



Office of the  
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# **Tapping the Global Information Base to Build an Innovative Knowledge Society**

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Canada

## **Introduction**

Je vous remercie de cette chaleureuse introduction. C'est pour moi un plaisir de participer à cette conférence sur l'information et l'innovation.

For 50 years, the International Association of Technological University Libraries has provided important leadership in helping technical librarians around the world meet the changing knowledge management needs of the research community. And this is a time of unprecedented change.

So I'd like to start with a quote from T.S. Eliot, who wrote:  
*“Where is the wisdom we have lost in knowledge? Where is the knowledge we have lost in information?”*

Je crois que ces mots sont empreints d'une sagesse qui peut être directement appliquée aux défis auxquels IATUL est confronté, et auxquels vous faites face en tant que spécialistes en gestion de l'information.

I am a scientist, not a librarian. But as Canada's National Science Advisor to the Prime Minister I can see a set of forces at play that are rapidly changing the scientific and technological enterprise and are poised to transform the scholarly communication system as well.

Today's researchers need rapid, unfettered use of data, information and knowledge to remain at the cutting edge of discovery. The internationalization of science and technology is combining with an unprecedented flow of data, information and knowledge to create increasingly complex linkages between research and development, innovation, economic growth and social well-being.

Access to global databases and information sources across the natural, engineering, health and social sciences has become absolutely critical to the development and maintenance of an innovative knowledge society, both nationally and internationally.

These pressures, together with developments such as digital content, e-publishing and on-line reference, are creating both challenges and opportunities for policy makers and the

technical library community that are intricately linked to national innovation agendas around the world.

Mon objectif aujourd'hui est de présenter – en m'inspirant de l'expérience du Canada – certains des liens qui existent entre l'information et l'innovation, et de vous proposer, en votre qualité de représentants de la collectivité des bibliothèques techniques, des façons de relever ces défis.

In doing so, I want to make it clear that I am speaking about scholarly communication in the broadest terms – from the preservation and exchange of data and metadata generated by publicly funded scientific research, to the short and long-term accessibility of peer-reviewed journal articles, to the “grey literature” found in research reports, conference proceedings and pre-prints, and the informal e-mails, electronic fora and weblogs that now play such a growing role in scientific collaboration and discussion.

It is clear to me that researchers, policy makers and information management specialists must work together to ensure that as a society we capture the full benefit of the full

range of information and knowledge that the scientific and technical community is generating around the globe.

## **Snapshot: Canada's Innovation Agenda & International S&T Performance**

To begin with let me set the stage with some background on Canada's investment in science, technology and innovation and our relative performance internationally in R&D.

I hope that as a mid-size country, there are elements in Canada's approach that will resonate with everyone in the audience – whether you are working in developed or emerging economies.

As these first slides show, Canada performs quite well in comparisons of international scientific metrics, ranking among the top countries in the world on several measures.

Last summer, Sir David King, my British counterpart published an article in *Nature* on the scientific impact of nations, comparing outputs (#s publications and citations) to get a measure of productivity and quality of science ranked

Canada 6<sup>th</sup> in the world in its share of the top 1 percent of most frequently cited publications.<sup>1</sup> Even more impressive is that Canada is second only to the United Kingdom in the number of citations per researcher, citations per unit of GDP, and publications per researcher.

Thomson ISI's citations per paper ratings now place Canada first in space science, and among the world's top performers in clinical medicine, pharmacology, ecology, environmental science and chemistry.

All of these rankings are an important measure of both the productivity and impact of a nation's scientific and technological base.

Industrially, Canada now has internationally competitive strengths in such diverse sectors as ICT, biotechnology, clinical medicine, aerospace and automotive, environmental and ocean technologies not to mention of course our vast natural resources.

And there are signs of even greater potential to come.

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<sup>1</sup> David A King, *Nature*, vol 430, July 2004.

In 2002-2003, Canada ranked first in the G-8 in per capita spending on Higher Education R&D (or HERD).

