Management of Construction Information Technology

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ABSTRACT

Technology transfer is a buzz word of the 1990's; in many cases this means making research results and technical information available to construction practitioners. Large government and professional organizations own, manage and distribute tomes of information to a wide selection of clients. In the existing situation the default medium is paper; most agencies in an industry work independently of each other; and the distribution network for the information is slow and uncoordinated.

Conventional computer technology provides an inexpensive alternative to the paper medium. Compact Disk Read Only Memory is one of many technologies available to information suppliers; others include read-write optical disks, Compact Disk-Interactive and distributed networks such as Gopher or the World Wide Web. Off-the-shelf packages now enable information suppliers to produce and distribute their information using in-house resources without having to go to outside sources. Many technologies permit cooperative publishing and distribution ventures between industry-related suppliers without affecting the suppliers' document pricing. In light of these new technologies, distribution could be near instantaneous and accomplished at significantly reduced costs. In addition, many software companies are now providing turnkey services to capture, organize and distribute electronic information for the information suppliers.

This paper outlines the information technology activities of the Institute for Research in Construction -- past, present, and future. It describes the experience gained from the production of the Construction Resources compact disk by the Institute and summarizes the findings of a survey of the beta test sites using user-friendly, interactive software. The paper outlines technologies available to information suppliers including distributed networks, the Internet, and optical disk technology.

Key Words

information technology; technical information; building standards; computers

INTRODUCTION

The construction industry is information intensive. It needs accurate, reliable, and timely information, ranging from legal requirements, building

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codes and standards, through scientific and engineering research results, to manufacturers' product specifications, and including finally site-specific data about present and past construction projects.

Furthermore, the need for information is becoming more urgent and more critical. Projects are becoming more complex, and time frames for decision-making are shorter. There are many reasons for these changes, including increasingly complex projects, the debilitating cost of long term projects, and shifting demographics and client requirements. The task of managing this vast quantity and variety of information in a professional and timely manner represents a very considerable investment on the part of the construction industry around the world (Mackinder et al, 1982) . The authors believe that economies and efficiencies which can be effected in the area of information management can have a significant impact on the success and profitability of the entire industry.

The Institute for Research in Construction's (IRC) mission to serve the Canadian construction industry means that it has a strong interest in the methods needed to transfer that technology, as well as to assist put the technology into practice. IRC has been supplying technical information to the Canadian construction industry for the past 46 years, through the dissemination of research papers and practical publications, preparation of state-of-the-art Canadian building codes, and through provision of seminars, library and inquiry handling services.

The Information Technology (IT) projects currently under way at IRC represent a natural extension of these interests. These will be detailed later in the paper. The aim of the projects is to use IT to organize and integrate information of different types, formats and structures, and to distribute that information to construction practitioners.

At first glance, this ought to be a simple problem. After all, almost all information available today is produced electronically. Furthermore, many off-the-shelf IT packages are available to construction practitioners to assist their data retrieval and communication needs. These include computer-aided design (CAD) software, optical disks, electronic mail (email), the Internet, Wide Area Networks (WAN), Local Area Networks (LAN), Electronic Data Interchange (EDI), multimedia, and international information databases such as ICONDA, to name just a few.

However, these technologies can only represent partial solutions, and they create many problems of their own. They often leave users lost in a maze of communications protocols and operating systems. The information providers typically supply data in the form from which they originate; not in the form they will be used. But the fundamental problem of integrating data from many sources into a readily usable form - of providing true information, and not just data - is still left to the end-user, who can be poorly equipped to

resolve the problem.

The authors hope to stimulate thought and discussion about the potential of integrating different IT solutions for the design industry.

Construction Resources Compact Disk

IRC has been supplying electronic information to the construction industry for a relatively short time. One major effort is the Construction Resources Compact Disk-Read Only Memory (CD-ROM). It contains over 100 megabytes of technical information for designers and construction practitioners, ranging from design specifications, regulations and standards to technical information on construction practices, materials and systems (Worling et al, 1992). The goal of the Construction Resources project is to organize and integrate information of different types, formats and structures, and to distribute that electronic information to construction practitioners on CD media.

