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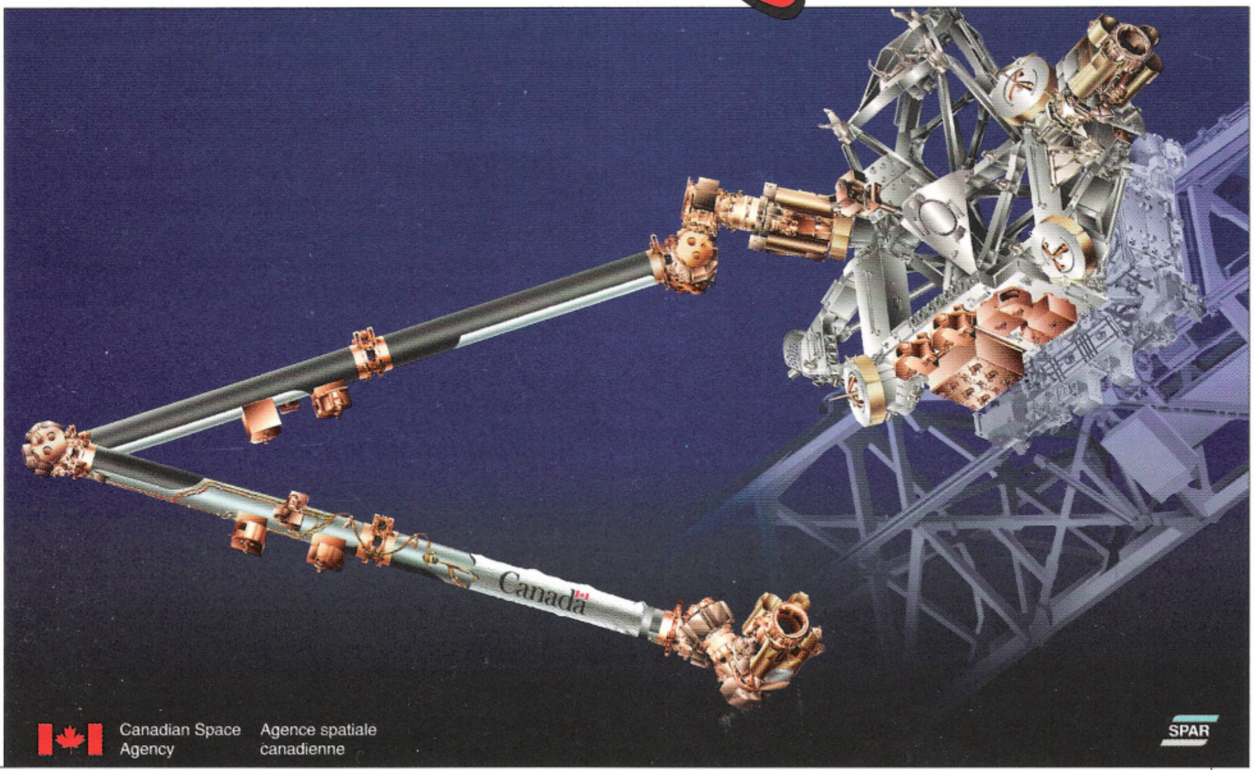
IEEE Canadian Review



- *-The Productivity Paradox of New Information Technology in Canada: an Evaluation Study.*
- *-Software Patent Engineering - Part III.*
- *-Robotics Training for Space Station: Overcoming Limitations.*
- *-Five-Year Second Degree Programs at University of Saskatchewan.*
- *-1997 Canadian Design of the Year Award.*

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IEEE Canadian Review General Information

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(ii) Canadian members of the profession and community who are non-members of IEEE;
(iii) the associated academic (i.e. universities, colleges, secondary schools), government and business communities in Canada.

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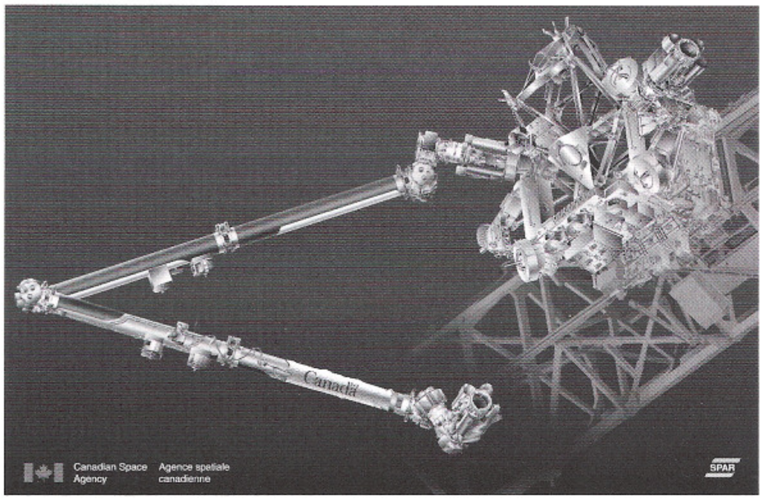
Cover picture

On the cover is an artistic representation of the Mobile Servicing System (MSS) fully assembled on the International Space Station. In this configuration, the Special Purpose Dexterous Manipulator (SPDM: 2-armed robot) is attached to the Space Station Remote Manipulator System (SS-RMS)), which can be positioned along the Space Station structure via the Mobile Remote Services Base System (MBS) and NASA-provided Mobile Transporter. (Painting by Paul Fjeld, courtesy of Canadian Space Agency).



CONTENTS / *SOMMAIRE*

The Productivity Paradox of New Information Technology in Canada: an Evaluation Study

by Dr. Hadj Benyahia, Abdelgafour Belayachi
Université du Québec à Montréal.

This study shows that almost half of the national employment and production in Canada are due to the vast information technology (IT) sector. However, it is shown that, even if the labour productivity in this sector has been superior to that of the national productivity, its annual growth rate has not only decreased in the sector as a whole, but more particularly in one of its components the new information technology (N.I.T.) group, comprising the computer and telecommunications industries. One observes therefore, as in the U.S.A., a productivity paradox of the N.I.T. Explanatory factors for this paradox are finally identified.

Cette étude montre que près de la moitié de l'emploi national et la production nationale au Canada sont dues au vaste secteur de l'information. Par contre, l'étude montre que, même si la productivité du travail dans ce secteur a été supérieure à celle de la productivité nationale, le taux annuel de croissance de la productivité a non seulement diminué dans le secteur de l'information mais aussi dans une de ses composantes, le groupe des nouvelles technologies de l'information (N.T.I.) qui regroupe les industries de l'informatique et des télécommunications. On observe donc, comme aux Etats-Unis, un paradoxe de la productivité des N.T.I.. Les facteurs explicatifs de ce paradoxe sont ensuite identifiés.

Issues

Many studies have been devoted recently to this subject in the USA and they all lead to two conclusions:

There is no statistically significant relationship between the growth of information technology investment in American enterprises and the growth of their profitability and their productivity (Strassmann, 1994).

This massive investment estimated at more than $1000 billions made during the last 15 years has not been followed by significant productivity gains in the whole American economy as productivity growth remained low, about 2% annually, and even negative for certain years according to Loveman (Harvard, 1992), Berndt (M.I.T., 1990) and Keyes (1995).

The objective of this study is to show, for the first time, whether this productivity paradox of new information technology (N.I.T.) exists also in Canada which is included in the group of the ten first countries having invested the most in N.I.T. (O.E.C.D., 1996).

Components of the Information Sector

The information sector may be compared to an iceberg (Figure 1), the visible portion of which represents the New Information Technology (N.I.T.) sector, which groups together computer and telecommunication industries (components, hardware and software). These industries only contribute 1 to 2% to national employment and Gross Domestic Product (G.D.P.), but they are of strategic importance as they serve as the engine for the vast information sector. The hidden area of the iceberg represents not only the traditional information industries existing prior to the electronic revolution of the early 1980's (e.g. telephone, radio and television, editing, financial services, education, public administration industries, etc.), but also those industries which utilize informational products and services for the production of non-informational goods and services (e.g. automobile and aeronautical industries).

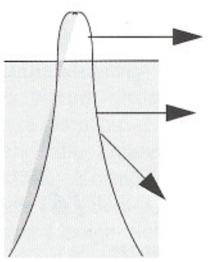


Figure 1: Information sector compared to an iceberg

Research Methodology

To evaluate the productivity of Canadian information sector, three research steps are needed:

1) Identify in the Canadian occupational classification (Statistics Canada no 12-605) only the informational occupations which correspond to the following OECD classification,
2) From Statistics Canada data banks (catalogue no 93-332), identify the number of informational employees and their average annual salary which corresponds to their contribution to national wealth (Gross Domestic Product),
3) Divide the production of the information sector by the number of its employees to obtain their labour productivity.