Over the past seven years, Canada's federal government has committed \$13B of incremental investment in S&T mostly in the HERD system – significantly transforming the research environment in the academic sector. Provinces have also contributed significantly to this transformation through matching funding. Our universities can now compete with the very best in the world including the USA. And since 70 per cent of this increase has been in the last four years, its impact on Canada's international performance in R&D has yet to be really felt.

This year, total Canadian R&D expenditures are expected to reach \$24.5 B. Of this, some \$9.2 B will come from the federal government.

Most recently, the federal government's 2005 budget announced \$1.18B in new direct expenditures in the research base including increases for the Granting Councils, Genome Canada, the National Research Council and the Canadian Space Agency as well as the creation of the

Canadian Academies of Science and an additional \$2.4B in new funding for targeted initiatives with a substantive science, technology and innovation component particularly under the themes of climate change, sustainable development and meeting our global responsibilities.

## **Canada's Socio-Economic Challenges for the 21<sup>st</sup> Century**

But we must recognize that we can't afford to rest on our laurels.

Canada is a small-market, highly trade-dependent nation. In an increasingly competitive, global knowledge-based economy and society, we must continually push ourselves to be at the leading edge of S&T and innovation and to increase our productivity and competitiveness.

To generate wealth, we realize that we must embed science, technology and innovation in our business practices, our manufacturing processes and our resource-based industries. And in a tightly-focused, 24/7, business world, we must have

the capability to deliver R&D when and where it is needed most.

We must also play at the very top of our game if we are to find solutions to some of the pressing challenges that face us as a society – from the impacts of climate change to the health of our aging population and our desire as expressed by our Prime Minister to play a meaningful role in supporting peace and justice throughout the world.

The rapid response of our medical and scientific community to the SARS outbreak two years ago – in which teams of researchers in Winnipeg and Vancouver built on each others' work to quickly sequence the genome of the SARS virus – is just one example of the kind of agile, world class, research we will need to access more and more in the years to come.

Canada is increasingly aware that building a strong science culture and effective knowledge and innovation system must be a national priority if we are to prosper and fully reap the benefits of advances in science and technology – no matter if they originate here in Canada or abroad.

Also, I might add, we understand that as a mid-size nation, we don't have the resources to always do everything we would like to do ourselves. This means we have to invest wisely and strategically to ensure the greatest benefit to our economy and society as a whole. And we have to partner with others to extend our resources and ensure that we contribute to the global community.

### **S&T and Innovation: Policy Challenges for Canada**

I've touched on some of our recent accomplishments. But we still have more work to do. To give you some idea of where we need to focus our attention, I'll give you my own list of key policy challenges. These include:

- Maintaining Canada's leading position in the G-8 in higher education R&D – or HERD/GDP – and building on our strong research base.
  
- Ensuring that we harvest the economic and social benefit to Canadians of R&D investments through knowledge transfer and commercialization.

- Stimulating industrial innovation R&D expansion and collaboration – one of our ongoing weaknesses.
- Increasing international collaborations across the innovation spectrum.
- Revitalizing public good government science to respond to the priority policy challenges facing Canadians.
- And developing national strategies in emerging areas, such as nanotechnologies, quantum information technology, biotechnology, sustainable energy and environmental technologies and northern science.

## **The Sleeping Giant: The Fundamental Role of Research Communications**

And what about scholarly communications? In many ways, this is the sleeping giant that underpins our ability to meet the challenges I've just mentioned.

Canada must confront the question of how best to reshape its research communication system in order to tap into the global information base and strengthen our capacity for cutting edge science and the commercialization of discoveries.

This is a challenge shared by national research communities around the world. It is also the challenge I put before you today.

As I said at the beginning, research libraries in all corners of the globe are experiencing new pressures. Research data that is “born digital,” new capabilities for metadata harvesting, e-publishing and the impact of the Internet and on-line searching are all changing the scientific enterprise and the information infrastructure as we know it.

Key challenges such as the rising cost of scholarly publications, intellectual property rights and ethical issues relating to privacy and security have all become flash points for attention and debate.

I'm sure Stevan Harnad, David Schulenberger and other speakers will be touching on these and other matters from different angles this week.

I'd particularly urge you to pay close attention to their perspectives on the "open access" movement – for without a doubt, whether we are talking about open access publishing, archiving or data sharing, the open access concept is here to stay.

