PREPARING FOR THE FUTURE: THE IMPLICATIONS OF THE INFORMATION REVOLUTION FOR THE CANADIAN NUCLEAR INDUSTRY

MICHAEL O. LUKE

Whiteshell Laboratories,
Atomic Energy of Canada Limited,
Pinawa, Manitoba, R0E 1L0
e-mail: Lukem@wl.aecl.ca

The information revolution provides an opportunity for the Canadian nuclear industry to reinvigorate the information environment that supports companies and employees in achieving business and personal goals. Five necessary steps are to intensify the information environment; develop a new human resources model that stresses access to, and sharing of, information, and which comes to grips with the need for better programs to retrain and retain employees and to accommodate the "mercenary" workforce; promote awareness of the information revolution; nurture individual initiatives; and develop an integrated approach called information engineering, which involves collaborative work between information technology, information management, and human resources. At the heart of all of these steps is the need for a new way of thinking about information and a determination to share information widely within our organisations and industry. Applying the recommended approaches within our industry will enable us to compete successfully in a global marketplace in which we are outnumbered and outgunned.

1) INTRODUCTION.

An information revolution is shaking the foundations of our organisations, our work processes and our approaches to business. Like it or not, it is going to change our lives, our jobs, our companies and our industry. In this presentation I say a few words about the roots of the revolution, describe business trends arising from it and propose steps each of us, our companies, the CNA and the Canadian nuclear industry can take, not merely to survive the revolution but to benefit from it. We are already immersed in a world where there is no refuge, no safe harbour, and where there is a necessity for on-going strategic reorientation. Our markets are fiercely contested, our business acumen tested as never before and our technical proficiency challenged mercilessly. We can prevail only by wrapping ourselves in an armour of information; information to leverage our knowledge, our assets and our skills, information to guide our business decisions and actions. This presentation provides a starting point for adopting such a strategy.

2) THE ROOTS OF THE INFORMATION REVOLUTION.

The information revolution is a long-wave revolution that to my mind started in the fifteenth century, with an explosion in printing, then progressed, gathering speed, through the sixteenth, seventeenth, eighteenth and nineteenth centuries with the birth of the scientific journal and the beginnings of the industrial revolution. This revolution was already bothering people long before the Internet arose. For example it is reported that in 1492 the chancellor of the University of Paris, Jean Gerson, complained that the boom in book production was dangerous. It was giving rise, he said, to theological confusion and shaking the

solidity of the church's traditional teaching. Even when things double quickly, they can remain obscure for quite some time, and then one more doubling and they are everywhere. The whiff of smoke on the horizon suddenly is a supertanker bearing down at full speed. So it is with the information revolution. By now it has achieved an enormous momentum. In this century we have witnessed change of staggering rapidity - the human population has tripled[1], manufacturing output has increased ~ 40 times[2], the amount of scientific literature has grown about 100 times[3], and the amount of information even more rapidly than that. Recently we have entered a zone of doubling times measured in months (for the Internet and microprocessor speed). In many areas of science the massive amounts of data now generated challenge our ability to process them. The Canadian Meteorological Centre, for example, receives 3 Gb of data each day and some massive astronomy surveys generate almost as much. Visions of the future indicate a world in which information increasingly liberates people and enhances business activities[4,5]. However, growth is a great disturber of the status quo. It threatens and challenges arrangements that worked well in a smaller, less information-intense world, and provides a fertile breeding ground for technical and organisational innovations, some of which undermine and indeed destroy the old order. Among institutions severely challenged by this revolution are universities[6] and scholarly publishers[7], and, I suggest, every organisation and every person in them.

3) BUSINESS TRENDS SPURRED BY THE INFORMATION REVOLUTION

- Business restructuring. Delayering and restructuring has both been made possible by, and driven the need for, increased immediacy and directness of information. Employees obtain directly and promptly the information they need to do their work. Work teams collaborate electronically and share data and information extensively. As disintermediation progresses, even simpler organisational structures and smaller coteries of permanent employees may be possible. Re-engineering has a high failure rate, but may be rejuvenated using a focus on information.

- Enhanced information environment. Information is now a critical enabler for many business activities. Companies seek to leverage their existing information and knowledge. In his recent landmark article, Peter Drucker said, "The corporation that is emerging is being designed around a skeleton: information."[8]. He went on to point out that, "the majority of organisations have yet to start the job...of building systems to gather and organise .... information". Improved information flows alter radically how work is done, obliterating some types of jobs and changing many others. New opportunities are created while old niches die. This trend is evident in health care, the retail trade, banking and financial institutions, aerospace, the automobile industry, education and in fact virtually every sector of the economy.