Table 1. OECD Classification of Information Occupations

Information Producers	Information Processors	Information Distributors	Information infrastructure Occupations
-Scientific and technical -Market search and coordination specialists -Information gatherers -Consultative services	-Administrative and management -Process control and supervisory -Clerical and related	-Educators -Communication specialists	-Information machineworkers -Postal and telecommunication

Results of the Research

Table 2 shows that the information sector is on the threshold of becoming the largest employment sector in Canada by providing almost 50%

Table 2:
Contribution of Informational Employment to National Employment in Canada

	1980	1985	1990	1980-85	1985-90
Information Sector					
- Employment	5.500.533	6.043.555	7.112.615	--	--
- Annual Growth (%)	--	--	--	1,9	3,3
- % of total economy	44,8	46,2	47,7	--	--
N.I.T. Sector					
- Employment	85.823	91.790	131.995	--	--
- Annual growth (%)	--	--	--	1,5	7,5
- % of total economy	0,7	0,7	0,9	--	--
Total Economy					
- Employment	12.273.255	13.074.460	14.905.395	--	--
- Annual Growth (%)	--	--	--	1,3	2,6

Table 3:
Contribution of Information Production to National Production in Canada

	1980	1985	1990	1980-85	1985-90
Information Sector					
Total employment income (constant $ million)	115.271	137.921	173.751		
Average employment income (constant $)	20.956	22.821	24.428	--	--
% of national employment income	49,1	52,3	55,2	--	--
Production (constant $ million)	180.111	215.501	271.485		
Production as % of G.D.P.	47,1	49,2	53,7	--	--
- Annual growth (%)	--	--	--	3,6	4,7
N.I.T. Sector					
Total information income (constant $ million)	1.263	1.665	2.930	--	--
Average information income (constant $)	25.002	28.426	31.649		
Production (constant $ million)	5.049	6.459	10.331	--	--
Production as % of G.D.P.	1,3	1,4	2,0		
Annual Growth (%) of production	--	--	--	5,0	9,8
Total Economy					
Total employment income (constant $ million)	234.827	263.554	314.436		
Average Employment income (constant $)	19.133	20.157	21.095		
G.D.P. (constant $ million)	381.992	438.450	504.787		
Annual Growth (%) of G.D.P.	--	--	--	2,7	2,8

Note: Use of constant dollars eliminates the artificial overstatement of revenues due to inflation. For this purpose the G.D.P. price index has been utilized, with 1986 as the base year=100; 1985=97,7; 1980=73 and 1990=118,5.

of jobs in 1990. One can also see that the employment growth rate in this sector is greater than that of the total economy. As a result, informational employment is less vulnerable to periods of economic recession (e.g. 1980-85) than national employment.

The N.I.T. Sector is a new sector that has only begun to develop since the early 1980's with the emergence of the micro-electronic revolution. As a consequence, its employment accounted for less than 1% of national employment in 1980-85 with a modest annual growth of 1,5% during this takeoff period. Conversely, since 1985, the N.I.T. Sector has undergone a rapid employment growth: twice that of the information sector and nearly 3 times that of national employment. We can therefore say that the N.I.T. Sector has its own dynamics of employment since, although its direct jobs are relatively few, this sector is of strategic importance for the creation of indirect jobs in the information sector by providing it with new products and services.

Table 3 reveals the following observations: The information sector has became the largest sector of economic activity in Canada since 1990, accounting for more than half (53,7%) of Canadian production. The annual growth of production in this sector (3,6% and 4,7%) was greater than that of the whole economy (2,7% and 2,8%). This growth is even more significant when we consider the N.I.T. sector (5,0% and 9,8%) even if its contribution to national wealth (G.D.P.) was only 1,3% and 2%.

Table 4:
Evolution of Productivity in the Information Sector and in the Whole Canadian Economy

	Productivity (constant $)			Annual Growth (%)	
	1980	1985	1990	1980-85	1985-90
Information Sector	32.774	35.658	38.169	1,7	1,3
Information Producers	39.475	46.548	49.090	3,3	1,1
Information Processors	29.635	31.554	34.107	1,2	1,5
Information distributors	40.212	39.360	41.341	-0,4	0,9
Information Infrastructure occupations	27.276	30.102	30.587	1,9	0,3
N.I.T. Sector	59.207	70.294	3,5	2,1	
Total Economy	31.124	33.534	33.866	1,5	0,2

Table 4 shows, as expected, that productivity in the information sector exceeds that of the total economy in the 1980's. Productivity in the N.I.T. Sector, in particular, has been approximately double that of the information sector and of the whole economy. It then follows that the information sector contributes to the improvement of productivity gains in the entire economy. Moreover, the N.I.T. sector is identifiable as a high productivity sector.

Lastly, and chiefly, Table 4 includes an important result which confirms the productivity paradox observed in the United States (Dué, 1994). Indeed, even if the value of productivity in the Canadian information sector increased in the 1980's (32.774$to 38.169$), its annual growth rate has diminished from 1,7% in 1980-85 to 1,3% in 1985-90.

This decline in productivity growth is also seen in the N.I.T. sector, from 3,5% to 2,1%. This paradox is justified if one considers that it is precisely in the decade of the 80's that American and Canadian enterprises made massive investment in information technology to improve the productivity of their employees (OECD, 1996).

The major causes of the Productivity Paradox

According to Dué (1994) and Keyes (1995), the main factors which explain this paradox are:

The learning curve:
According to this explanation, we are still in a transition period, as the micro-electronic revolution is only 15 years old, and therefore relatively new. Several historical examples from the industrial revolution (e.g. electricity, tool machinery and telephone) demonstrate that there is a considerable delay (20 to 60 years) between the introduction of a new technology and its mass distribution resulting in substantial productivity gains.

The overinvestment in capital:
Professor Berndt of M.I.T. (1990) notes that the growth of high-technology capital stock has been twice as fast as the growth of the other components of capital stock in the American manufacturing industries. Moreover, he demonstrates that each dollar invested in N.I.T. yields benefits of only 80 cents. He then concludes that there is overinvestment in capital. As productivity is a ratio between production and resources used (capital and labour), an overinvestment in resource (capital) decreases productivity growth.

Difference between technical and Organizational Productivity:
Technology by itself is a necessary but not sufficient condition to achieve productivity gains. Organizational changes must accompany technological advances. For example, the advent of the paper-less office, expected in the 1980's, was not realized and even a contrary effect has resulted, because of mismanagement (lack of strategic planning and lack of project management).

Difference between competitive advantage systems and comparative advantage systems:
Much of the investment in information technology is made by enterprises not to improve productivity gains but to be more competitive (gains in sales and market share). By contrast, comparative advantage systems are based on a decrease of operation costs which leads to productivity gains (e.g. safety program or crew scheduling program in the airline industry).

Problems in measuring productivity of information technology:
According to R. Dué (1994), 95% of U.S. companies have no metrics program to measure the productivity of their investment in information technology. Moreover, cost-benefit analyses of information systems often take into account only short-term tangible benefits although a large part of these benefits are intangible and only come in the long term because of the learning curve. Finally, it must be noted that 80% of investment in information technology is realized in the service sector whose productivity cannot be accurately measured.

References

Dué, R. "The Productivity Paradox". Information Systems Management. Winter, 1993,pp. 69-71.

Dué, R. "The Productivity Paradox Revisited". Information Systems Management. Winter, 1994, pp.74-76.

Keyes, J. "Solving the Productivity Paradox". McGraw Hill Inc., New-York, 1995.

Loveman, G. "Cash drain, no gain", Computerworld, 25 (47), 1992, pp. 69-72.

OECD. "Perspectives of Information Technology".Paris-France, 1996.

Statistics Canada. Ottawa.

Catalogue No 93-116 and 93-332. "Employment Income by Occupation "

Catalogue N 31-203. "Manufacturing Industries of Canada".

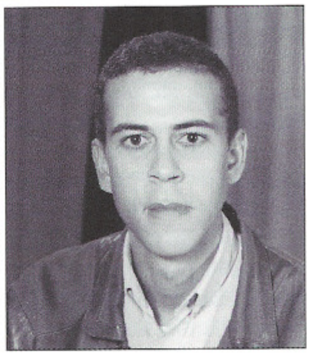
Catalogue No 56-001. "Communications".

Catalogue No 56-205. "Cable Television".

Catalogue No 63-222. "Software Development and Computer Service Industry

About the authors

HADJ BENYAHIA is a Professor in the Computer Science Department of the University of Quebec at Montreal since 1983. He has a "Doctorat d'Etat" from the University of Paris. He was formerly a project manager and consultant at Gamma Institute specializing in evaluation of new information technologies. His present research fields are economics of computers, software engineering economics and office automation. He has published many books, reports and articles in these research areas.



ABDELGAFOUR BELAYACHI was formerly a programmer-analyst in an international project of Bell-Canada. He has received his M.Sc degree in Business Computing in 1996 at the University of Quebec at Montreal. He is now completing another Master 's degree in Management Sciences at the H.E.C. school of Montreal.