The scientific community has long had a tradition of collaboration and the open exchange of research results for the advancement of knowledge and humankind.

But scientific convergence and the arrival of the information commons are opening up powerful new forms of scientific collaboration in all corners of the globe. From the open source software movement to the creation of collaborative virtual environments, e-science is transforming the way the world's scientific community works and shares its intellectual, analytical and investigative output.

Let me zero in on some of the rapid changes that are going on in the way researchers work with data just to illustrate the tremendous potential impact the open and efficient exchange of scientific information and knowledge can have in terms of innovation and benefits to society.

As you may know, the recent phenomenal rise in computing power and capacity has given us the ability to store, manipulate and network huge data sets. Researchers are increasingly able to share and bring together data from different disciplines and to collect, interpret and re-interpret data in new ways.

These new technologies and new ways of working are opening up vast new opportunities to accelerate the pace of discovery for the benefit of society – from genomics and proteomics for health care to nanotechnology for new materials our capacity to engage in interdisciplinary research has dramatically improved and international collaboration in areas such as bioterrorism or climate change is being enabled.

The recently published Long Range Plan for High Performance Computing in Canada illustrates some of the incredible opportunities in the development of new knowledge that lie before us in the immediate future. This explosion of data and information will also present new challenges to the scientific community in terms of management, dissemination and interpretation of vast new complex data sets.

For example, a recent “biocomplexity” study supported by the U.S. National Science Foundation illustrates these links very well.

Over the course of the study, researchers drew on a variety of international data from epidemiology, NASA remote sensing, marine biology, microbiology, genomics and social science data banks to determine the relationship between cholera outbreaks and a number of environmental factors. As a result of this broad input, their findings have led to both an improved scientific and sociological understanding of cholera epidemics and their prevention.<sup>2</sup>

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<sup>2</sup> “Promoting Access to Public Research Data for Scientific, Economic, and Social Development,” Final Report of the OECD Follow Up Group on Issues of Access to Publicly Funded Research Data, March 2003.”

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The key to this potential is, of course, the ability to properly archive, manage and openly exchange data and metadata. As a result we are seeing the creation of more and more global databanks, where the quality of data can be assured and the goals of international and interdisciplinary collaboration can be nurtured. GeneBank, the Global Biodiversity Information Facility (GBIF) and the International Virtual Observatory (IVF) are all prime examples.

And this is just the tip of the iceberg. With massive amounts of data now available over the web, the Internet is becoming a huge database in itself. More and more computers are designed to interact readily with people, and advances in autonomic computing (in other words, “Self Managing Computer Systems”) are making it possible for computers to deal directly with each other.

## **Building a 21<sup>st</sup> Century Research Communication System**

So where is all this headed? It is difficult to predict.

The only thing that seems a safe bet is that the research communication system of the future is not going to be the same as it is now.

And this is especially true when you factor in the reality that a demanding new generation of researchers is coming of age that will expect to take full advantage of the creative and analytical potential of today's and tomorrow's ICT-based tools.

To me this underscores the importance of looking at the big picture. Even as we are coming to grips with the open access movement in publishing and data archiving, what we really need to be doing is looking at the full landscape of the research communications system and determining how it can best deliver the maximum benefit to researchers – and to the economy and society – through the free flow of knowledge.

The image that comes to mind – as indicated by this slide – is one of a highly interactive and distributed knowledge and information environment, fuelled by new technologies, new management processes, new sources of data and

information and new users – including commercial users and members of the general public – all interacting in highly creative and often unpredictable ways.

Quite simply, and I want to underscore this key message: those countries that move early to create a 21<sup>st</sup> century research communication system – that embraces an open access environment and harnesses its full potential – will be the leaders in building the knowledge economies and innovative societies of tomorrow.

Already the fast movers are heading in this direction.

Individually, the United States, the United Kingdom, Germany, France, Netherlands and Australia are all moving ahead, although none have a national access and digital archives facility in place yet.

Certainly, over the last two years have seen a series of important milestones propelling the open access movement forward.

