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PROJECT MANAGEMENT IN THE YEAR 2020

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ABSTRACT: This paper describes the results of a survey that examines speculations about how information technology will be used to support project management 20 years from now in the year 2020. The paper reports and interprets the responses received from a group of experts in the field of architecture, engineering and construction. Various perspectives of information technology and project management are considered, such as the project management environment, computing systems, application areas, and information integration.

Similar questions were asked in surveys conducted in 1991 (Froese and Waugh, 1991) in 1996 (Waugh et al. 1996). The results were interpreted separately and in comparison to each other. Based on the results of those surveys, hypothetical scenarios of a day of life of a project manager in the year 2010 and 2015 were included in the papers. Here, we continue this analysis and present a comparison to the results of previous surveys. Although highly speculative in nature, we have found this study to help focus our thinking about future directions in technology, so that we might better contribute to the developments that will shape the future of project management.

1. INTRODUCTION

In 1991, the paper "Project Management and Computers in the Year 2010" presented the result of a survey that asked experts from architecture, engineering, and construction (AEC) to speculate about the use of information technology (IT) to support project management (PM) at a time 20 years into the future. The survey asked about: the project management environment, computer hardware, integration and connectivity, programming languages and software development, user interfaces, and computer applications for project management.

In 1996, the paper "Project Management, 2015 AD" reported the results of a similar survey conducted five years later. Responses from the two surveys were compared and, based on the results and the authors' perspectives of the future, a hypothetical scenario about the daily life of a project manager in the year 2015 was also included in the paper.

These papers presented interesting and useful speculations from numerous experts about future directions in IT for PM. Now, five years later, we have conducted a similar survey to once again look for trends in the thinking about how IT will shape the future of PM for AEC.

2. THE QUESTIONNAIRE

The survey was conducted during February 2001. A full copy of the survey, along with a complete listing of responses, can be found online at <http://www.civil.ubc.ca/~tfroese/pubs/>. Forty-eight responses were received from 18 countries, with the majority of responses coming from Canada, USA, UK, and Australia. 58% of respondents were from education/research, and 29% from construction/ construction management.

3. PROJECT MANAGEMENT ENVIRONMENT

The first section of the questionnaire asked about the project management environment in the year 2020. Only 29% of respondents believe that the number, size, and type of companies involved in construction projects, as well as the relationships between them, will be essentially the same in the year 2020 as now.

Most comments centered around two main themes, as suggested by the following comments:

"More big national/global firms, more small, local specialized firms, fewer regional mid-sized firms".

"Likely to be consolidation amongst medium to larger companies. Some smaller players will be driven out of the business, but other medium to small companies will fragment. These changes will be due to demands for higher levels of technical capabilities and the ability of technically savvy workers to do well by themselves. "

Consolidation, increasing complexity and regulation, globalization, and requirements to self-finance projects were given as reasons for a trend towards larger companies. At the same time, a trend towards smaller companies was justified by increasing specialization, improved coordination technology and management skills, collaboration in alliances of networked organizations, and improved efficiency requiring fewer employees.

Most respondents said that the need to meet face-to-face and to visit the project site will be reduced through IT, with a third indicating that the reduction will be "significant". Many people reinforced the importance of meeting face-to-face and on job sites, but there was widespread confidence that various "tele-presence" technologies will reduce this need, and some envisioned a very different future:

"Meeting in virtual space including things like within a sewage flow to track problems of leakage or environmental damage. Meetings will be held INSIDE things."

A very high percentage responded that new computer technologies will have a positive impact on the market potential/competitive advantage (94%, see Figure 1) and the effectiveness in managing projects (98%).

71% of respondents feel that new computer technologies will have a positive impact on the working environment and job satisfaction:

"With hope, this industry can become somewhat fun again with the A/E's doing their job like they used to with experienced people working out the details of construction for constructability."

"The potential will be there for an improved work environment and job satisfaction but some organizations will opt to achieve other goals."