- Information connectivity. Networking within organisations and within industries is becoming essential, electronic commerce speeds and simplifies intra-organisational transactions, and facilitates the development of extended enterprises electronically interconnected with suppliers, customers, partners and stakeholders. Digital transactions weave an electronic fabric about the industrialised world, and the tide of electronic interaction grows daily faster and more intense. For example, electronic international payments transactions, just one measure of this phenomenon, have increased from 518 million per year in 1977, to 1361 million in 1986 to 2766 million for 1995. World-wide electronic currency, bond and equity trading has attained a daily value of $3 trillion.

- The rise of digital information. Digital libraries are being developed in most of the advanced industrialised countries, most notably in the U.S. and U.K.[9]. Digital information usually can be stored, moved, analysed and processed easily, quickly and at relatively low cost. Companies mine electronic data for new product development, improved efficiency, and more focused marketing[10], while researchers generate huge databases for analysis and the development of improved understanding.

- Wired science. The rise of scientific collaboratories[11], online authoring, electronic journals, shared remote access to scientific apparatus, and the ability to collect and analyse very large quantities of data are driving understanding and progress in many fields of science. The information intensity of science is

increasing rapidly. Approaches such as evidence-based medicine[12], the proliferation of online sources of chemical information[13], and the pioneering work on electronic pre-prints in the physics community[14] point to rapid changes in how scientists produce and apply information. Scientists now form interactive communities across disciplines, locations and even organisations, often marked by intense, on-going engagement. In many ways, science is like a protostar about to go nuclear. For a long time it has been getting hotter and denser giving up gravitational energy as it prepares to ignite helium synthesis in the core.

- Advances in information technology. The development of the information and communications technology infrastructure continues at a mind-boggling pace. It has been predicted that by the year 2005, the Internet will be transformed into an Interspace, containing a billion depositories each containing a million information objects[15]. By then it will be possible to navigate precisely through this immense information universe[16]. Today the development of Java and the promise of network centric computing offer tantalising new ways of acquisition, generation and manipulation of information[17]. The sudden rise of intranets is intensifying information access within organisations[18].

4) AN INFORMATION-ORIENTED ACTION AGENDA

In one of his articles, George Gilder says, "Over the next decade computer networks will expand their bandwidth by factors of thousands and reconstruct the entire U.S. economy in their image. TV will expire and transpire into a new cornucopia of choice and empowerment. Great cities will hollow out as the best and brightest in them retreat to rural redoubts and reach out to global markets and communities. The most deprived ghetto child in the most blighted project will gain educational opportunities exceeding those of today's suburban preppie. Small towns will become industrial centres in the new information economy. Hollywood and Wall Street will totter and diffuse to all points of the nation and the globe. Families will regroup around the evolving silicon hearths of a new cottage economy. Video culture will transient its current mass-media doldrums, playing to lowest-common-denominator shocks and prurient interests, and will effloresce into a plethora of products suggestive of the book industry."[19].

As Gilder's statement suggests, we are faced with cataclysmic change. I remember great glass-roofed train stations, filled with the smell of coal smoke, and the sight of huge driving wheels tall as a man, hissing steam and the clank of connecting rods. In its day, steam transformed society, multiplying human labour thousands of times, but those scenes I remember and the huge, belt-driven farm machines and steam-powered factories are long gone. Today information, not steam, is the great driver of productivity and wealth.

To deal with the promise and the threat of the information revolution, the Canadian nuclear industry must adopt an information-oriented action agenda aimed at vigorous renewal. The purpose is to improve the information environment within which we work and do business and to trigger a veritable transformation of our industry. Five interconnected steps are suggested here:

- intensity the information environment,
- adopt a new human resources model,
- promote awareness of the information revolution,
- nurture individual information-oriented initiatives,
- develop information engineering: an integrated approach to the information environment.