Errata

Authors of the article in the *IEEE Canadian Review*, Issue #27, Summer 1997, "Control of Non-Ferrous Electric Arc Furnaces" by Benoit Boulet, Vit Vaculik and Geoff Wong, wish to make the following corrections:

Errata #1: Sixth to tenth line of first paragraph, section on "Three-Electrode Furnaces" (on page 4 of the Review, second column):
- replace:
"In star configuration, a neutral is typically connected to hearth ground straps which make contact with the molten metal and provide a ground for the electrodes. On the other hand, in a delta configuration, the matte bath essentially becomes a floating neutral".
- with:
"The star (or wye) configuration is typically used at low power for furnace startups and idling. Regular medium to high power furnace operation uses a delta configuration".

Errata #2: Second line of second paragraph, section on "Electrode Slippage", (on page 6 of the Review, second column)"
- replace:
"Graphite electrodes"
with:
"prebaked carbon electrodes".

IEEE Canada News

The New Brunswick Section recognized the contribution of NBTel to the IEEE through the presentation of an award acknowledging support through technical activities and the payment of employee dues. The award was presented on November 21, 1997 (see Photo) at the NBTel Vibe* Laboratory in Saint-John by L. "Pete" Morley, Vice Chairman of the Technical Activities Board, IEEE and was received by Peter Jollymore, Vice President, Planning and Marketing of NBTel.

* "Vibe" is the Extreme Speed Internet and Multimedia Service.

Photo: (from left to right)

Brent Petersen, Professor at UNB, Colloquia Speaker,
Dave Kemp, 1998-99 President, IEEE Canada,
Peter Jollymore, Vice President, Planning and Marketing at NBTel,
L. "Pete" Morley, 1997 Vice President - Technical Activities,
Bruce Colpitts, New Brunswick Section Chairman,
P. Wes Spencer, 1997 Colloquia Steering Committee Chair.

Consultants Corner

As a service to members, the *IEEE Canadian Review* is commencing a new page for Consultants to be able to advertise their services by publishing their business cards.

For 1998, the cost will be 300 dollars per issue or 750 dollars for a series of three issues of the Review.

Please contact the Editorial staff for further information regarding publishing dates and rules.

Software Patent Engineering - Part III

by James Anglehart, Swabey Ogilvy Renault
Patrick E. Kierans, Ogilvy Renault

This is the third in a series of three papers on patent protection for software. These papers are based on a lecture on software patents given during the IEEE Montréal/Patent and Trademark Institute of Canada's two-day seminar on patents held in Montréal in October 1996 and 1997 in french (and to be repeated on February 9 and 10, 1998 in English). This paper explores how a patent legally protects a software invention and is beneficial to a technology business. The first two articles in this series published in the last two issues of this Review provide important background to this article.

Cet article sur la brevetabilité d'un logiciel est le dernier d'une série de trois basée sur une conférence prononcée lors du cours offert à Montréal en octobre 1996 et 1997 par la section de Montréal de IEEE et l'Institut canadien de brevets et marques. Ce cours de deux jours s' est offert de nouveau en anglais les 9 et 10 février 1998. Cet article a pour but d'exposer de quelle façon légale un brevet peut effectivement protéger un logiciel et avantager une société de technologie de pointe. Les deux premiers articles de cette série publiés dans les deux derniers numéros de cette revue pourront nous servir de données de base à ce sujet

Introduction

Intellectual property has an important role in developing and managing technology businesses. Whether a business is a start-up or well established industry player, having a patent portfolio is a key asset and can be a core part of the corporate growth strategy. A world leader in "software patent engineering" is IBM (Figure 1), who sets a good example for how to make use of patents to prosper. Although the number of US patents granted to IBM declined from 1996 to 1997, IBM obtained the greatest numberof US patents than any other patentee in 1997. Although Microsoft has started from modest beginnings (see Figure 2), it is rapidly expanding its patent portfolio. An objective of IBM's research and development efforts is to produce patents to which the computing industry will need to obtain a license. According to IBM (see http://www.ibm.com/ibm/licensing/), they have a portfolio of 2,500 patents in the area of software-related inventions. By granting non-exclusive licenses, IBM generates revenue, and patent licensing is a significant line-of-business for IBM. While it is IBM's policy to grant licenses "upon reasonable and non-discriminatory terms and conditions to those who respect IBM's intellectual property rights", many companies are more selective in deciding to whom a license under their patents should be granted.

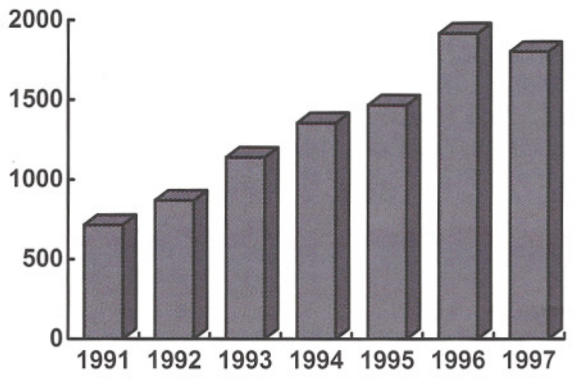


Figure 1: US Patents Granted to IBM

By entering into cross-license agreements, IBM not only generates revenue, but also gains access to technology patented by others. For example, IBM and Virage announced a broad patent cross-license agreement in October 1997 for multi-media information management technologies. In the cross-license agreement, Virage granted to IBM a license under all Virage patents, while IBM licensed its patents related to the specific technology to Virage. Such cross-licenses represent a win-win arrangement for both companies. IBM will be able to expand into the market Virage develops without legal conflict. The competition in the market can be between friendly competitors.

What is useful about the IBM example is that it is entirely scalable for small technology businesses. A single patent can be a key patent in a particular area of technology and be worth licensing or cross-licensing. Cross-licensing is a very effective way to resolve a patent infringement conflict, and having a few patents in its portfolio can save a technology business' proverbial bacon by making a cross-license feasible. In most cases, litigation is not the most rewarding means for generating revenue from a patent, while non-exclusive licenses to one's competitors is often much more profitable.

For start-up and expanding technology businesses, having a patent portfolio reassures investors and often makes financing easier or less costly. Patents give companies "something to show for" new product research and development. A small technology company with a well developed and well managed intellectual property portfolio stands to be worth more during a merger or acquisition.

Intellectual Property Management

While most technology companies have a Vice President of Technology or a Technology Manager, only a small portion have Intellectual Property Managers. Intellectual property is something that can be managed along with technology. As innovations are made, a decision has to be made how to manage them. An innovation may result in new know-how, a patentable invention, an obvious, unpatentable, but useful improvement, or a trade-secret. This intellectual property becomes an asset of the company for as long as ownership is maintained. If an innovation is kept a secret then it is a trade-secret owned by the company for as long as it is only known to the company. If the innovation is published or disclosed to the public without filing a patent application, then the company loses ownership of any exclusive rights. The object of intellectual property management is to transform innovations into assets with efficiency.

Simple documentation of innovations is an essential tool in intellectual property management. An innovation record document need only be a two-page document to provide a basic record for management purposes.

The record sets out what problem has been solved and by what means. A sketch can be added to the innovation record. One possible innovation management decision flow chart is shown in Figure 3. A single manager or an intellectual property management committee reviews innovation records to decide on how to manage each innovation. Only three conclusions are possible: 1) keep secret, 2) patent, and 3) publish defensively.

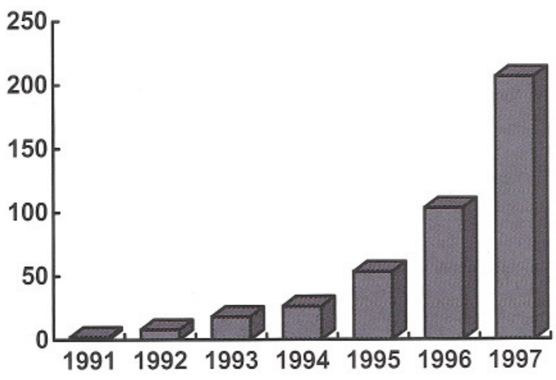


Figure 2: US Patents Granted to Microsoft

Of course, only those innovations which cannot be easily reverse engineered from the publicly sold product, or easily independently discovered, should be handled as a trade-secret. To manage a trade-secret, it is important to make sure that those people privy to the trade-secret are aware of the secret status of the information. All precautions must be taken to keep the innovation secret, otherwise the value is lost. The decision to patent an innovation often follows a

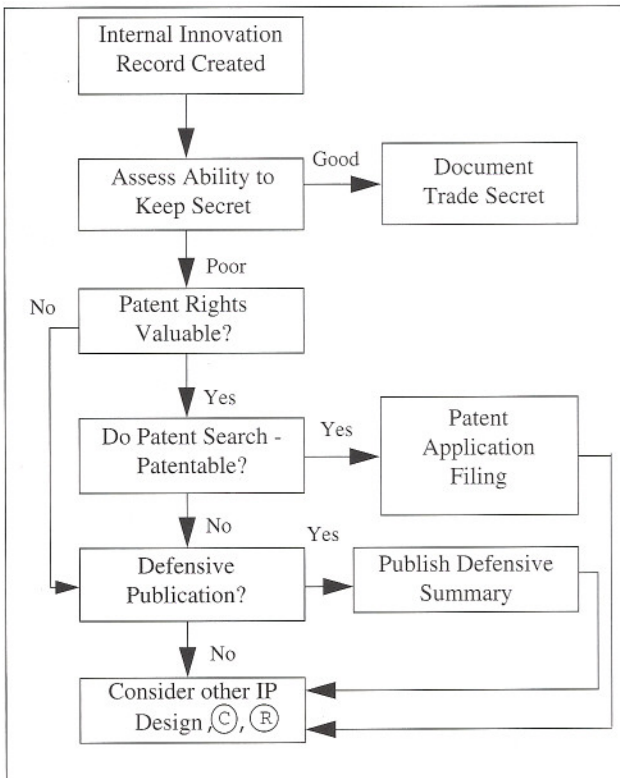


Figure 3: Managing Innovations

patent search and patentability opinion prepared by a patent agent. A defensive publication is useful to let the public know who is the originator of the minor or obvious improvement, and also to create a publication that will prevent a competitor from obtaining a narrow patent on the improvement.