"More computers and less people do not make ideal working environment."

Almost all respondents (92%) believe that new computer technologies will have a positive impact on the quality of information

"Particularly at the management end of the project. Better transfer of information to the long term holders of the asset will assist greatly."

"Although there will be improvements, increased expectation and 'information overload' will negate any improvements"

62% of the respondents suggest that the size of project management teams will be smaller in 2020. Almost all respondents (96%) believe that the information technology will be more important for project managers in 2020 compared with today (two-thirds say much more important).

Neda Saleh finishes her lunch and walks into the cellar that makes up her office on the afternoon of March 8, 2020, which happens to be her birthday.

Neda works from Iraq as an independent specialist in certain types of construction. Currently, she is working as a member of a large project team assembled by Delta Allied Inc., with whom she has worked several times in the past. Delta Allied is a large multinational engineering and construction firm based in Singapore, which has become a world leader in the construction of large marine structures.

Neda has completed her Master of Science in Civil Engineering degree online from home. She is a widow with five kids and usually starts work at noon, which suits her schedule and seems to work well with a number of key colleagues in various time zones around the world.

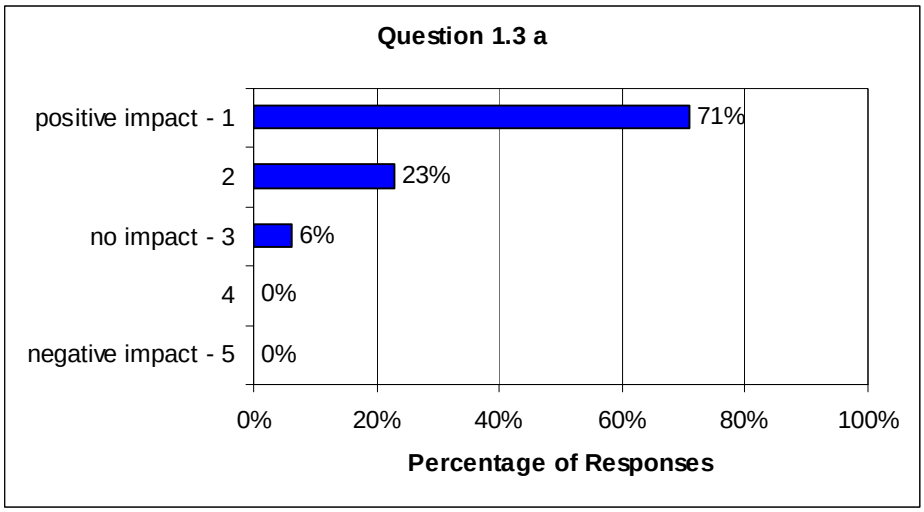

Figure 1: Impact of new computer technologies on market potential/competitive advantage

4. COMPUTING SYSTEMS

When asked about the speed, memory capacity, and relative economy of computing systems over the next 20 years, over three-quarters of respondents (77%) believe these will increase at a *faster rate of change* than the past 20 years (this is higher than in previous surveys):

> *"While the death of Moore's Law and its relatives has been predicted for some time, there have been enough reports in the media about other approaches to computing and new methods for increasing the density of computer chips that I expect that we will continue to see the same rate of growth."*
>
> *"Perhaps the question should relate to networks rather than to computers per se - it seems that networking bandwidths are now a more significant bottleneck than raw power."*

Figure 2 shows expectations about the types (form factor) of computers used in 2020.