4.1 Intensify the Information Environment.

The information environment of most organisations resembles that shown in Figure 1. Here both the internal and the external information environment can be characterised as a huge, rather formless volume of unmanaged or barely managed information. Within that space is a much smaller zone of managed information and within that in turn an even smaller volume of directly addressable information. It is

perhaps little appreciated how huge the internal information space can be. The managed internal information space in AECL, for example, is undoubtedly as large or larger than the world wide web. This may seem surprising to those of us who think of the web as almost immeasurably immense, which really it isn't yet, but it is a situation that is probably true for most organisations of reasonable size. Furthermore the information space is inflating rapidly. Of course it is with directly addressable information that the most leverage can be obtained. This is why web type approaches to making internal information widely available within an organisation are so important. I should note that this view is not universally shared within our industry or elsewhere for that matter. The desire to control and to limit information flow seems to go deep. My point, however, is that from the evidence to date, success will come only if we build an information infrastructure that combats that regulated model. Control will bring demise! Disintermediation is not just a process for eliminating unnecessary work, but for freeing employees from the fetters of conventional information boundaries and corporate controls that foster conformity, passiveness, cynicism and resignation. As George Gilder puts it, "computer networks...free individuals from the shackles of corporate bureaucracy and geography and allow them to collaborate and exchange ideas with the best colleagues anywhere in the world." Ricardo Semler's recipe for enabling his company, Semco, to govern itself, is founded on "three values: employee participation, profit sharing, and open information systems."[20]. Semler's information sharing recipe is "to make all of it available to everyone...to undercut and so eliminate the process of filtering and negotiating information that goes on in so many corporations." In effect, pushing information down, or disseminating it without reservation, puts the tools for serving the customer, for innovating, for improving the process, for asking why it can't be done better, for effective job action into everyone's hands.

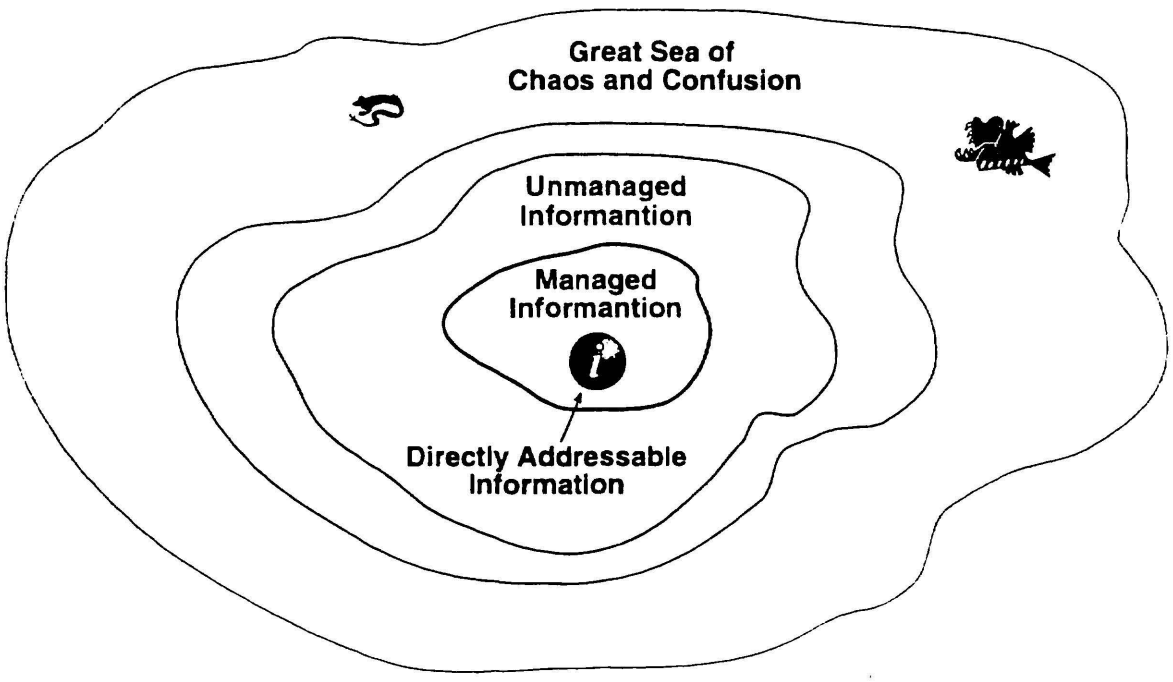

FIGURE 1. THE INFORMATION UNIVERSE

4.1.1 Expanding Managed and Directly Addressable Information

It should be noted that the proportion of the three information zones shown in Figure 1 may differ between organisations but the overall pattern applies to all organisations. Improving the information environment consists both of moving information into the managed zone and expanding the zone of directly addressable information. Let's look at how information can be moved from one zone to another, and its value enhanced as a result.