The Construction Resources CD-ROM provides reasonable access times for search and retrieval and uses a common, simple and intuitive interface. It is intended as a part of the practitioner's library; residing on a desktop computer, to be used as and when required. It is based on hypertext technology and inverted indices. The hypertext environment (Vanier, 1990) allows the design and implementation of user-friendly, intuitive software and the inverted indices permit fast keyword search; these were identified as two mandatory requirements of IT products for the construction industry.

Construction Resources Data sets

IRC Publications: Include abstracted information of over 2900 technical papers published by the IRC since 1972, as well as significant publications preceding that year.

Publications de L'IRC: Includes the french versions of the abstracted information for approximately 2000 IRC publications.

Canadian Building Digests: Include a full text collection of all CBD's published since August 1966. It contains over 350 pages of text, graphics and tables.

Building Science Insight: Includes full text of five years of the BSI seminar series. It contains over 400 pages of text, graphics and tables on topical construction technologies.

Construction Expertise: Includes expertise resources in construction research. It contains over 600 records of people, organizations and projects dealing with construction research.

Canadian Building Codes: Include full text and tables of the 1990 editions of the National Building Code of Canada, the National Fire Code of Canada and the Canadian Farm Building Code. For additional information on this

implementation of an electronic code see Vanier (1991a).

<u>Canadian Standards Association (CSA)</u>: Includes Construction Plus, a publication containing summaries of all CSA construction standards. Each of the 300 summaries outlines the scope and content, as well as a listing of requirements and test methods of the standard.

Construction Resources Beta Evaluation

The survey of the usage of the beta version of the Construction Resources will be forwarded to the 78 sites which will participate in the evaluation. The questions range from general demographic information to detailed data about user interface design and functionality. It is hoped that the survey results will confirm the original assumption that the construction industry is seeking user-friendly, yet powerful, integrated IT solutions.

Construction Information Integration

Construction Resources provides only a fraction of the design information necessary in the construction industry. Research papers, building codes, building practice notes and building digests are a small portion of the literature that should be in a designer's on-line library. National standards, construction thesauri, manufacturers' technical information, CAD libraries, and design handbooks are reference documents that could be easily included in any electronic library. This volume of information could easily reach gigabytes of on-line disk storage (one gigabyte is a thousand megabytes) and most optical media cartridges hold approximately 640 megabytes.

In addition, there is a requirement for retrieval and communication of project-related information such as specifications, CAD drawings, design changes, and project administration. This is normally maintained by the designer or by the project manager, and in many cases this is shared information among the design team.

For most designers, conventional libraries and personal experience provide the background technical information, but this is not readily accessible to the entire design community. In addition, the information is not in the form designers need because it might be too technical or not match the design problem at hand. The information is not readily accessible when needed; conventional delivery systems are too slow once the information is located (facsimile machines are a boon, but limited in scope); or the information sources might be impossible to maintain because of the sheer volumes and updating schedules of the various publications and manufacturers' catalogues. How does one catalogue and access the information needed in the construction industry, these gigabytes of loosely connected packets of information? Figure 1 demonstrates the close relationships and the overlapping of various information sources in the construction industry.
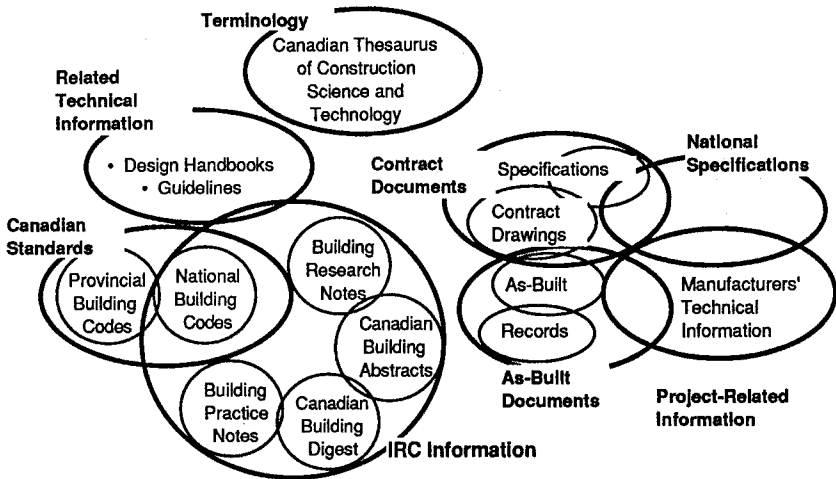
Figure 1. Relationship of Design Information