> *"Heads up, wearable computers"*
>
> *"Biological forms as well implants and hybrids"*
>
> *"I think that there will be a definite shift away from computers that try and do too many things. The move is more likely to go toward specialist micros (palm and less) to perform transactional work and very large ones to undertake complex modelling (3d and 4d). Data is also likely to be far more distributed."*
>
> *"People may have more than one computer. 'Embedded computers' is a tricky category -- a typical car even today has dozens. The issue is how small a controller chip classifies as a 'computer' and is the number a reasonable measure of each form factor's relative importance, rather than say, the fraction of bits processed by each, etc."*

When asked how computers will be networked, respondents suggested, on average, that 47% will use some form of wide-area wireless network (eg. Satellite, cellular, etc.), 28% will use some form of local-area wireless network, 21% will use some form of wired network, and only 4% will not be networked at all.

The questionnaire asked how often various user interfaces would be used for project management tasks in 2020, on a scale of 1=always, 3=often, and 5=rarely. The responses (listed here with average responses in order of decreasing expect usage) show the expected use of direct "thought" input and output is only slightly less than paper printouts:

a) Voice input and output (1.98)
b) Graphical user interfaces (eg., windows, icons, mice or other pointing devices) (2.13)
c) Video input and output (2.38)
d) Intelligent agent mediated interfaces (electronic agents which act on high level instructions) (2.53)
e) "Virtual reality" interfaces (e.g., 3D video goggles, "fish tank" room-sized 3D interfaces, feedback from sensor gloves, etc.) (2.90)
f) Handwritten input (including sketching, gestures, etc.) (3.25)
g) Paper printouts (3.4)
h) Direct "thought" input and output (3.51)

When asked how much effort the development of new software will take in 2020 compared with the present, responses were distributed approximately evenly on the scale of significantly less to significantly more. A few respondents commented that "applications" will be easier to construct from much more complicated "application building" software. Figure 3 shows the average responses to

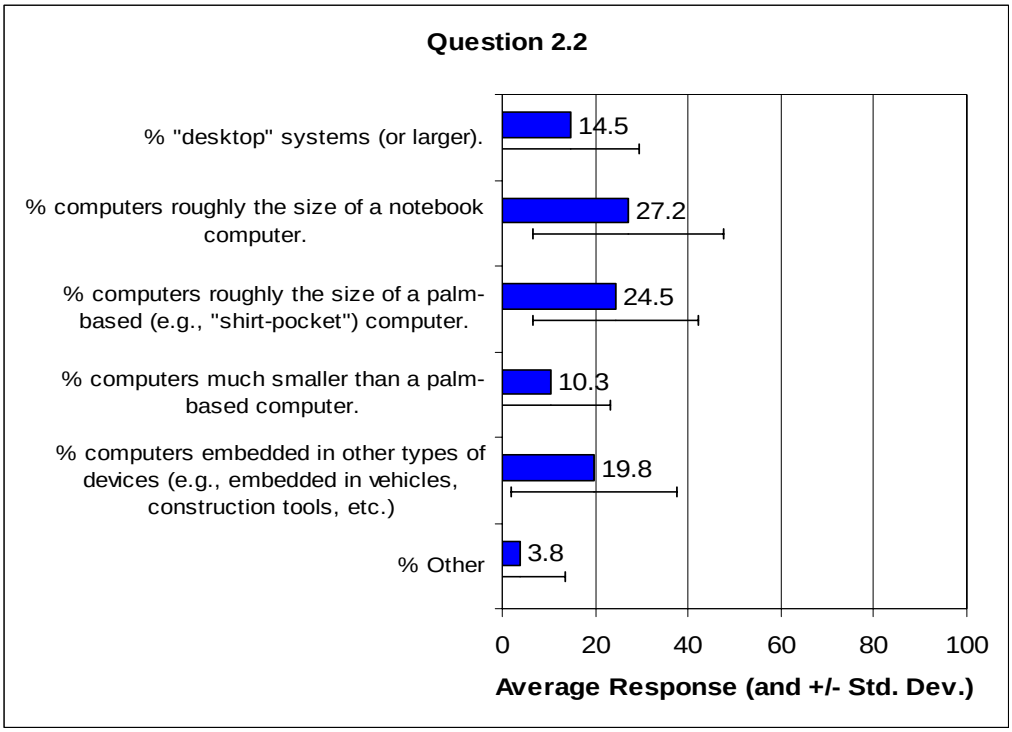

Figure 2: Types of computers used by project managers

a question about the percentage of software from different origins used by project managers.