Several years ago a concern arose in one of the R&D programs at Whiteshell Laboratories that information accumulating from ten years or so of R&D was not readily available for use by researchers and managers in the program. Most of the material was in the unmanaged or barely managed zone, basically in the hands of individual scientists, or branch offices, widely duplicated, and mostly uncatalogued. To deal with this situation, a system was developed for managing these records, which at the time consisted of almost two million paper records and a wide variety of maps, videotapes, photographs, computer tapes, diskettes and so forth. After successfully implementing a system comprising an online index of holdings and microfilm archiving of textual material, the authors stated, "more than a final resting place for information, a records management system may be able to play an active role in improving the circulation of information in a research organisation and thereby enhance the pace and quality of the research itself."[21]

An example of moving information into the directly addressable zone is provided by Talisman, an oil and gas exploration company which uses seismic and other kinds of surveys to identify areas worth further exploration including ultimately drilling. The seismic surveys use an array of up to 400 detectors per detonation, which are sampled 500 times per second, each sample consisting of 16 or 24 data bits. The seismic lines are 10-15 km long and have charges every 20 m. At one time these data were collected and stored off line, but by putting the data online, accessible immediately at any time, Talisman has speeded up processing of the data and increased the productivity of its geophysicists. [22]

4.1.2. The Need to "Unlearn".

While these examples illustrate the kinds of individual projects that we must undertake to build a better information environment, we need to go beyond what they offer and try to define a more systematic, aggressive and deeper penetration into the heart of this information business. So how do we go about intensifying the environment? One way is be re-examining what we do, why we do it and how we do it, that is to define what is needed and the most simple way in which the function might be performed (even if technically it is not possible to achieve that ultimate state yet), stripped of all the cultural, behavioural, vested interest, bureaucratic, organisational, departmental and attitudinal baggage that normally we drag along with us, much of it even unconsciously. This is a difficult and uncomfortable process, a long one, and a long-term one. It is difficult to walk into the future with your boots mired in the mud of the past! Change is a messy business, a little like growing up, especially when the rules of the game seem to be changing much faster than we are. How we do research, how we manufacture, how we sell and the product itself, are all up for grabs.

We have to make sure that the CANDU® reactor does not become the steam engine of the next century, a once powerful technology now used, shining and gleaming as they never were when doing real work, only to satisfy nostalgia. Instead we would like it to become the efficient, long-range jet transport of the future (see Figure 2). To do that we must outnimble not just Framatome and Westinghouse, from a base much smaller and less well funded, but suppliers of alternative sources of energy as well. This may well mean subjecting ourselves to a process of going back to first principles in a sense, perhaps a form of what some call "unlearning."

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Unlearning means jettisoning ways of thinking and attitudes that are no longer relevant in a changed environment. Unlearning amounts to rethinking what we do from first principles, a kind of zero-based activity analysis. First I must look at how to define my work function in terms of information flow. Almost any function and task can be defined in such terms. What information do I need to do my job in the quickest, best way possible? That defines what I need to function within my organisation. What information must I provide for customers, other employees, etc.? That defines what I do. Thinking this through over time should lead to a cascade of simplification, elimination and improvement ideas. The process is iterative and on-going. This kind of program is possible at every level within an organisation and can be adopted by individuals, teams, branches, programs and whole projects. The aim is not to cut out information channels but to increase them, simplify them, streamline them and make them as direct and quick as possible. To exploit the future, we must ransack the information treasuries of the past.