In IBM's case, defensive publications are largely found in its "Technical Disclosure Bulletin" which is distributed to libraries and to the major patent offices. For Canadian small businesses, the authors propose as the most effective way to publish a defensive technical disclosure the filing of a Canadian patent application with a request for immediate publication. As a published Canadian patent application, the technical disclosure will be made available in patent offices in Canada and in other countries. Once filed and published, the patent application is then abandoned. A patent agent can handle the preparation and filing of such a technical disclosure at a fraction of the cost of a complete patent application.

Designing Around Competitors' Patents

Before spending time and money on designing new products, it is worthwhile to check out what has already been patented in the same area. A patent agent can conduct a good search of patents relating to a product feature or a process for about $1000 to $3000, depending on the detail of the search and analysis of the results. Such a search can guide the new product engineering design team's effort in two important ways. First, seeing what has already been tried can inspire a new design which is more efficient, costs less, uses a better material or different hardware. Many good ideas can be found in the patent literature. A majority of patents are for inventive product designs that are never commercialized and are never published in the literature. Secondly, such a patent search may indicate what technology not to use if patent infringement is to be avoided.

If a patent "appears" to cover something that the design team wants to include in the new product, it is usually possible to "design around" the patent. Designing around a valid patent is a joint effort between a patent agent and the design team who study the new proposed product functional requirements and the related patent to suggest a workable design that steers clear of the patent. Although not every patent can be circumvented, a patent is usually never as broad as it appears, and often only a particular detail or feature is what is being protected by the patent. So, what exactly does a patent protect?

The Scope of a Patent

A patent is a legal document which is printed and issued by the government. The purpose of a patent document is to make public the fact that the patent owner has exclusive rights for an invention and to define precisely the limits or scope of these rights.

A patent typically contains five sections. The front page sets out bibliographic information including a title, filing date, date of grant, the name of the inventor and the name of the person or company to whom the patent is granted. An abstract describing the invention may be found on a separate page or printed on the first page in the case of U.S. and European patents. The substantive portion of a patent includes a disclosure, drawings and a set of claims. The disclosure often includes a description of the field of the invention, an exposé of the problem which the invention addresses, prior technology and its limitations and a detailed description of the invention often with reference to a set of drawings. A patent ends with a set of claims which set out, for legal purposes, the scope of the exclusive rights granted to the patent owner.

The disclosure and drawings are, of course, helpful in understanding the invention, however, the exclusive rights are defined only by the claims. It is not unusual that the disclosure and drawings describe a broad solution to a technical problem whereas the claims grant exclusive rights to only a portion of that solution.

A patent agent will initially draft the abstract, disclosure, drawings and a set of claims for filing in the Patent Office. A Patent Office Examiner will then examine the application and research the prior art in that area of technology. The Examiner will then request that the claims be limited or narrowed to a specific aspect of the overall invention that has not already been described in a pre-existing patent or other form of prior publication or knowledge. There is, of course, some negotiation during the prosecution of the patent application it being in the interest of the inventor to obtain claims with as broad a scope as possible.

In summary, when reading a patent to determine the scope of the exclusive rights granted, it is only the claims which are relevant. The disclosure and drawings may be helpful in understanding the technology but they are irrelevant when it comes to determining whether or not a patent owner's exclusive rights are trespassed upon or, in legal terms, infringed. The claims of a patent are infringed when someone makes use of the invention as described in the claims.

What a Patent Can Claim

According to the Patent Act, a patent may claim exclusive rights in an invention, and an invention is defined as "any new and useful art, process, machine, manufacture or composition of matter, or any new and useful improvement in any art, process, machine, manufacture or composition of matter". In general, almost anything that has a commercial or industrial utility and is both new and innovative, can be patented. Depending on the nature of the invention, the claims may be for the method or process, the apparatus or machine, the product or manufacture, or the material, chemical compound, microorganism, or composition of matter.

In the case of software, a patent can claim a commercially useful process or method of processing data, or a new data processing machine (system or apparatus) resulting from the new software. Examples of software inventions are found in the first two articles in this series. For computer scientists, the concept that a new computer program creates a new finite state machine is well accepted. In the United States, a disk or recording medium on which software is recorded, that when loaded and run on a computer yields a patentable invention, can be claimed as a "manufacture" or software product (this has been U.S. Patent Office policy since 1996). Canada appears also to accept "disk claims", but other countries do not presently accept disk claims according to policy.

Interpreting Claims and Deciding Infringement

The disclosure and drawings are generally written in terms readily understood by a technical person. The language and construction of claims is something altogether different. A body of law, rules and practice has evolved over the years which dictate the construction and language of claims. Knowledge of claim drafting and interpretation is a skill acquired and developed by a patent agent. Some patents contain few claims. Others, particularly in the chemical arts, may contain hundreds of claims. The interpretation of claims often requires a complex factual and legal analysis.

Claim analysis will become necessary to determine whether a particular activity comes within the exclusive rights granted to the patent owner. A competitor may wish to determine whether proposed activity infringes a claim and thus exposes it to legal liability and a potential order from a court restraining it from continuing that activity. A patent owner, on the other hand, may wish to interpret a claim in the light of the activity of a competitor in order to determine whether to take action against that competitor to enforce the patent owner's exclusive rights.

In general, if all of the elements or steps defined in a patent claim are found in a product or process not authorized by the patentee, there is infringement of the claim. If the product or process also contains more elements or steps than found in the claim, there is still infringement. If the product or process omits one or more elements or steps, there may be no infringement. When there is a perfect match between the definition in a claim and an infringing product or process, we say the claim "reads" on the product or process, and that there is "literal" infringement.

It is significant that in most countries it is not necessary that a claim in a patent be infringed in each and every one of its minute aspects. The courts in many countries have developed a doctrine referred to as "taking the substance" of an invention as claimed. In other words, infringement may not be avoided by "changing one screw". Here again, the skill and experience of the patent agent, familiar with the decisions of the courts is well placed to give a reasoned opinion as to what a court may view as infringing the substance of a claim even in the face of some differences between the competitor's activity and the language of the claim.

Only Valid Patents Infringed

A patent claim may be considered invalid on a number of grounds, for example, a claim is invalid if it defines something that was not new or non-obvious according to patent law requirements (i.e. the Patent Office should not have allowed the claim in the first place). When considering the validity of a patent, each claim is considered separately, and this is why most patents have a large number of claims, usually between 15 to 30. Even if some claims are declared invalid, others may remain valid. Only valid claims can be infringed, and thus if all claims in a patent can be shown to be invalid, then the patent is not infringed. It only takes infringement of a single valid claim to infringe a patent and thus to be held liable for damages.

A patent agent can conduct validity searches and prepare validity opinions on patents. Patent agents are also skilled at conducting searches to identify existing patents which might be infringed by the proposed activity of a company. Avoiding infringement makes it less likely that a company will have to defend an expensive patent lawsuit and lose its investment in the proposed activity.

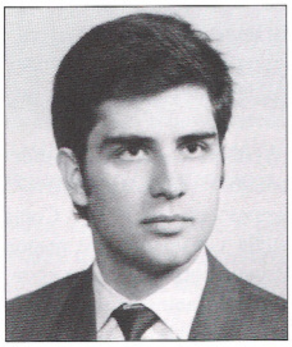
Lawsuits for infringement of patent rights are handled by lawyers with experience in this area. A patent owner who successfully sues an infringer will be entitled to obtain an order of the court restraining that infringer from continuing the infringement with whatever financial consequences that may have for the infringer. In addition, the patent owner may recover the profits it would have derived from the sales lost to the infringer. In certain circumstances, the court may permit the patent owner to recover the infringer's profits; in some cases this is an attractive form of financial compensation.

Typically, a defendant sued for infringing a patent will respond with an allegation that it does not infringe and that the patent is invalid for some reason or other. It is for this reason that before instituting a lawsuit, a patent owner should be satisfied the patent is likely to be found by the court to be valid and infringed.