A question asking what the most important advances in software development would be by 2020 prompted a wide variety of responses. The majority, however, related to greater integration/connectivity and greater ease-of-use (particularly through improved user interfaces):

> *"Truly integrated and universally compatible packages"*
>
> *"Ease in customizations to suit specific project needs, and multi-level integration, e.g. cost of materials used vs. cost vs. design performance vs. delivery time, etc. "*
>
> *"Hybrid computer-humans enhanced chips/software initially driven by sports and entertainment industries but spilling over into all industries"*

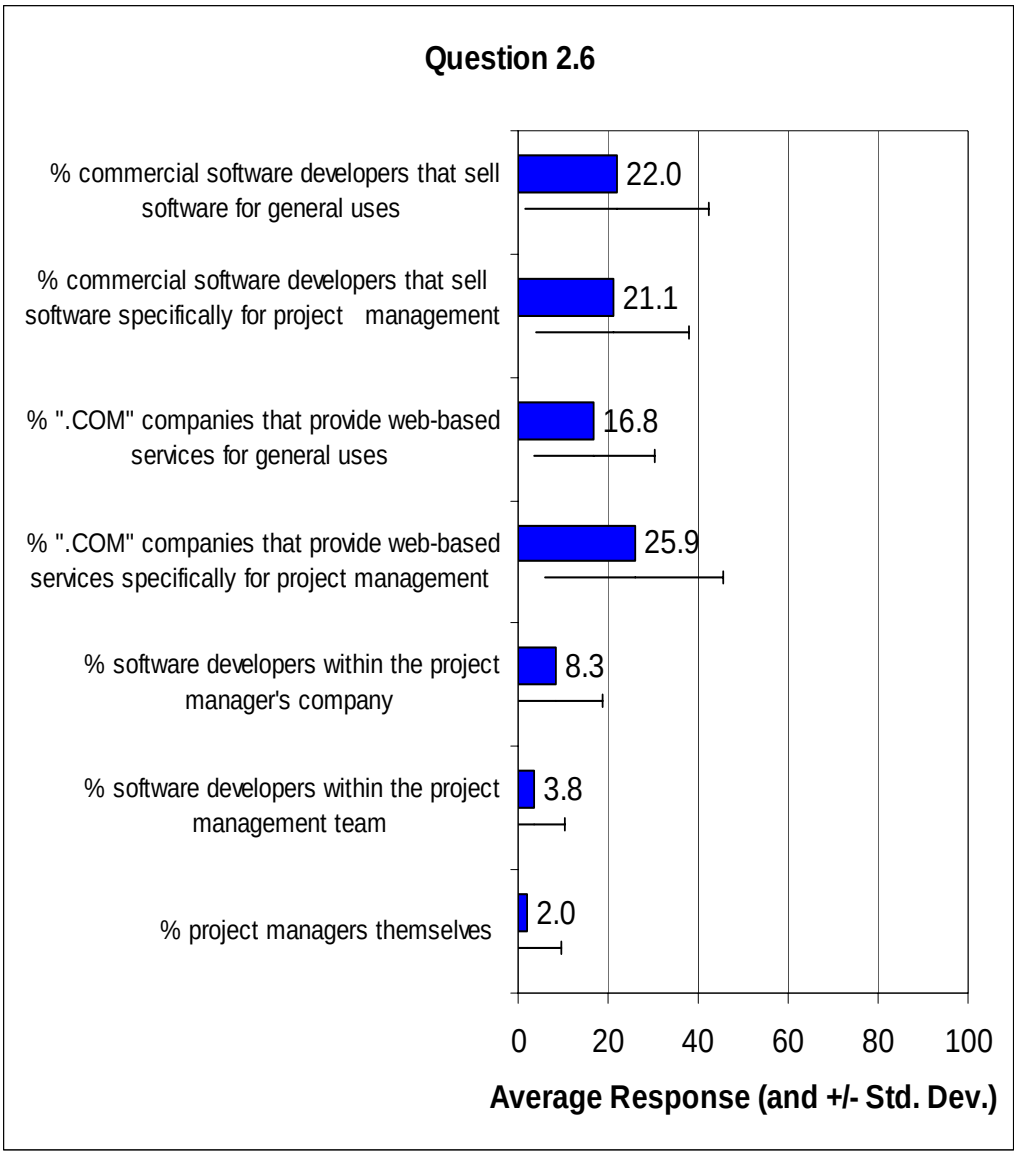

Figure 3: The origin of software used by project managers

Neda greets her workspace as she enters the room. She still has the last computer that she bought 7 years ago, but she uses it as a plant stand now. Her "computing power" is now provided by dozens of components that are built into the room itself and by numerous devices throughout the room, all of which communicate wirelessly.

Three of the walls in her workspace act as large-scale display devices. Neda generally communicates with other people through their images displayed on these surfaces. The wall displays work in conjunction with her glasses to give the images a 3D effect when called for. When not interacting with her "work walls", Neda works mainly with numerous sheets of digital paper that range from small notepad to large table-top size. She enters information and instructions to her workspace through speech, sketching, and a series of hand gestures that simulate the way that she would actually manipulate physical objects in the real world. When she wishes, she can call upon her workspace avatar, Sahar, an embodiment of her system in the image of a human, which can accept instructions, provide guidance, etc.

This morning, she is surprised when it is not Sahar that answers her greeting, but a group of her friends from around the world who have gathered "electronically" in her workspace for a surprise birthday party. Neda enjoys the opportunity to catch up with some of her friends that she hasn't spoken with for a long time. Although her friends are all speaking their own language, Neda hears the words in her own native tongue and accent.

5. APPLICATION AREAS

Table 1 shows the average responses to the question of what role various computer application areas will play in supporting project management in 2020 (on a scale of 1=fundamental, 3=useful, and 5=no role.)