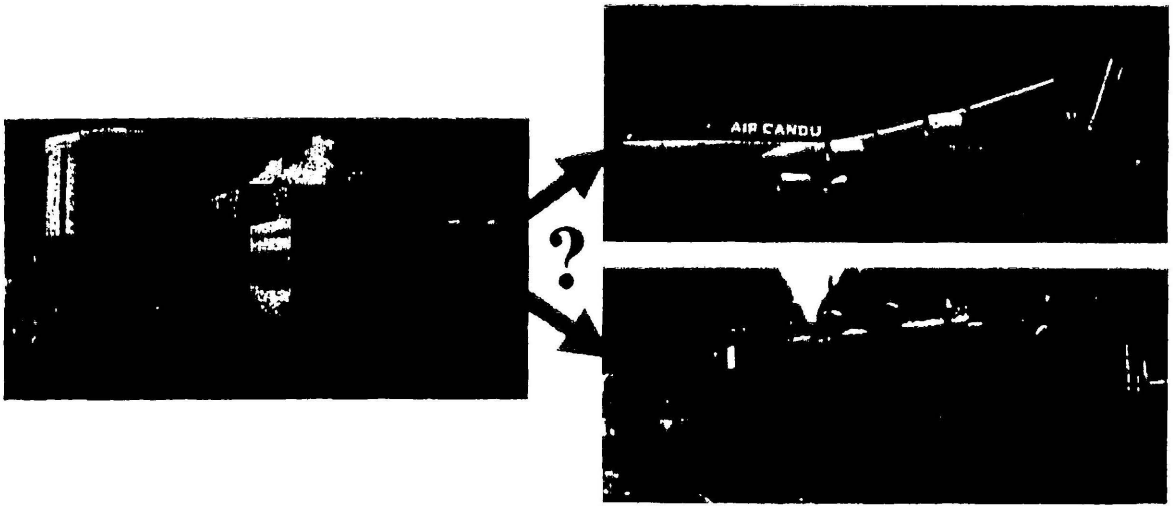

FIGURE 2. DESTINY OF CANDU?

4.1.3. The Inter-disciplinary Team.

One approach within a spectrum of possible avenues to such a program is to establish an interdisciplinary team or even a series of such teams to improve the information environment, both in the short term and over the longer term. These teams should spawn initiatives both large and small, and both strategic in scope and direction as well as operational and immediate. Similar action is also urgently needed across the industry to facilitate information sharing, work co-ordination, marketing co-operation, public awareness actions, and possibly even enhanced leverage in functions such as procurement, materials management, subcontracting, outsourcing, and hiring. The CNA, for example, might examine how it can promote public awareness, help support pro-nuclear spokespeople, and help succour a stronger industry through an information-centric approach. Improved conferencing and publication methods, such as making the proceedings available through the Internet are also possibilities. These are not always easy processes. There is a great tussle going on now for example between authors and publishers of scholarly journals and this may spread to the commercial world as well. This pits authors, who have seen the price of journals explode, against publishers, who fear the threat posed by electronic publication on their revenues, their profits, their very existence.[23]. We can expect a similar struggle from vested interests within our industry as we move to change, sometimes radically, how we function.

4.2 Adopt a New Human Resources Model.

The President of General Motors of Canada said recently, "we're striving for the total involvement of our people in the business."[24]. In my mind this means getting the best out of every employee, each day and every day in an environment in which the turbulence of change is constant. And I believe that to do this we need a new model of Human Resources. This new model puts information at the service of employees, fully and directly, uncontaminated by management interpretation and "spin". It seeks to liberate rather than to constrain employees, by providing a transparent information environment in which information serves to nurture employees and to facilitate their independence and individuality. It seeks to nurture employees as independent workers, highly productive and highly employable. And it seeks to improve the psychology of the workplace. This is not just a pipe dream tossed out as an anti-dote to all-too-frequent downsizings! In one of a series of articles that they have written for Harvard Business Review, Bartlett and Ghoshal [25] argue that "top management's principle challenge is not to design systems that will process data more efficiently but to create an environment in which people can exploit information more effectively."

4.2.1. Empowerment, the Psychological Health of the Workplace, and the Mercenary Workforce.

Sharing information with all employees is the true road to empowerment, a term widely used and rarely applied. I argue that our industry, which is small by comparison with other national programs, must adopt this kind of transforming approach to managing people to be successful in a global marketplace and a rapidly changing regulatory environment. What applies to the macrocosm applies to the microcosm. Making ourselves more productive is essential if we are to continue to be employable. Becoming more productive ourselves is essential to making our industry more productive. Making our industry more productive is essential if we are to continue to have an industry, if in fact we are to seize the commercial opportunities that seem now to be available. Our products and our services are aimed precisely at leveraging the effort of our customers. Our competition wants to do it. There is a great global race to be best, fastest, first, leanest and so on. This is a race we might prefer to take a vacation from, but to do is to risk forced retirement.

The last thing we need is the following scenario, described by Bartlett and Ghoshal [25], "with amused resignation, employees implemented corporate-led initiatives that they knew would fail." Avoiding this kind of scenario being played out over and over again within our own organisations is easier said than done. There is a pressing need to improve the psychological health of the workplace. There is much more to this than habituating employees to the brutal realities of the "real world". Career-related anxieties deflect attention from business matters. Currently the "normal" work environment creates continual anxiety of this kind, the long-term effects of which, if left unrelieved, are detrimental to employees and to the organisations which employ them. As well, gaining the full commitment of employees will be difficult in the face of increasing distractions from outside. These distractions include the effort to remain employable in a world of rapid change and the excitement of outside peer communities brought in-house through electronic communication. What I call the mercenary workforce will be even less inclined to do anything that conflicts in any way with its own self interest and there is likely to be a wide gulf between the self-interest agenda and that of our organisations and our industry. We must find ways of offsetting these attractions and distractions with internal systems that succour employees' self interest and combat somehow the job surfing syndrome.