Building on the 2003 Berlin Declaration on Open Access, a number of key research institutions around the world, including France's Centre nationale de la recherche scientifique (CNRS), Germany's Max-Planck Institutes, the European Centre for Nuclear Research (CERN) and the national Academies of Science in China, India and the Netherlands, have adopted the principle of providing free online access to refereed research journal articles.

So too have several leading funding agencies. Researchers receiving funds from the National Institute of Health in the U.S. and the prestigious Wellcome Trust are now encouraged or required to deposit a copy of their published articles in an open access repository. The Research Councils of the United Kingdom (RCUK) are also currently formulating an open access policy.

The e-publishing movement has its champions as well. In the UK, the Joint Information Systems Committee (Jisc) has funded free access for universities to journals by Biomed Central. And in the U.S., the Public Library of Science has rolled out several high-profile open access journals, including PloS Biology and PloS Medicine.

And finally, on the data side, the OECD nations signed a Ministerial Declaration on Access to Research Data from Public Funding, committing members to work towards the establishment of open access regimes for publicly funded digital research data. Canada is a signatory to the declaration and is playing a substantive role in the working group following up on the declaration.

Here in Canada, recent consultations by the Social Sciences and Humanities Research Council (SSHRC), the Canadian Association of Research Libraries (CARL) and the National Consultation on Access to Scientific Research Data (NCASRD) have touched on different aspects of the research communications system of the future. SSHRC has also enacted a policy requiring publicly funded researchers to make their data available for open access.

As you can see, the momentum is clearly growing. The OA train has left the station. So the question is not whether you want to get on board, but how quickly you need to do so to avoid being left behind?

Talking about trains reminds me of a story about Albert Einstein – 100<sup>th</sup> anniversary of ‘annus mirabilis’ – 3 famous papers one on theory of relativity. Albert Einstein was on a train. Einstein searched in his pockets and case for his ticket. The conductor approached him and said ‘Dr. Einstein, everyone knows who you are. Surely Princeton can afford to buy you another train ticket.’ To which Einstein replied ‘I’m not worried about the money. I need to find the ticket to figure out where I’m going.’

So the moral of the story is don’t worry about the money, but about where you are going. If you figure out where you’re going, the money will come.

## **A Vision of a 21<sup>st</sup> Century Research Communication System**

So what exactly would a 21<sup>st</sup> Century Research Communication System look like?

First and foremost, its goal must be to maximize the impact of research knowledge for society. And not just for the developed world. Developing nations everywhere must have

the capacity to access and contribute to the vitality of any scholarly communication system that develops.

Such a system would facilitate connections between individuals and between institutions to provide pathways for the rapid circulation, effective management and preservation of information. An open access philosophy would be critical to its success.

From a Canadian perspective, a 21<sup>st</sup> Century Research Communication System would:

- First of all, take full advantage of the enormous potential of new information and communication technologies;
- Second, be capable of handling an unprecedented flow of information in a wide variety of formats;
- Third, bring Canadian research knowledge to the world and bring the world's research knowledge to Canada;

- Fourth, be sophisticated enough that its procedures, processes and regulations do not place unwarranted additional burdens on researchers, research librarians and their institutions; and,
- Fifth, be accessible by all Canadians, in all sectors, ensuring that public investment in scientific research leads to wealth creation and improvements in social and cultural well-being.

I expect other countries would have similar goals.

With a 21<sup>st</sup> Century Research Communication System in place, any researcher in Canada would be able to access, on their desktop computer:

- The full text of the most current issues of their discipline's journals, as well as an extensive collection of back issues;
- A comprehensive set of monographs and theses in their field of study;

- The relevant research data that underlies and supports the hypotheses in the published outcomes;
- Powerful search engines that find and present the latest research results, in both of Canada's official languages (and others such as Mandarin, Korean and Japanese);
- Research reports, conference proceedings, and non-peer reviewed research materials from both academia and government sources;
- A full suite of discussion fora, contact lists, directories and other basic information sources; and,
- The electronic tools necessary to customize both the channels of communication, such as websites and weblogs, and the way that search results are packaged and presented.

## **Canada's Building Blocks**

Creating such a system is no longer just a question of developing appropriate technologies; most already exist.