Opinions about the way that applications will work with and share data are given in table 2. The table gives the percentage of respondents that expected each alternative to be typical in 2020 (respondents could choose more than one alternative):

> *"'D. all of the above.' For data exchange, I think we will have data 'wholesalers' and 'retailers'. That is, applications that can interface with different types of databases and over different operating systems to exchange data with other applications. The applications that will die out are those who cannot exchange information."*

The party soon winds down and Neda gets on with her day's work. This project is a bridge and tunnel linking Vancouver Island in Canada to the mainland. Neda is a "virtual cement mason". Her job is to construct the concrete portions of the virtual project. The virtual project drives many aspects of the project planning and design, as well as the physical work on the actual job site. It is used to help develop and refine the project design, to create project estimates, schedules, and to plan work methods. All procurement, worker recruiting, etc. is derived directly from the completed virtual project model. Neda specializes in marine construction, and she is one of the world's leading virtual builders of underwater concrete structures. Because of the work environment, most of the underwater concrete work will be built by construction robots, which are controlled in a large part using Neda's virtual project.

6. INFORMATION AND INTEGRATION

There are a variety of audiences and mechanisms that may drive the evolution of data standards. Respondents were asked how common various data standards would be in 2020. Average responses ranged from 1.7 to 2.7 on a scale of 1=very common, 3=often used, and 5=rarely used. The standards (with the average responses) are listed in order of expected use:

a) General purpose inter-industry standards for data sharing (e.g., HTML, SGML, XML) (1.68)
b) Construction industry-wide standards for related information allowing data sharing between any systems used by any project participant (e.g., ISO-STEP, IAI-IFCs) (1.91)
c) Intelligent software agents that automatically perform the necessary translation when exchanging information (2.26)
d) Defacto or proprietary industry standards allowing certain programs to exchange data (e.g., .DXF, .WKS) (2.48)
e) Project wide standards allowing all participants to share data (2.51)
f) Company-wide standards allowing all applications used by a company to share data (2.72)