John Dalla Costa [26] points out, "Average people have been forced to come to terms with the harsh realities of limitation and uncertainty. Through this pain, many employees have already fashioned their own street smarts. What they now need is for their employers to respect and engage them on this wiser plain.....By looking out for themselves, employees look out for the company.....People are the essence of companies and somehow, in the orthodoxy of the new management of productivity, they've become the enemy." The only way to turn that around, it seems to me, is a new human resources model that drives towards an information environment based on the widest possible internal access to and sharing of information, and the widest possible spectrum of authoring and communication avenues for employees, so that employees can contribute to any program wherever it happens to be headquartered. This environment supports widespread sharing and development of each employee's interests and skills and extends to the potential for involving

any employee in any project at any time, rendering the branch, division and project walls permeable, mere administrative conveniences. Employees increasingly will demand this kind of access to information, this kind of access to opportunities.

4.2.2. Retrain and Retain, vs. Fire and Retire

As another example of how to apply information in the workplace, organisations must take better advantage of modern educational methodology, electronic access to instruction and improved training processes. We need to learn how to adapt to new work situations more quickly and we must develop the ability to adjust to new tasks promptly. There is a need for much more employee counselling aimed at employees in transition from one job to another, for better methods of integrating contract employees into the organisation, and for ways of helping employees to switch roles swiftly and successfully. We must become as adept at retain and retrain as at fire and retire. Although organisations are moving away from large establishments of permanent employees, there should still be an enormous advantage accruing to those which can find a way of retaining highly skilled specialists for long periods of time.

Our business is a complex one. To design, manufacture, sell and maintain our products we need a very wide range of skills and an intricate network of organisations, some playing multiple roles simultaneously: supplier, partner, customer, stakeholder, developer etc. The research and technology support necessary for our products likewise is complex, covering a wide range of disciplines and skills, some of which are represented by only a few individuals world-wide. With fewer permanent employees and rapidly changing skill sets, we will need to ensure that we can continue to tap into the wide range of highly specialised expertise required to keep our products and services competitive. We must find better ways not only to retain and nurture the wide range of special skills needed but to complement those within our industry with outside help. In doing this, if we think for a moment that we can get by with a second rate information infrastructure we are dreaming!

Finally, although we have discussed much here about electronic support systems, human, hands-on leadership is needed as never before to complement the electronic systems in the new information environment. Although the emphasis of this presentation is on the information environment, information is inanimate, abstract and incapable of action or feeling. Information stimulates thinking, thinking leads to ideas, and ideas, focused on the business, lead to success, sales, new products, individual renewal, and personal achievement. Ultimately, as with information technology, information is merely enabling -making things possible. Translating the possibilities vigorously into action requires people and leadership. Leadership is a matter not just of facts, not solely of brains, but also, very importantly, of heart, and never more so than when the future is uncertain and the stress of change at its highest. Skilled individual counselling and leadership is needed at all stages of employees careers - new recruits, neophytes, veterans, and employees in transition. Microsoft's jobs are said to be "revered". Ours must be so considered too.

4.3 Promote Awareness of the Information Revolution.

Each of us needs considerable help in adjusting to and implementing the kind of approach I am arguing for here. Awareness is half the battle. We need to know more about the information revolution and what other organisations are doing about it, to help overcome our natural inertia, scepticism and conservatism towards new ways of work and the revolutionary nature of the changes in the information environment. We also need to know more and more about where to go to identify useful ideas to steal! The information revolution is pervasive: no functions are exempt from its transforming influence. Accordingly, everybody has a role to play in ensuring the exhaustive, vigorous and imaginative application of this transforming power in all aspects of our work. Employees who understand the background are more likely themselves to adopt new approaches and to co-operate with others who wish to implement them. We are much more likely to contribute to the design of new programs if we understand why they are necessary and when we are confident we can help ensure they will be focused on real needs and real users.

In promoting awareness, it is important to use a variety of ways of getting the message across. Of all ways of doing this, however, by far the most influential is personal contact. To try to establish or improve such contact, in May of this year, Business Services, which is the semi-permeable wall behind which I hide, organised a series of presentations and demonstrations around the theme of Information in Support of the CANDU Business at CRL, WL and Sheridan Park. This was designed to talk about the future directions of information support, including some of the themes discussed in this presentation and to showcase some of the efforts underway within AECL to improve the information environment. The aim was to show and provide an opportunity for entering into dialogue with employees.

