time program by milestones which had graphical representations to assist understanding. A barchart would be provided and such milestones as 'frame complete' would have a rendering of the total frame as an image that could be clicked on. In this way the plan came alive for many who could not visualise a barchart form of planning communication. As the project progressed, a live link of video images was provided from key points on the building. Cameras were permanently in place to monitor the work activities. This helped Sonya to quickly review what was going on without having to do a site walk each day. She could merely check the video images from her portable computer wherever she was, whenever she wanted. The down side of this was that she was drawn to check out progress far more often than she used to when it meant walking around the site. So her saved time was less real than she would admit. The cameras clicked their images real-time and regularly updated the internet site so you were actually more up to date at your computer than you would be walking around the site. The net also gave access (through password control) to the daily supervisors diary reports and of course all this was automatically archived and catalogued so that if you needed to you could do key word searches to rapidly search the information bank. This proved amazingly useful when negotiating claims for additional time due to unavoidable delays and it provided a handy tool for defusing potentially hostile exchanges between client's representative and construction team. Cost and time control information was provided on the net in a similar fashion so that progress information was available to all authorised personnel at 24 hour notice 7 days a week.

The remaining function of project control meetings was the team gaining a shared direction forward to complete the project within constraints set out under the project objectives and mission, the project charter. This took the form of a more social occasion, a project bulletin net page accessed more personal information about the project. With more companies using the net it was possible to link each project stake holder's home page to the bulletin so that you could quickly find out who was involved with the project, gain access to their email address, automatic dialling to their phone extension, fax and other form of communication. In this way quick communication with an individual was possible. The personal home pages of team members provided valuable information that each individual chose to make public, this meant that if you were attending a social function you could 'swat up' on people you might meet and avoid forgetting who they were or important aspects of their personality. Sonya had been able to bookmark key events to remind her of

birthdays she should remember and other important personal events. The result of this situation was that the project control meetings were informal social parties where loyalties were affected for good or bad. Some cynics had intimated that this trend was just another form of manipulation and disneyfication of a serious management function. Opinions varied.

When Sonya drove her children to the crèche one day, she pondered on the project control meetings of old in the late 80s and early to mid 90's, and wondered how much change lay in store for the next decade. While the current way of handling project control communications had many advantages it placed a huge pressure on people to be so information technology literate. The three R's were so passé by comparison, it was a shame, and besides fountain pens cost more than computers these days!

### **Questions Raised**

In studying and analysing the case above some questions are raised. These include but are not limited to:

- Given that it takes people and their goodwill to make any change management process work, are individual employees working lives enhanced by the perceived futures?
- What is the extent of change management required for the future scenario?
- How will the brave new world described change the education and training needs of employees entering the industry implementing the technologies described?
- How can senior management today provide the vision and leadership to realise a preferred future similar to that described above?
- To what extent is current strategic management and communication management holding the industry back from taking a competitive advantage to prepare for survival in the next decade?
- If talented and intelligent young people currently making (or close to making) career choices are increasingly socially and technologically prepared for using the web in an increasingly matter-of-fact manner, will they be interested in a career in the Construction Industry if it appears backward and old-fashioned?

It is not proposed to attempt to answer these questions or many others that flow from the scenario. Rather it is intended to use this paper as a sound starting point to lead the theory building and strategic thinking about how the web, and other information technologies, can add value to the Construction Industry.

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