At this point it is really a matter of building, integrating and improving technical infrastructure, operational standards, institutional roles and responsibilities, research support systems and regulations.

Canada is fortunate to have a number of key building blocks in place to create such a system if it chooses. Let me just mention some of these briefly.

To start with, Canada's university research libraries are rapidly putting in place the technical infrastructure and human resources necessary to build an effective network of institutional repositories. Twenty-six are now up and running or in advanced stages of development. Regional initiatives, such as the Ontario Scholars Portal, are also developing the networking capacity and content databases necessary for the advanced search and retrieval of scientific materials.

Next, the National Research Council's Canada Institute for Science and Technical Information – CISTI – Canada's national science library and largest publisher of scientific, technical and medical research literature, provides secure

web-based document searching, ordering and delivery, and access to full text NRC Electronic Journals. It also links researchers to partner collections around the world.

CISTI's new strategic plan contains two fundamentally important goals:

- 1) providing universal, seamless, and permanent access to information for Canadian research and innovation; and
- 2) enabling researchers and entrepreneurs to advance and exploit knowledge through accelerated, innovative scientific communication.

Third, the National Library and Archives of Canada, re-invigorated with a new forward-looking mandate, is a world leader in the management and organization of electronic materials and the long-term archival preservation of digital objects.

Fourth, CANARIE's Ca\*net4, the high capacity optical data pipeline connecting every Canadian university, can routinely handle enormous volumes of digital traffic.

Fifth, Canada's High Performance Computing Network provides both massive computational power necessary to analyze the terabyte-scale datasets that are quickly become routine in scientific research, as well as the short and mid-term storage capacity necessary to handle the huge volumes of smaller datasets that make up the basic knowledge material of everyday research.

Sixth, *Érudit*, the Quebec-based non-profit electronic publication service, provides the academic community with a full range of manuscript preparation, file management, electronic publication and repository services. *Érudit's* repository includes journals, research reports, monographs, theses and data sets from the human, social and natural sciences. Academic journals using *Érudit's* digital publishing services can make their content available on either an open access or tollgate basis.

It is notable that France's Centre nationale de la recherche scientifique (CNRS) recently purchased *Érudit's* leading edge software platform and will be implementing it across all of its institutes.

And seventh, our research councils and foundations provide both financial support and the regulatory frameworks needed to build the next generation of research communication systems.

Three proposals are currently gaining support across Canada's research and library communities that may also prove to be springboards to the creation of a comprehensive scholarly communications system.

- The Strategic Alliance of Federal Science and Technology Libraries is preparing a business case for a Federal Science eLibrary (FSeL). This collaborative initiative involving six key science-based departments and agencies aims to create a virtual library that could be used by all Government of Canada scientists, S&T researchers and policy analysts.
  
- The Social Sciences and Humanities Research Council and the Canada Foundation for Innovation are supporting the development phase of the Synergies Project. Building on the *Érudit* model, this project would

bring cutting edge electronic publication and digital repository services to all university researchers in Canada regardless of their location or the resources at their home institution.

Each regional centre would provide production services for electronic academic journals and dissemination services – through institutional repositories – for faculty research outputs, including journal articles, research data, theses, research reports and more.

- And the National Consultation on Access to Scientific Research Data (NCASRD) recently recommended the creation of a national infrastructure to ensure the open and secure access to key databases of scientific and historical importance to Canada and the world.

## **From Vision to Reality**

So what needs to be done to take this vision from concept to reality?

Let me move away from Canada now and speak more broadly.

From my perspective as a policy advisor, building a 21<sup>st</sup> century research communication system, both nationally and internationally, will require specific attention to a variety of managerial, legal, policy, cultural and financial issues.

Some of the key challenges that would have to be addressed include:

- Overcoming institutional silos;
- Updating regulatory and legal frameworks;
- Improving researcher and other stakeholder familiarity with new channels of communication;
- Training networks of systems and managers; and
- Providing adequate human and financial resources for program structures.

Meeting these challenges will require leadership, political will and institutional collaboration at all levels of the system.

Above all, achieving a comprehensive, open-access research communications system will require a culture change. We can create all the networks, facilities and systems we want, but unless researchers choose those media to share their data and results with others our efforts will be meaningless.