I have an ad here for Information Scientist - we tend to call them searchers in AECL, perhaps that's part of the problem. It's from Astra Merck. I used to work for Merck, back in Palaeolithic time. It was a good experience for me, so the company name still always catches my eye. The ad says, "We've put our hearts and minds into a new kind of company." Incumbents, it goes on to tell us, participate in technology assessment and process improvement teams to fully integrate Information Resource capabilities with drug development initiatives. Now this is an idea that we've had for years in AECL, but we've rarely done it - partly because our few information scientists are simply inundated with work. But I suggest that part of our recipe for riding the information revolution will be to pay much closer attention to information, to accord it much less of a support role and more of a core constituency, and that includes resourcing adequately the information management skills that are needed to make it happen. It also requires that each of us become much more information conscious.

4.3.1. Rethinking Our Approach to Information

It is rapidly becoming clear, as the previous example suggests, that we have to start to think differently about information - how to deal with it, how to use it. Unfortunately, this imperative need for a different mind set is not yet widely appreciated and understood, so there is some resistance to the kind of ideas discussed here. Legacy attitudes, developed when the need for control was greater, when the unwritten labour contract was still in force, when the business pace was slower and competition less intense, must now be jettisoned. It is simply going to be unacceptable to hold back from employees any information, whether external or internal, even preliminary information, that has even the remotest possible relevance to the work situation. That is the new standard of information transparency. For every step away from that ideal we will pay a price in employee effectiveness. Where before we might have been cautious and careful about what we make available, now we must be aggressive, assertive, pro-active in making information accessible. Of course this is not an easy adjustment to make.

Information science clearly is going in the direction of information analysis, matching, correlating, extracting, in a huge universe of multiple information sources. That is the kind of orebody and mining equipment from which all of us in this industry will draw our future livelihood. From our ability to access and mine information effectively will come tomorrow's new businesses, new products, new jobs, better management, smarter plans, new designs, more effective marketing strategies and implementation. Companies reluctant to adopt the new approach to information will not only damage their business prospects, they will also impair their employees' effectiveness. Ultimately, that will figure largely as a critical measure in determining if your company is an employer of choice, for who will want to work for an organisation with antediluvian ideas about information, or which cannot clear away the fog of information fettering quickly enough to remain competitive in a world using information aggressively? The job of spreading awareness about the importance of this task is therefore critically important.

4.4 Nurture Individual Internal Initiatives.

It is important and useful to have some overall control of the process of improving the information environment, but ideally it should be a loose one, persuasive, and helpful, coordinative in nature, aimed at promoting information availability, ease of use, density, relevance, and at dislodging information from corporate prisons rather than acting as jailer. Very often there is a tendency in organisations and by

managers to want to identify the information that matters. My own experience both as a manager and an information user is that that not only is impossible but reflects a mistaken notion about how discovery works. Of course, some people ask if we are still in the discovery business, but I think the answer is clear. You bet we are! We are product focused and business focused but we must be innovative, creative, inventive, clever. Certainly one can identify the bread and butter information resources that are necessary, but my experience is that you cannot predict where the vital spark of information that triggers sudden understanding or a new idea or the answer to a particular problem will come from. It is, I believe, in a broad sense, inherently unpredictable. That means that the effective information environment must allow users to cast a very wide net.

It is likely that action is already underway to improve the information environment in most companies. In AECL, for example, an Internet site has been developed, an internal web site is being built, the information technology and communication infrastructure is being beefed up, direct access is being provided to external, commercial databases, several library systems across the company are being integrated, an electronic document management system has been implemented, and there are various records and document digitisation projects underway. Much more is needed, however. Efforts such as the records audit conducted at CRL and WL[27] need to be expanded and extended. An audit essentially develops self knowledge, which is one of the prerequisites of the action agenda for improving the information environment. An audit or survey can take many forms, but the basic notion is to find out what information exists, in what form it exists, how it is used or not used and then to imagine how improvements in availability would benefit the business. My guess is that in most organisations this will reveal, as it did in AECL, a highly heterogeneous state of affairs, with a wide variety of forms, formats, organisation (and non-organisation), systems used for access and so on. This undertaking, therefore, is a long-term task - a truly comprehensive audit of information resources is a considerable amount of work and will require the co-operation of many parts of the organisation.