Conclusion

For technology companies, proper knowledge and innovation management will lead to the creation of valuable Intellectual Property assets. Part of such management involves considering patent protection for innovations, including patent protection for software innovations. The authors hope that this series of three articles on software patent protection has provided some useful insights into innovation management and the patent process. Since only a limited amount of information can be packed into this series, proper advice can only be obtained through consultation with a registered patent agent and/or an intellectual property lawyer. If there are other topics regarding innovation management you would like to see covered in future articles, please let us know.

About the authors



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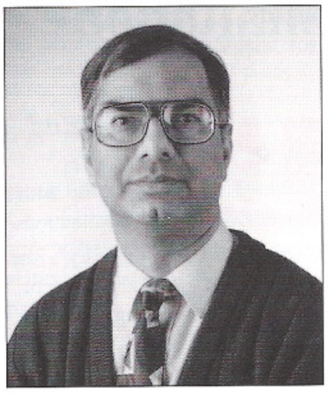
A few words from the Managing Editor



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This edition of the Review brings to an end a series of three articles on Patent protection for software. This series has been well received by the membership considering the numerous calls for previous issues. A course organised by the IEEE Montreal section on the same topic is currently being run and there is a good chance that this course will be offered elsewhere in Canada. The administrator of this course (Maurice Huneault) was recently awarded a Regional Activities Board award (see page 17 in this issue for further details); my personal congratulations go to Maurice for his dedication.

I also wish to congratulate my predecessor, Paul Freedman, on being awarded a prestigious Regional Activities Board award for services to the Review (see page 17 in this issue for further details). Paul continues to be extremely active and is currently an Associate Editor of the Review. The recognition is very well deserved.

I welcome the nomination of another Associate Editor from Western Canada, Terry Malkinson from Calgary (see inside cover for further details).

Changes are being implemented in the content of the Review. A new Consultant's Page (see page 7) will be created so that they will have a low-cost, nation-wide facility to advertise their business cards and services offered. The other new items will be: Letters from members, Members in the news, Book reviews,......etc. I will be pleased to entertain any suggestions from members.

This issue also marks the end of the two-year support offered by my employer (IREQ - Hydro-Quebec) in the preparation of the IEEE Canadian Review. I thank the administrators at IREQ (formerly Alain Vallee and presently Michel Tetreault) for their patience and encouragement. Downsizing changes in the organisation, and in my employment have occured (I have recently moved to another department within IREQ) which has meant that I will lose the excellent secretarial help provided by Eileen Dornier. I take this opportunity to thank her for many hours of assistance in the preparation of previous issues of the Review.

Since I will not have the support of secretarial help from the next issue onwards, the next issue of the Review will have a changed organisational structure. I hope that I will have the means and your support to continue to augment and improve the Review; at present, it is not totally obvious, but hopefully things will clarify as we go into 1998. So far the ice storm seems to have slowed things down quite a lot, hence the lateness of this issue.

Robotics Training for Space Station: Overcoming Limitations

by: Elaine P. Greenberg,
Canadian Space Agency, Montréal, Québec

In 1999, the first element of a complex robotic system, called the Mobile Servicing System (MSS), will be launched into orbit and installed on the International Space Station (ISS) - a human-tended research and development facility which will reside in low earth orbit. As a partner in the ISS program, the Canadian Space Agency (CSA) is responsible for training the international astronauts who will live and work on board the Space Station to operate the MSS for Station assembly and maintenance. This paper represents the first in a series of articles about CSA's MSS training program, and focuses on the design and implementation of facilities and courseware to respond to numerous training challenges

Le système d'entretien mobile (SEM), premier élément d'un système robotique complexe, s'envolera vers la nouvelle station spatiale internationale en 1999. Comme partenaire du programme, l'Agence spatiale canadienne est responsable de la formation des astronautes internationaux qui vont y vivre et opérer le SEM aux fins d'assemblage des composantes de la station spatiale et de son entretien. On présente dans cet article, le premier d'une série portant sur la formation des opérateurs du SEM, un survol de la conception et de la réalisation des éléments technologiques du programme.

Background

In keeping with its mandate to "lead the development and applications of space knowledge for the benefit of Canadians and Humanity", the Canadian Space Agency (CSA) is involved in several different space-related activities intended to advance space technology and stimulate commercial benefits within Canadian industry. The International Space Station (ISS) program is one such activity, as described by former CSA president, Dr. Roland Doré in a previous issue of the IEEE Canadian Review [1].

As a partner in the ISS program, CSA will provide a sophisticated robotic system, called the Mobile Servicing System (MSS), to assemble and maintain the Space Station in orbit (Figure 1).

The Mobile Servicing System (MSS) is being developed by Spar Aerospace Limited and its Canadian sub-contractors as the next generation of the Canadarm which presently supports Space Shuttle

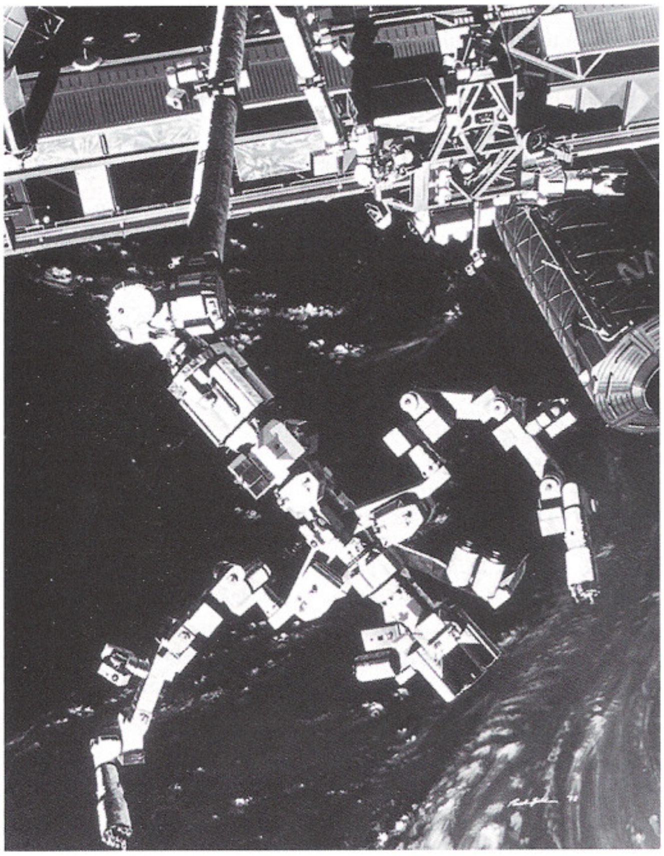

Figure 1. Two key components of the MSS are the SSRMS and MBS. In this graphic, most of the thermal blanket has been removed to expose the booms, joints, cables, and electronics bosex of the SSRMS.

flights. The MSS consists of several sub-systems and elements which include: The Mobile Servicing System (MSS) is being developed by Spar Aerospace Limited and its Canadian sub-contractors as the next generation of the Canadarm which presently supports Space Shuttle flights. The MSS consists of several sub-systems and elements which include:

- Space Station Remote Manipulator System (SSRMS) - a robotic arm which measures approximately 17 metres, has 7 degrees of freedom (DOF), and is capable of manipulating masses of up to 116,000 kg;
- Special Purpose Dexterous Manipulator (SPDM) - a 15-DOF, two-armed robot used to perform fine motor tasks;
- Mobile Remote Servicer Base System (MBS) - a mobile base which, together with the U.S.-supplied Mobile Transporter, provides mobility to the SSRMS and/or SPDM along the Space Station truss;
- Artificial Vision Unit (AVU) - a video processing tool used to assist astronauts in robotic manipulation by providing position and orientation cues;
- MSS control hardware and software.

The SSRMS is the first MSS element to be launched (presently scheduled for June 1999), and will be used to handle large payloads and manoeuvre a portable work platform, on which astronauts can be supported while working outside the Space Station. Astronauts who are located within the pressurized (or "shirtsleeve") environment of the Space Station will operate the SSRMS (and other MSS systems when launched) from a Robotic Workstation equipped with two 3-DOF hand controllers, a Portable Computer System, a display and control panel, and three video monitors. Since there will be limited "out-the-window" views, astronauts will have to rely heavily on camera views for tele-operation [2] of the MSS.

Training for MSS Operations

In addition to providing MSS hardware and software for the Space Station, CSA is also responsible for training astronauts and ground personnel in the skills, knowledge, and attitudes associated with MSS operations. Astronauts will be trained to operate the MSS to perform initial activation and check-out of the system, handling of payloads, Space Station maintenance, payload handoffs between the MSS and other robotic manipulators, and support of astronauts working outside the Space Station (also known as Extravehicular Activity [EVA]).