Electronic technical information provides the possibility of 'just-in-time' rather than 'just-in-case' information. However, the search and retrieval of relevant facts for a specific design task in gigabytes of data will quickly inundate the user. Methods, tools, and networks have to be in place to allow thorough, accurate, consistent and reliable browsing and searching of information.

Construction Resources is IRC's first step in automation of technical information dissemination; using the same text and pictures, but employing electronic medium. The next logical step in information automation is developing the medium to suit the information requirement. The long-term goal of information providers should be to make electronic information widely available. The mechanism proposed is to use modest desktop workstations to access this data through a combination of technologies: magnetic, optical, email, EDI and the Internet; in fact, to have a catalogued electronic library on your desk. This can not be accomplished by one person or one research team. It requires the combined activities of all information providers in the construction industry. Perhaps it is ambitious at this time to achieve full integration of all design data. The industry may have to rely on people to perform the integration, and machines to record and retrieve the data, for the time being.

New Information Technology

Optical disk technology is rapidly replacing magnetic media as the preferential storage mechanism for large files and applications. CD-ROM is

only one of a growing number of optical technologies available off-the-shelf; others include Write Once-Read Many (WORM), 21 megabyte flopticals (9 cm format), and 640 megabyte magneto-optical cartridges. Any of these technologies can store the background technical information for design professionals.

Email is replacing conventional mail, or snail mail, as a communication device. This is invaluable to members of the design team, allowing them to communicate directly to their colleagues', consultants', contractors' or manufacturers' workstations without numerous telephone calls or expensive meetings. Email also automatically provides a written, albeit electronic, record of all the discussions, decisions and project notes.

EDI will replace conventional paper for ordering material, for invoicing, and even for payment (Stokdyk, 1988). Although relatively new in the construction industry, it is already well-accepted in the automotive and aerospace industries. Design changes, site modifications, contract amendments, and extras to the contract will all be electronically moved between designer, project manager and contractors. Material availability, delivery schedules, product pricing, material equivalents will also be quickly available through EDICON or EDI for the construction industry (Sanders, 1988).

Internet describes the comprehensive web of interconnected computers around the world (Krol, 1992). Originally started as a communication tool between university researchers, it is now becoming a communication standard for everyone dealing with computers and computer networks. This can also be visualized as the backbone of communications for a design network. Email uses the Internet to exchange messages; designers transmit drawings, sketches and specifications via File Transfer Protocol-Unix (FTP); and the Internet allows use of systems such as Gopher.

Gopher was developed at the University of Minnesota and now over 600 Gopher servers exist around the world (Exploring, 1992) (Tomer, 1992) (Gopher, 1992). It uses the Internet to transport small information packets over the network and allows users to interactively log onto distant computers quickly and efficiently. For the designers it allow access to computer databases around the world. It permits the users to connect to distributed computers, to request information from selected databases, and to download information from these distant locations.

Yet another distributed information network is the World Wide Web (W3) which provides the concept of an integrated world wide information source. W3 (Berners-Lee et al, 1992) is built upon the basis of a distributed hypertext system which has access to searchable indexes. When users read a document they have two possible actions: to follow a link from a particular piece of text to a related document or part of a document; or to query a

server with a text string. Both operations result in the display of a new document, but in the case of the query the new document is a synthesized list of items pointing to other documents which match the query. The documents themselves need not be hypertext documents but can be just plain text where the links have been automatically generated. Where the document is a hypertext document the link information is marked-up within the document using the Standard Generalized Markup Language (SGML) and a defined Document Type Definition (DTD). This approach provides a possible mechanism for linking together all of the existing LAN and WAN information server systems. At the current time it has been possible to map onto the web WAIS (Wide Area Information Service), Gopher, VMS(tm)/Help, FTP archives, the "Hyper-G" system, Gnu TexInfo, unix manual pages, unix finger, and several proprietary documentation systems.