Table 1: Average responses for the importance of various applications areas in 2020

Application Area	Average
Project scheduling	1.40
CAD, 3D models, visualization, and GIS to support construction	1.46
Project estimating	1.46
Project team communication and collaboration	1.48
Project procurement and bidding	1.60
Project performance monitoring and control	1.65
General business application areas (e.g. word processing)	1.69
Economic and risk analysis	1.72
Planning and design of construction operations	1.79
Coordinating construction operations	1.83
Cost/schedule/productivity analysis	1.83
Planning, controlling, and advising, for quality, safety, and environmental	2.02
Field automation and robotics	2.48
Advisor systems for construction methods	2.48
Legal advice systems	2.79

Table 2: Expectations about the way that applications will work with and share data in 2020

"Web/server" based systems that users access through generic "browser" type interfaces	69%
Applications that operate on bodies of information that they don't 'own' such as project databases	48%
Applications with the ability to exchange all forms of data with other applications on demand	48%
Programs that are not stand-alone applications, but perform a specific function within an overall integrated system	42%
Systems that automatically search the 'net' for the needed applications and data	40%
Applications that are similar, but with more standardized and widely accepted ways of exchanging information	35%
Applications that are essentially the same	6%
Other	4%

Comments from respondents include the following:

"Ubiquity is too expensive (lack of ability to collaborate) without common standards"

"Computer communication and interaction will replicate and mirror the human interactions"

In several other questions relating to information and integration, respondents indicated the following:

- Multi-purpose project databases or "data models" of construction projects (e.g., IAI Industry Foundation Class models) that are shared among all main project participants will play an important role in 2020.
- In 2020, specialty 'information management' organizations will be important for the construction industry. (e.g., specializing in locating, generating, organizing, storing and exchanging information used by design and construction companies. These may be like current DOT.COM's, or may be other forms of organizations.)
- Companies participating in construction projects will need to spend more effort on information management issues than they do today (almost half of respondents said that much more effort would be required, although 30 percent said that it would be about the same, or less).

  "They will spend about the same amount of effort but achieve greater results and productivity."
- Typical design codes (e.g. the National Building Code of Canada) will be distributed in an executable form, somewhat like grammar checkers in today's word processors (according to 83% of respondents).

Neda's role in the project is to model the construction of the structures that have already been designed. She does this in a way that, to a large extent, follows the way that workers used to work with the concrete in the old days. She can only use materials and equipment that have already been "delivered" to the virtual project, so she first must arrange for the procurement of the resources she needs. She can then apply the work crews (labour and equipment) to carry out any task within their capabilities, provided any necessary preconditions have been met. Because unexpected events occur in the real world, she calls upon an extensive "project risks library" to simulate unexpected events, and she designs her work methods to be as flexible as possible in dealing with these risks. Once she has determined the exact sequence of work tasks that will lead to a successful completion of the virtual project, she can be quite confident that the same tasks will lead to the same results on the physical project.

As Neda carries out her virtual construction operations, the images in her workspace look very much like the physical construction site will look, and she performs her tasks in a way that closely mimics the physical actions that will be performed. The simulation software components that she uses are often provided by the manufactures of the materials and equipment that will be used on the physical project. Over recent years, this software has become much more reliable at working together seamlessly.

Like any construction project, much of her work is highly interdependent with the work of others. Neda works collaboratively with the other virtual constructors in her workspace, and her simulations interact with each of theirs. The final virtual construction is very much the result of their combined and coordinated efforts.