Although astronauts will train for 2-1/2 years to prepare for Space Station missions, they will be in Canada for only two weeks to receive MSS training. Given this short time frame, CSA has adopted a systems engineering approach to training (SEAT) [3], which ensures that the training objectives match the operational tasks to be performed. Since the focus is on job performance requirements, rather than on systems requirements, trainees will develop only those skills, knowledge, and attitudes that are directly relevant to the jobs they must perform. Using this SEAT approach, training needs are analysed; training courseware is designed and developed; courses are conducted; the training program [4] is evaluated and validated to ensure that training needs have been met both following the course and while on the job; and the results are fed back into the process in order to improve performance.

Starting with an analysis of the MSS Robotic Operator's (MRO) job tasks, CSA has determined which tasks require training by examining their difficulty, importance, and frequency, and the skills, knowledge, and attitudes required to perform the job. An analysis of the target population (i.e. astronauts who are selected as robotic operators) provides additional information regarding any gaps or deltas that may exist between a trainee's entry-level skills, knowledge, and attitudes and those required for job performance. These analyses culminate in the creation of performance objectives on which the MSS training is based, and which include the standards required for MRO qualification.

Once performance objectives are defined, the process moves into the design and development phase, during which the details of training are established and courseware is developed. It is within this phase that instructional designers select and apply specific instructional methods and media to effectively and efficiently accomplish the learning objectives.

Each instructional medium has an appropriate application depending on the nature of the training task and the individual learning styles of trainees. For example, Computer-Based Training (CBT) uses a personal computer to provide individualized instruction, in cases where trainee interaction with the material is necessary for knowledge and/or cognitive skill acquisition (e.g. understanding MSS coordinate frames, architecture diagrams, etc.). For the development of complex psychomotor skills (e.g. use of hand controllers to command the SSRMS), more powerful simulators or part-task trainers are often recommended.

These media complement the learning activities, which are sequenced in a logical flow from simple to complex tasks, in accordance with the theories of adult learning [5], in order to facilitate the integration of new information into trainees' existing cognitive framework. Through an appropriate combination of text, graphics, animation, video, and audio, multimedia courseware can convey highly detailed, technical information to trainees in an interesting and efficient manner.

To date, CSA has performed the analysis and design of training for the MRO, and has documented and recorded the results of these activities in a relational database to facilitate maintainability and traceability of training data. The Course Training Plan, which was created during the design phase, provides the primary training requirements for training systems and courseware development and is an essential document for CSA training development contracts.

Training Development Contracts

Given the challenge of training astronauts to operate a highly complex system in the short period of two weeks, CSA has maximized the use and integration of a variety of media to more efficiently and effectively conduct training. The CSA facilities in St-Hubert, Quebec will be used for MSS training, and include kinematics and dynamic simulators, virtual reality tools, models and mock-ups, and multimedia courseware.

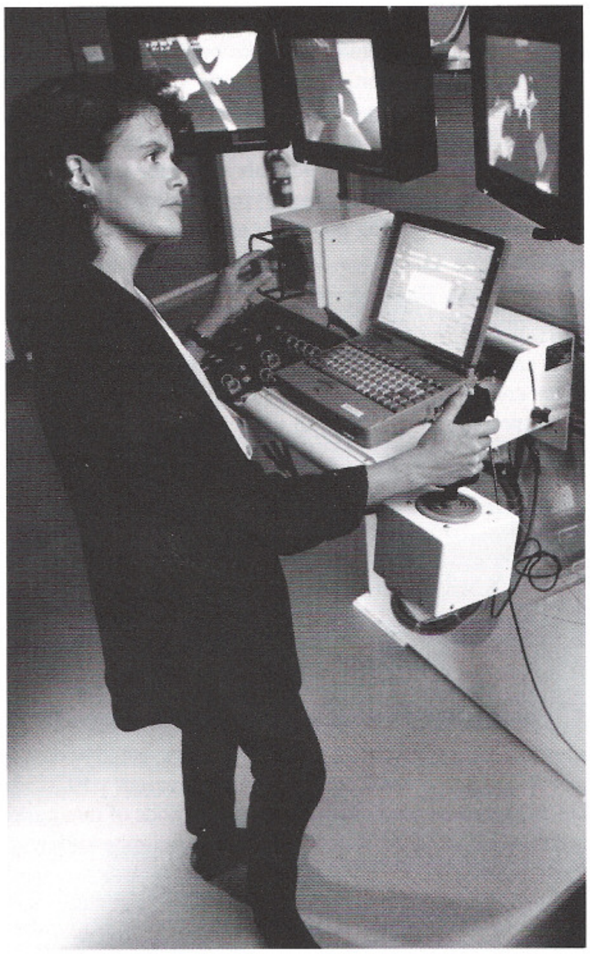

Figure 2. MSS Operations and Training Simulator (MOTS). Canadian astronaut Julie Payette operates the MSS from the MOTS Class 2 Crew Station during a training simulation.

As part of its mandate to promote Canadian industry, CSA has awarded contracts to large and small companies with relevant experience and expertise. In 1995, CAE Limited was awarded a $6.7 million contract to develop the first phase of the MSS Operations and Training Simulator (MOTS), which is designed to provide a dynamic simulation of the SSRMS, replicating the full functionality of related systems and the human-computer interface (e.g. hand controllers, display and control panel). Using a flight-equivalent (Class 2) robotic workstation, trainees will learn to operate the SSRMS (Fig. 2) under nominal and off-nominal conditions.The MOTS includes both CAE proprietary and commercial off-the shelf (COTS) software. Using COTS, CSA support contractors are developing an expert system, which will provide visual and auditory warnings to trainees to avoid operational problems (e.g. singularities and collisions), as well as tools which permit an instructor to monitor and record trainee performance during a simulation session.

CAE has worked closely with CSA personnel and support contractors to ensure that training and operations requirements are met. The next phase of MOTS development, which began in September 1997, involves the delivery of the actual RWS flight hardware (i.e. Class 1 workstation), additional MSS and Space Station models, and integration of SSRMS and MBS models.

Group instruction will take place in CSA's Multimedia Learning Centre (MMLC), which provides a high-technology "classroom" environment for instructor-led training. MMLC lessons integrate computer presentations, graphics, slides, recorded and live video (e.g. downlinked video from orbit), which are displayed on three large screens and/or individual desk-top computers connected to a Local Area Network. Instructors also have the capability to control MOTS sessions from the MMLC using a portable instructor station and a set of hand controllers. This is useful for demonstrating specific procedures, and for providing pre-briefs and de-briefs for simulation training on MOTS.

In 1996, Tecsult-Eduplus was awarded a $1.5 million contract to design and develop multimedia courseware for both MMLC group instruction and individualized instruction, in the form of CBT. This multimedia courseware, in conjunction with training sessions on MOTS, will provide astronauts with the formal training they require for qualification to operate the MSS.

Training Challenges

Ideally, training should prepare individuals for the actual conditions under which they will work. But how does one simulate zero gravity? And how can one make the sun rise and set every 92 minutes, as occurs in low earth orbit?

At the National Aeronautics and Space Administration (NASA), a swimming pool the size of a football field is used to create a neutral buoyancy environment for training EVA astronauts, but this is not zero gravity. Specialized aircraft, such as the American KC-135 or Canadian T-33, can be used to generate brief periods of microgravity by flying through parabolic curves. However, a limited amount of training can be accomplished in 30 to 60 seconds of weightlessness at a time. As a result, CSA has explored the potential of virtual reality to "fool" the brain and create the neuro-physiological perception of zero gravity [6].

Virtual reality will also be used as an aid to train astronauts to better interpret the 2-dimensional (2-D) camera views on which they must rely for the tele-operation of the MSS. Trainees will don a Head-Mounted Display (HMD) to observe MSS movements in 3-dimensions (3-D) and will have access to additional training cues, such as 3-D audio and arbitrary viewpoints (i.e. god's-eye view), in order to develop a 3-D mental model of the operational environment and an awareness of the spatial relationship between the MSS and the Space Station structure (Figure 3).

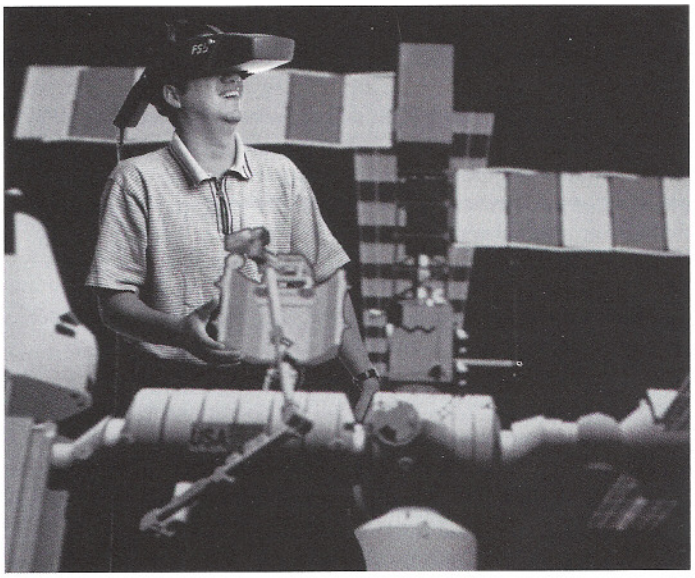

Figure 3. Photographic representation of CSA intern Régent L'Archevêque immersed in the Space Station external environment through virtual reality

As a training aid, virtual reality will be implemented to facilitate the acquisition of new skills; however, it will be gradually withdrawn from the training flow, as trainees become more proficient during MSS simulations. Ultimately, trainees will be required to demonstrate their proficiency without virtual reality and other training cues, by merely using the 2-D camera views as they will operate in orbit.