Researchers in all countries must be motivated to properly preserve and exchange their research data, to publish their findings in open access journals and to deposit their published articles in institutional repositories.

For this to happen we will need to shape a change in mind-set across academia and government that recognizes and rewards researchers for the value of their collaborative work and state-of-the-art data management. We will have to look at institutions in a different light as well, recognizing the size and quality of their data archives and open access repositories as measurable scientific outputs.

There is also an international dimension to this issue. As I mentioned earlier, it is absolutely essential that the international research communication system of the future

effectively engage the research libraries and research institutions of developing nations.

Given the vital link between science, innovation and economic and social development, this is as much an issue of social justice as it is of scientific progress.

According to figures presented by Stevan Harnad at the recent open access conference in Southampton, England, there are currently 114 OA archives in the United States, 51 in the UK and 28 in Germany. In contrast; there are only six in India and four in China.<sup>3</sup> In Canada, 26 universities have registered their repositories as open access.

For my part, my office will be working with the Canadian research and library community to ensure that Canada engages with developing nations to develop the infrastructure, skills and expertise they need to build and manage their information and knowledge resources, as well as to tap into the global information commons.

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<sup>3</sup> Stevan Harnad as quoted in David Dickson, "Open access archiving: an idea whose time has come? SciDev.Net, March 7, 2005; Personal communication with David Moorman, Social Sciences and Humanities Research Council, May 26, 2005.

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## **A Challenge to the Technical Library Community**

As IATUL members and technical librarians, I urge you to consider how you can fit into the policy process as the global community begins to consider how best to structure the research communication systems of the future.

You have a unique knowledge of the technical and managerial challenges that we will have to overcome to build such a system. You are ideally placed to facilitate discussion and collaboration across many disciplines. And you can bring an important international awareness and set of linkages to the dialogue.

Your participation is very much needed and will be valuable indeed.

Sachez également que le Canada vous soutiendra dans cette démarche. En tant que membre de la communauté des nations, il s'est engagé à être responsable et proactif sur la scène internationale, c'est-à-dire à prêter main-forte aux autres et à apporter un avantage réel dans tous ses partenariats internationaux.

## **Conclusion**

In closing, I'd like to go over some points I hope you will keep in mind:

- The first is that data, information and knowledge are fundamental to innovation, economic growth and social well-being. Knowledge and information generated by publicly funded research are truly public goods – we have a responsibility to manage them well and maximize their impact on society for the betterment of all.
  
- Second, building a 21<sup>st</sup> century research communication system is both a national and international challenge. Knowledge is a global commodity and the future of humanity depends very much on our ability and willingness to ensure that all nations have the capacity to access and use scientific and technological knowledge, information and innovation.

- Third, we are not starting from scratch. Science has a long history of collaboration and there are many international associations at the disciplinary level with networks and expertise we can draw upon. We can build on existing strengths. Leveraging national, international and multi-disciplinary partnerships will be key.
- And fourth, there is a compelling need for action. In an age when the world is looking to science to come up with solutions to global challenges, the need to safeguard, evaluate and exchange information and knowledge has probably never been more pressing. Unless we act, the unprecedented volume of research information will become increasingly difficult to manage. Highly valuable, and often irreplaceable, research data will be lost.

As a global community, we must move now to ensure that we maximize the impact of scientific, technological and medical research for the benefit of society as a whole.

As technical librarians, your profession is indeed coming to a crossroads – with a choice of challenges and opportunities.

Which path will you take?

I'm sure I don't need to remind you that there is a stereotype that paints librarians as cautious individuals, who like to stay in the background and seldom take risks.

But I personally don't believe that for a moment. Success doesn't come to those who stand pat or move only incrementally. Sometimes, we do have to challenge ourselves to move out of our comfort zone.

I often find these words by science-fiction writer Arthur C. Clarke inspiring:

*The world needs uninhibited thinkers, not afraid of far out speculation; it also needs hard-headed conservative engineers who can make their dreams come true.*

Vision and practicalities – each are equally important. As technical librarians, you are capable of both.

Thank you.