4.5 Towards Information Engineering: an Integrated Approach to a New Information Environment

It is important to distinguish an information improvement process from an information technology action program, or an information management action plan or any other action plan. The way I look at it, information enables people, information technology enables information. Not to diminish the IT people, for whom I have great respect, there is a great of deal that is useful that amounts to not much more than pulling technology off the shelf once the work or process has been examined and thought through carefully. In terms of dealing with the information revolution the really critical ingredient is people. As Costa points out, "Human beings, not the hardware and the software, create value."[25]. All the resources, facilities, goods and services in the world will not advance our industry one step into the future. Only people can do that. This is why I stressed earlier the need for a new human resources model, one that uses information to liberate employees. To become a truly information-enabled industry, we need to develop a fully integrated approach to using information. I call this process information engineering. This involves harnessing information technology, information management, human resources, and even the overall organisational structure to the task of transforming the information environment. And by integrated I also mean:

- across disciplines,
- across information sources, internal and external,
- throughout the organisation,
- across the industry,
- into all work functions and activities

This means that there is a multi-dimensional set of integration needs, a full, vigorous, and relentless partnership with many functions in our industry. But how specifically do we do this integration? One way is by establishing teams, as I have already mentioned - get them looking, get them working towards a freer, richer information environment. But I'm convinced that we won't do this alone. Each company may start alone and may indeed reap big benefits, but the real multiplying affect for each company is to become a

much more interconnected part with the whole industry, so that information flow and thinking flow and even work flow isn't bottled up into small units with strong, impermeable cell walls but that these units at least partially coalesce into a super cell in which the rigid identity of the original independent cells has been lost and the firm boundaries originally there softened and less distinguishable, with more freedom for the contents to intermix and mingle - people, ideas, information, work, forming a super alliance, not each pursuing rather independent courses, but collaborating, co-operating, functioning as an industry team. Collaborative work using shared information is far more likely to gain us the kind of future profitable to Canada and for our organisations and industry than merely pursuing our present course of loose association. I'd like to see the CNA build an industry-wide Internet facility, for example, a co-operative business involving input from all the members of our industry, certainly the major players. I'd like to see us work together on Intranets, perhaps build an intranet of intranets. These are actions that can be started immediately.

I think we should also be looking long-term at how we can gain competitive advantage by improved information resources and through increased sharing, and increased flow of, information within our industry and its special interest groups. We should be looking at an industry network of networks, to a superset of information resources across the industry, to multiply the impact of existing resources and ensure that they evolve towards more industry-oriented as opposed to company-oriented configurations and contents.

As well, we should be looking at our collective information assets, not just internal ones, but also what we have and how we use external sources of information. Ideally we should develop a kind of road map of our collective information resources and we should look for ways to leverage these assets again across the industry rather than just within our own organisations.

Information engineering requires a new approach to work teams, work processes and projects, one based on considering the total information environment in which the work, process or project takes place, the information threads they need to draw from, the information products they need to create, the information threads individuals need to achieve their own full potential, the threads the team or unit needs to work effectively as a group and then to go beyond the bounds of the team, process or project to consider what the organisation as a whole needs to be able to leverage the results. In this approach, the traditional boundaries of information delineated by terms such as records, reports, libraries, and even internal and external must be abandoned in favour of a unified environment, seamless and cohesive. The fact is that today we do not know how to do information engineering. I can't tell you how to do it. I may be father of the term, but I am not father of the action plan. But I can talk about it, I see a glimmer of how it might be done and I can understand how we might start towards achieving an information engineering approach, namely precisely some of the activities I have talked about in this presentation, but we need to explore it together. I should like to suggest that it offers a means for our industry, outnumbered and outgunned, to achieve success.

5) CONCLUSION

The aim of these initiatives is to provide a relentless, methodical, systematic and comprehensive approach to improving the information environment via a process which I call information engineering. The heart of this information-centric approach is putting people in intimate contact with information. Done with a thorough brush and imaginative ways of capitalising on the improved information environment, these actions will unleash the knowledge capital in our industry and liberate the innovative, and productive potential within all of us.

The goal of this industry is to apply the advantages of CANDU and related nuclear technology globally, providing economic benefits for Canada and for the world. As we head towards the next century, achieving that goal will be possible only if we fully embrace the information revolution. Stuart Kauffman said, "We live on a self-organised sandpile that sheds avalanches down the critical slopes with each footstep. We have hardly a clue what will unfold."[28]. Hardly a clue doesn't sound like much of a brief for the future, but

riding the information revolution will give us at least all the clues there are, so that we can adapt as we go, riding the wave of change successfully. Our future depends upon it.

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