The reliance on camera views poses additional challenges as well, since the lighting conditions in space frequently change, thereby affecting the quality of the camera images. Most simulator developers strive to achieve the highest quality graphics for simulation purposes; however, this would provide an inaccurate representation of the working environment and could provide inappropriate cues to astronauts training for space operations. As a result, CAE has built special visual effects (e.g. camera blooming and out of focus effects) into MOTS, in an effort to more realistically depict the working environment of the Space Station and more effectively train astronauts for MSS tele-operations.

An additional challenge facing MSS training developers is the level of maturity of the system itself. MSS training must be conducted well in advance of the systems being launched, in order to ensure that crew members are qualified to operate them while in orbit. Given that the MSS is still under development at Spar, and the graphical-user interface for MSS operations are currently being developed by CSA and NASA, training developers must rely on subject-matter interviews and analogous robotic data to fill in missing and/or incomplete information.

To develop multimedia courseware, instructional designers at Tecsult-Eduplus have relied heavily on engineering drawings and documentation, and have worked very closely with CSA engineers and instructors to ensure the accuracy and currency of MSS technical information. These subject-matter experts have become an integral part of the courseware development team, and have provided relevant data, responded to questions, and reviewed the courseware at various stages of its development.

In addition, CSA has taken a modular approach to training design and conduct. This permits Tecsult-Eduplus to develop courseware for modules which contain more mature systems information earlier in the development cycle, and leaves the lesser known data to be incorporated later in the schedule.

The modular approach also provides customization of the MSS training program for individual trainees, in accordance with their previous experience in robotic operations and attainment of course pre-requisites. For example, astronauts who have operated the Canadarm on the Space Shuttle are already familiar with basic robotic principles and the movements of the hand controllers, and therefore may be able to skip MSS modules (or sections thereof) which address these teaching points. The modular approach, in this case, allows CSA to focus on the delta between the MSS and the Canadarm, in order to increase the efficiency of MSS training.

Visions for the Future

In response to the challenges of designing and conducting robotics training for Space Station, CSA and its contractors have applied creative solutions to meet training requirements. It is anticipated that the technology resulting from this endeavour will have spin-offs to other commercial or research projects, in accordance with CSA's mandate.

As part of their contractual agreements, CSA training contractors are required to implement a plan for commercialization of their products. The experience and expertise acquired through the development of robotics courseware and training systems, as well as the products themselves, could be applied to other markets. Training opportunities may exist with national and international industrial sectors; for example, nuclear robotics, marine robotics, and security robotics used for explosives detection and detonation.

Through partnerships with Canadian research organizations and universities (e.g. University of Calgary Computerized Sports Systems Group), CSA can help promote the advancement of training technology. Studies would be initiated by each research centre and conducted at CSA's facilities, which can serve as a testbed for research and development in a variety of different areas, including training fidelity and learning transfer, cost-effectiveness analyses, expert system development, and virtual reality training applications. CSA could then apply these results to the continuous quality improvement of training for space operations, whereas the research centres may find applications in various sectors, such as medicine, engineering, or education.

Canada's continued involvement in the International Space Station Program will result in further developments in automation and robotic technology, thereby maintaining Canada's reputation as a leader in space robotics. And the application of innovative approaches in training equipment and courseware development will enable CSA to continue to meet its training challenges.

References

[1]. Doré, R., "The Canadian Space Agency", IEEE Canadian Review, Fall 1992, pp. 6-10.

[2]. Freedman, P., "Robotics in the 1990's", IEEE Canadian Review, Winter 1993, pp. 5-8.

[3]. Logan, A.I., Greenberg, E.P., "CSA Functionally Integrated Training System: A Systems Engineering Approach to Training", 45th Annual International Astronautical Federation (IAF) Conference: Jerusalem, Israel, October 1994.

[4]. Department of National Defence, Canadian Forces Manual of Individual Training, A-P9-000-001 to A-P9-000-019, 1991.

[5]. Bloom, B.S. (Ed), Taxonomy of Educational Objectives, Handbook 1: Cognitive Domain, Longmans Green: New York, 1956.

[6]. Logan, A.I., "Training Beyond Reality", Canadian Aeronautics and Space Institute (CASI) Conference: St-Hubert, Quebec, December 1995.

About the author

ELAINE GREENBERG has worked at CSA as a training contractor since 1991. With a Masters degree in Educational Technology from Concordia University, she has extensive experience in training analysis, media development, training evaluation and validation. She has specialized in computer-based training and television production, and is presently involved in instructional design and courseware development for the MSS Training program.

The Engineering Institute of Canada (EIC) News

At the Awards Banquet of the EIC held at the National Arts Centre, Ottawa on March 3, 1997 the following awards were presented:
1. The Canadian Pacific Railway Engineering Medal to Dr. O. Malik, and
2. The John B. Stirling Medal to Dr. M.Lecours

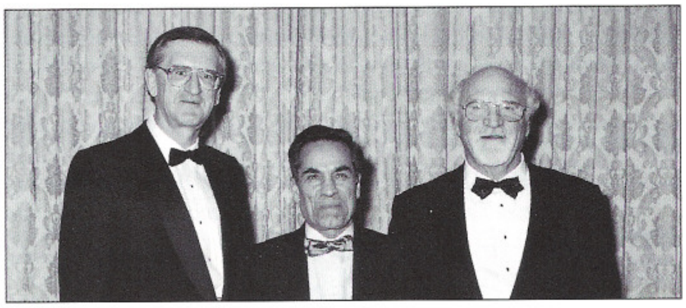

Photo 1: (from left to right) E. Rewuki (CP Rail), O. Malik and J.Seychuk (President of EIC - 1997)

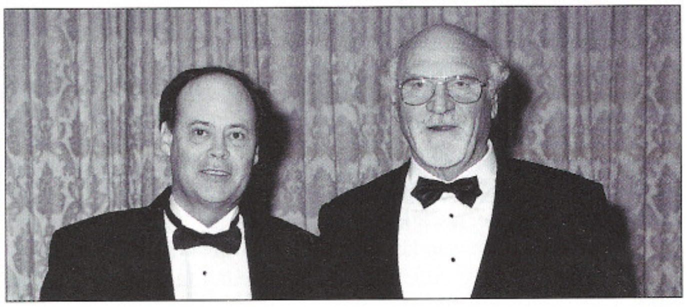

Photo 2: (from left to right) M.Lecours and J.Seychuk (President of EIC - 1997)

Five-year Second Degree programs at University of Saskatchewan

by Ram Balachandar, College of Engineering, Univ. of Saskatchewan and C.S. Vaidyanathan, IRD Inc.

Growing demand for information technology professionals in the last decade has prompted many Universities to offer second/dual degree programs in Electrical Engineering and Computer Science. Initial success of these programs encouraged many Canadian universities to offer second degree programs in multi-disciplinary areas.

A second degree is particularly attractive to graduating students who desire a solid foundation in a major study area (such as engineering) combined with a working knowledge in a second discipline such Arts, Science or Commerce. Dual degrees are a useful marketing tool for graduates seeking employment in the current engineering marketplace. Employers prefer such students for their diverse skills and adaptability.

The College of Engineering at the University of Saskatchewan provides for students to undertake programs which lead to a degree in both Engineering and Arts and Science. This program was initially launched in 1992 to provide an opportunity for students in Electrical Engineering to obtain a second degree in Computer Science awarded by the College of Arts and Science. Since then, the other departments constituting the College of Engineering have initiated several other second degree programs. Presently, students can obtain their second degree in Biochemistry, Computer Science, English, Mathematics or Physics. On successful completion of the program, students will be awarded a B. E. and a B.Sc. or a B.A. This second degree requires the completion of all the requirements of the four-year program in Engineering and 30 to 45 additional credit units in Arts and Science directly related to the second degree area. For instance, to complete a B.Sc. as a second degree, students must meet all the requirements of Program C in Arts and Science as outlined in the University Calendar. The student effectively needs to complete 90 credit units in Arts and Science. It is possible to satisfy this regulation with as few as 30 additional Arts and Science credit units not specifically included in the Engineering program. This essentially results in the additional one year of study. Optimum sequence of courses have been developed for most areas of Engineering to ensure that most students can complete the second degree program in a five or a five and one-half year time period.