With these kinds of tools readily available to users and with the rapid extension of instantaneous electronic links around the world, global access to information becomes a reality. One of the major problems the user will face is the ability to locate the relevant information needed. IT has not brought the rapid increase in productivity promised some 10 years ago. The reality now, is that users are suffering from information overload and it is taking time to locate the information needed and to separate it from information not relevant to the task!

Information management and access tools will become the key issue for the near future. The use of structured databases, standardized query languages and free text retrieval have been used over the years. We certainly are not going to give up on them or forego the tools and techniques that the library sciences have developed over the years; but the migration of these tools to manage a global and distributed information source is our next challenge.

Where Next?

The development of a framework within which computer-based construction information/data can be organized and exchanged has become an important issue in the global competitiveness of the construction industry. IRC has a research group investigating computer-integrated construction to facilitate construction information access and processing through the development and use of a Building Product Model. This model consists of the objects, relationships, properties, functions and processes that constitute a constructed object. Using the model as a structure in which information can be organized provides a mechanism for both enhanced access and enrichment of the information.

The context and focus of this project will be the development of a building product model as the basis for the management and the provision of

enhanced access to complex textual information such as codes, standards and other technical documentation. A number of specific partners have been identified including designers, compliance enforcement agencies, consultants, technical information suppliers and other groups who use complex textual information in their decision-making.

In conjunction with partners from the standards organizations and regulatory bodies, IRC intends to develop an integrated hypertext CD-ROM information source. The intention is to provide a system which contains the primary Canadian building code documents including all the regional variants as well as all the referenced standards. In addition, IRC is investigating the possibility of including building code interpretation documents from the various enforcement agencies.

The delivery software for the building code will incorporate the MiniCode generator (Vanier, 1993) to enable the user to identify the subset of the code that applies to their building. Future developments from the MiniCode generator, for inclusion in later versions of the CD-ROM, will move in two directions. The first is a custom code generator (Vanier, 1991) which identifies the applicable code provisions that apply to a specific building rather than a generic building type. The second, is an ExperText system which combines an expert system to guide the user through the code compliance checking process and a hypertext system to provide rapid navigation through the code documents.

One of the major users of the Code documents are the building inspectors for the Province or municipality. IRC is investigating the development of a version of our hypertext code to run, in conjunction with a check-sheet, on one of the new pen-based computers. This would allow inspectors to effectively carry their offices from construction site to construction site. Using a small portable printer they would be able to print reports on site and give them immediately to the site supervisor. In a period when regulatory agencies are having to reduce the numbers of personnel, there is considerable pressure on the remaining staff to become as cost-effective and efficient as possible. Tools such as the pen-based building code offer the opportunity to use technology to support these individuals by integrating the report generation and inspection processes.

In terms of the wider information network, IRC is investigating establishing a Gopher server on the Internet to provide access to many of its documents and information sources. Although, at the present time, the major connectivity to the Internet is for educational and research communities there has been a recent shift towards the provision of gateways from local bulletin boards and other connectivity suppliers. In many locations in North America, individuals or small companies can now get an email link and FTP access to the Internet for as little as $25 per month using modems and local telephone

systems.

One other area IRC is investigating is the delivery of targeted information to individuals using email systems. Anyone who has subscribed to some of the Internet News groups will be familiar with the inundation of information, of which only a small percentage is really of interest to them. A user profile that closely identifies the characteristics of their information needs can be used to reduce this information barrage to a more reasonable trickle. Using tools such as the Classification System (Vanier, 1991) and electronic thesaurus (Vanier, 1992), an automated tagging system would classify construction related information and distribute them via the email system to subscribers who's profiles match the information.

CONCLUSIONS

Construction Resources was started as an in-house tool for researchers at IRC. Using Construction Resources as a first step in information automation, more design information will be made available electronically in the future. Sorting through stacks of drawings and specifications was a difficult task in the past, but sorting through gigabytes of information distributed around the world is impossible.

The Institute for Research in Construction is committed to technology transfer and Information Technology provides a new medium. The research and development project identified will assist construction practitioners be more productive and more effective.

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