7. OVERALL

In the final section of the questionnaire, respondents were asked the general question, "What is the most important way that information technology will change the way project managers work by 2020?" Out of 46 responses, 65% described issues related to collaboration, communication, access to information, information sharing, interoperability, and data standards. Given the open-ended nature of the question, we consider this to be a high degree of consensus around one broad topic area.

"Enable greater collaboration between participants and coordination of the information base they need to share for a project."

"All project information will become accessible via a web browser on a common project web site, provided by an external specialist web-hosting organization"

"The barriers which currently exist to sharing information will be broken down significantly, allowing information to be freely shared between project participants and project stakeholders."

"All information and communication will be IT based. All persons will be connected and reachable. Information overflow will be the greatest problem. All benefits of IT will translate into increased time pressure. The gap between 'cans' and 'can nots' will increase."

"The integrative power of IT will increase the organizational transparency and will impact on the relationships amongst individuals and firms. Trust and collaboration will play a prominent role in project management."

"Sharing information. Possible problems with information overload!"

"Provision of immediate and accurate information; integration of design with construction; more fast-track style projects.

Communications - bringing people together 'virtually' on the real job site."

"Unlimited visual communication from everywhere accessing and changing everything"

"Fundamentally enable collaboration. Clients will DEMAND data and knowledge as part of product delivered"

There were no other clearly dominant themes, but 13% of responses related to decision-making support, and 20% addressed various other issues:

"Support for decision making at a lower level (ie everyday decisions) thus removing some risk... I'd also love to see less people killed and injured in the industry by being able to analyze the potential results of our actions before we take them"

"If things go well, the paper shuffle will be greatly reduced, allowing much more time for decision making and more hands-on management. We should also see a much better understanding of the construction process, hopefully making construction cheaper and more efficient."

"IT will probably globalize project management, allowing managers to work remotely from offices and project sites much more frequently. Project decision-making should become far more transparent to all stakeholders."

"Artificial intelligence/ visual/ knowledge based"

A final question asked "What are the most critical areas requiring the industry's attention, research, and development today in order to beneficially shape the future of computing in project management?" Of 44 responses, by far the largest number (48%) dealt with information standards and information exchange mechanisms. 11% addressed issues of education and training. Another 11% suggested the task of developing models of the overall construction processes, either to better understand and develop systems to support this process, or else to better standardize the process globally. 7% dealt with ease-of-use and reducing data entry requirements, while 5% addressed organizational issues. There were single comments and suggestions about several other topics such as automation, quality of information, and social issues.

Information Standards and Exchange:

"Product and process modeling standards."

"Increasing compatibility or standards to facilitate improved communication"

"I am optimistic to see the industry at large embracing the use of data models and standards in practice. "

"Development of comprehensive industry standard data models covering a wide range of processes. Development of open frameworks to enable collaboration/sharing between organisations at any level of IT capability."

"Establishing common information standards, eg product data modeling, so the automatic scheduling of quantities can be relied upon"

"Develop a common industry standard and specification (both product-wise and programme-wise) for the global, instead of country or city-oriented as the world is now being networked. Particularly when the ASP model of project information management are popular and more and more stakeholders of a typical project are spread around the world."

Education:

"Education for on site employees to be able to use computers and software"

"Education of the people at the workface. All the industry's intelligentsia is centered on research/academia and maybe some senior management... we need those who carry out the work, on site, to be better educated."

"Training in use of project management systems - to help change the culture of the industry to accept IT efficiencies. Simplification of use of programs to link different systems easily to enable any company to work with any other without interface problems."

"Education is going to be key to attaining many of the benefits of IT. The typical construction worker will need to become more skilled and better educated"

Modeling the Construction Process:

"Establishing a comprehensive model of the way the industry operates to serve as a platform for the development of an integrated system to exploit the potential of IT."