In 1997, nineteen engineering students graduated with a second degree. In most instances, the second degree program has been a combination of one of the Engineering disciplines and Computer Science. As a representative example, this article will focus on the development of a second degree program as a combination of Civil Engineering and Computer Science. Proper choice and timetabling of courses for Civil Engineering students wishing to graduate with a second degree in Computer Science is illustrated in Table 1. The program has been fit into a five-year time slot on the basis of six courses being taken per term for the entire five year duration. The courses indicated by an asterisk constitute the additional courses necessary to graduate with a second degree. It should be remarked that the second degree program in Computer Science is a very heavy program, particularly if taken within the proposed five year time frame. In general, students wishing to follow the five-year regime are advised to carefully consider both their ability to cope with the demands of the program and their extracurricular activities.

The percentage of students enrolling in the second degree program has been steadily increasing. For instance, about 50% of the students wishing to pursue a degree in Electrical Engineering or Engineering Physics also opt for the second degree in Computer Science. Students interested in Humanities, Social or Natural Science have the opportunity to consider a special arrangement of studies which enable them to complete the work leading to the B. E. degree and the B.A. or B.Sc. degree in approximately five years.

Table 1: Timetable of Civil Engineering courses for second degree program in Computer Science

Term 1	Year 1	Year 2	Year 3	Year 4	Year 5
	CHEM 111	CE 211	CE 315	CE 313	CE 416
	CMPT 122	CE 212	CS 316	CE314	CE 418
	ENG 115	CMPT 250*	CE 317	CE 415	CE 419
	EP 124	CMPT 260*	CMPT 215*	CE 417	CE 420
	GE 163	GE 210	MATH 266*	CMPT 393*	CMPT ELEC.*
	MATH 123*	MATH 223*	ELECTIVE	GE 449	ELECTIVE

Term 2	Year 1	Year 2	Year 3	Year 4	Year 5
	CMPT 123*	GE 213	BUSLW 111	CE 322	CE Option
	EP 125	CE 227	CE 316	CE 324	CE Option
	EP 128	CMPT 250*	CMPT 220*	CE 325	CE Option
	EP 155	ECON 111	GE 348	GE 390	ELECTIVE
	GEO E 118	GE 225	ME 325	ELECTIVE	ELECTIVE
	MATH 124*	MATH 224*	ELECTIVE	ELECTIVE	CMPT ELEC.*

Nomenclature:

BUSLW - Business law, CE - Civil Engineering, CHEM - Chemistry, CMPT - Computer Science, ENG - English, EP - Engineering Physics, GE - General Engineering, GEO E - Geological Engineering, MATH - Mathematics, ME - Mechanical Engineering

Besides the second degree program, the College of Engineering has initiated a Engineering Professional Internship Program (EPIP) which includes a minimum of eight or a maximum of sixteen continuous months of supervised industrial work experience. Those second degree students also opting for internship program usually commence their work after the first four years of study. In this case, these students will normally obtain their degrees at the end of six years. Interestingly, of the 49 students currently registered in EPIP, 28 of them have opted for the Engineering - Computer Science second degree program.

Additional information regarding the second degree program can be obtained by writing to: The Deans' Office, College of Engineering, University of Saskatchewan, 57 Campus Drive, Saskatoon, S7N 5A9

CCECE'98 / CCGEI'98

IEEE 1998 Canadian Conference on Electrical and Computer Engineering / Congrès Canadien IEEE de Génie Électrique et Informatique 1998

Waterloo Inn, Waterloo, Ontario, Canada
Sunday, May 24 to Thursday, May 28 / Du dimanche 24 mai au jeudi 28 mai

University and Industry-Partners in Success / L'Université et l'Industrie-Un Partenariat pour la Réussite

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The IEEE 1998 Canadian Conference on Electrical and Computer Engineering provides a forum for the presentation of electrical and computer engineering research and development from Canada and around the world, and for the fostering of interaction between industrial and university researchers. Information about the conference, as it becomes available, will be posted to the above URL.

Le Congrès Canadien IEEE de Génie Électrique et Informatique 1998 offrira un forum pour la présentation de travaux de recherche canadiens et internationaux en génie électrique et informatique. Il favorisera l'interaction entre les chercheurs de l'industrie et les universitaires. Pour les plus récentes informations sur la conférence, surveillez le site indiqué par l'URL ci-dessus.

IEEE CANADA NEWS

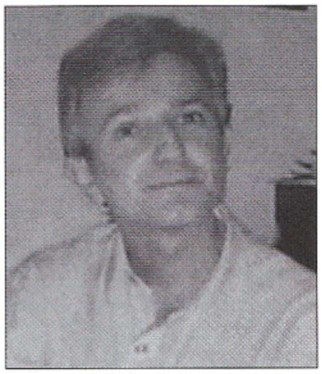
The Regional Activities Board of the IEEE recently announced the following RAB Achievement awards:

Maurice Huneault

He is the former President of the IEEE Montreal Section and is presently in charge of the Education Committee for the Montreal Section. His award caption reads: "*For significant contributions in the promotion of educational and professional activities.*"

Maurice has a Ph.D. from McGill University and is presently employed at CYME International in St. Bruno, Quebec. He is an active member of the IEEE Montreal Section.

Paul Freedman



He is the former Managing Editor, and is presently an Associate Editor of the IEEE Canadian Review. He was instrumental in the revival of the journal IEEE Canadian Review. His award caption reads "*For contributions in the promotion of Canadian Products and Enterprises in the quarterly journal IEEE Canadian Review.*"

Paul has a Ph.D. from McGill University and is presently employed as a Lead Researcher at Centre de recherche informatique de Montreal (CRIM) in Montreal.

1997 Canadian Design of the Year Award

Motorola Computer Group (MCG) has named the Nortel SuperNode Data Manager (SDM) Team as the recipient of its 1997 Canadian Design of the Year Award. The award is given annually for the most innovative product designed in Canada by an Original Equipment Manufacturer (OEM) - based on MCG technology.

The key criteria used by the Award Committee in selecting the winning design are:

- Innovation in the marketplace,
- Engineering excellence,
- Technology leadership,
- Commitment to quality.

The award was created to recognize design excellence for made-in-Canada global solutions. The award recognizes the impact in Canada that innovative design has on job creation, economic benefits and strategic R & D leadership capability.

The award presentation (see Photo 1) was made on 17 December 1997 at the National Arts Centre in Ottawa by Mr. Paul Holt (VP and Regional Director for Canada and Central USA, MCG).

Photo 1: (From left to right)

Back row: Wayne Sennett, Corporate Vice President and General Manager, Technical Products Division, MCG, Paul Holt, Vice President and Regional Director for Canada and Central USA, Technical Products Division, MCG. Clarence Chandran, President, Public Carrier Networks, Nortel, Dr. Michael Binder, Assistant Deputy Minister, Industry Canada, Mike Campbell, Director, DMS OAM&P Evolution, Nortel.

Front row: Phil Ruby, Design/Development Team, SDM, Nortel, Phil Roberts, Product Management Team, SDM, Nortel, Brian Gilligan, Project Management Team, SDM, Nortel.

The Award Caption reads:

"This award brings to life the integral work being done by Canadians behind the scenes everyday. Canadian Original Equipment Manufacturers are doing some very exciting things with technology - they're constantly pushing the envelope of today's technological frontier. Their efforts are having a significant impact on the way we live and the way we do business around the world. We want to recognize these made-in-Canada advances, and honour the people behind them. Motorola is proud to honour the Nortel SuperNode Data Manager Team - their efforts are truly in the spirit of this award. Working together as a team they produced a product uniquely suited to any telecommunications customer, anywhere in the world. The world will get even more 'closely connected' due to the innovative vision of the SuperNode Data Manager Team."

The SDM (see Photo 2) represents the next generation in telecommunications capabilities. The projected annual market for the SDM is in the tens of millions of dollars for telecom vendors. Currently, there are several thousand Nortel DMS switches in central offices worldwide which are expected to be the first to adopt the new capability.

This shows the SDM packaged in a C28B cabinet which is fully integrated with the DMS line-up and power, ground and alarm subsystems. The SDM is maintainable to the circuit pack level without shutting off shelf power. The equipment is FCC EMI, NEBS and Zone 4 Earthquake compliant.

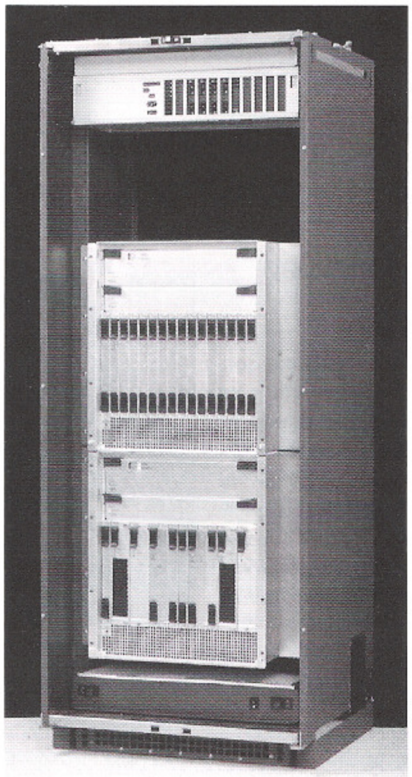


Photo 2: Fault tolerant SuperNode Data Manager