"Once the construction process itself has been fully mapped, new research in automation may be quite beneficial"

Organizational:

"Reshaping the organizational structure of the industry. This will need to align the incentive drives of each actor with the total optimization of life cycle "

"How organizations collaborate effectively with IT as one enabler. How this meets wider stakeholder needs including shadow stakeholders"

Other:

"The social issues that determine how the technology is shaped and whether it is used."

"Ability to benefit from developments in and for other industries"

"Integrated supply chain"

"Computer controlled automation of construction processes. It seems to be an area that is lagging behind in comparison to other industries"

"The wireless network"

8. COMPARISON WITH THE 1991 AND 1996 SURVEYS

As stated previously, similar surveys were conducted in 1991 and 1996. Ten years is a long time when it comes to IT. The time between the first and second surveys saw birth of the World Wide Web. From the second survey to the current one, we have seen the rise of DOT.COM's, XML technology, etc. Responses to the three surveys, however, have been predominantly consistent. The differences that were found were generally much less than the standard deviations of responses, and it may be inappropriate to try to interpret these as trends. Nevertheless, a few of the differences over the three surveys do seem to be suggestive of general attitudes towards IT:

- All of the surveys suggested that a company's proficiency in IT would have a positive impact on their competitive advantage, but the belief was noticeably stronger in this survey than previously.
- Although many have predicted an end to Moore's Law (including Moore himself), this year's survey showed a stronger-than-ever belief that computing speeds and economy will increase at a faster rate of change over the next 20 years then over the past 20 years.
- Compared with five years ago, this year's survey showed stronger support for the use of voice input, but weaker for the use of handwritten input, in the year 2020. This is interesting, since both voice and handwriting recognition technology have advanced significantly over this time period.
- This year's survey showed higher expectations than previous years for the use of CAD and 3-D models, project estimating and scheduling, and automation and robotics in the year 2020. Expectations were lower for various "adviser" type applications.
- In terms of data exchange in 2020, respondents had the highest expectations for general-purpose standards such as XML (greater than five years ago) and for construction-industry standards such as IFC's (similar to the previous survey). Expectations were lower for project-wide, company-wide, or proprietary de facto standards.
- Expectations for "executable" design codes in 2020, though still high at 83%, were down from the 93% five years ago.

These comparisons suggest that the already high expectations about the importance of IT have continued to increase. They also suggest increasing expectations about 3D/project modeling in industry data standards, and some softening of expectations about "intelligent" systems.

9. CONCLUSIONS

Overall, we find the results of this survey to provide fairly strong and consistent support for several important predictions about the future of IT for project management.

- Computers will, of course, be massively more powerful in 20 years, and user interfaces are likely to be significantly different from those of today.
- IT issues will become increasingly important for companies practicing project management, and IT will become fundamentally inherent in our work practices. However, these will not remove other important topics such as interpersonal skills, organizational issues, etc.
- The overriding role of IT will be to provide ready access to all information at all times, and to support much richer forms of communication and information sharing.

We believe that these speculative predictions provide some useful guidance in focusing research and development efforts toward improving the AEC industry through IT.

After she has finished work for the day, Neda's children join her for a birthday dinner. Her teenage son (who is much better at manipulating Neda's workspace than she is) presents her with a special gift. Using various old family images, he has created a new avatar that exactly resembles her late husband. He joins the party, interacting with the whole family. At times, Neda has a hard time remembering what is virtual and what is real.

10. REFERENCES

Froese, T.M., and Waugh, L.M., 1991. Project Management and Computers in the Year 2010, *Proceedings of the 1991 Annual Conference of the Canadian Society for Civil Engineering, Vancouver, BC, Canada, May 29-31*, pp. 435-444.

Waugh L. M., Froese T. M. , St. Pierre N. J., 1996 Project Management, 2015 AD, CSCE Annual Conference (Volume I); *Proceedings of the 1996 Annual Conference of the Canadian Society for Civil Engineering, Edmonton, Alberta CSCE, Montreal, Canada, 1996. Vol. 1, pp. 458-467.*