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Knowledge Management Practices at the National Research Council of Canada

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This paper will discuss some of the initiatives underway within the National Research Council of Canada (NRC) to share and to mobilize knowledge both internally and in concert with external partners. At this point in time, there is no formal NRC strategy or organizational structure for Knowledge Management (KM) but many 'good practices' exist or are emerging. Practices and initiatives at the Canada Institute for Scientific and Technical Information (CISTI) are highlighted as are corporate-level efforts. A few specific examples of KM related activity in other parts of the Council are mentioned but other initiatives also exist.

Background

Established in 1916, the National Research Council of Canada (NRC) is known as Canada's premier science and technology research organization, as a leader in scientific and technical research, the diffusion of technology and the dissemination of scientific and technical information. Until the 1980s, NRC's research generally followed internally generated priorities and was seen as part of the 'public good'. Research teams predominantly worked apart from industry although firms did come to NRC for expert advice and funding through the Industrial Research Assistance Program (IRAP).

Reductions in Federal funding began to affect NRC and other Canadian government laboratories in the 1980s. NRC then needed to adapt its culture, re-focus priorities and begin to generate more revenue. We began to see research groups working collaboratively with industrial firms and there was also more promotion of NRC infrastructure elements such as wind tunnels and towing tanks. Research programs became more aligned with areas key to Canada's economy.

Virtually all parts of NRC now work in partnership with innovative companies, universities and research organizations worldwide. Through knowledge, research and innovation, NRC and its partners are making a significant impact in science and technology and are promoting industrial innovation for greater competitiveness. Building and managing knowledge-based relationships is a significant part of NRC's new role, as is developing synergies in regional and industrial sector communities. The organization is strongly focused on helping Canada develop a knowledge-based economy through science and technology, and recognizes that to realize that goal, NRC's employees and their collective knowledge and experience are key elements. A national organization with regional and community presence, NRC works within Canada's innovation system and provides scientific and engineering infrastructure, research and knowledge to public and private sectors.

NRC's world class research teams across Canada help stimulate ideas and lead in the establishment of partnerships with industry and academia. People with knowledge, creativity and dedication are NRC's strength. One of the world's largest comprehensive information sources exists in the Canada Institute for Scientific and Technical Information (CISTI) within NRC. CISTI is a document supplier, a scientific publisher, and a provider of value-added information services. With its network of highly skilled information specialists, CISTI operates 20 NRC Information Centres located in regions across Canada as well as at the main Ottawa campus. Another large, knowledge intensive decentralized NRC group is IRAP, a team of 260 advisors located throughout Canada. IRAP shares technology-development expertise in local communities and provides cost-shared funding to small and medium sized companies to stimulate innovation.

Drivers for Knowledge Exploration

There are many reasons why an organization like NRC needs to focus on knowledge and on intellectual capital. New knowledge and innovation are interconnected and today's work environment is knowledge-

intensive. Increasingly there is an expectation and a need that information and knowledge are easily accessible to all. On the other hand, everywhere today there is an overabundance of data and information. Individuals find that there are not enough hours in the day to deal with everything yet their work demands that they make fast decisions. They need the right information/knowledge at the right time. Collaborative technologies can reduce duplication of effort and allow information to be synthesized into knowledge and made more widely accessible. Collaborations / partnerships / alliances / knowledge communities are increasingly associated with success and competitive advantage. KM can also be seen as a strategy for promoting competitive technical intelligence in firms.

Turnover and succession planning are issues for organizations with highly specialized workforces. At NRC, a significant amount of the organization's tacit knowledge could disappear as people retire within the next 5 years. Because people tend to leave if they feel that their talent is not being fully used, it is important to find ways to identify, reward and leverage the expertise held by the organization.

Corporate Knowledge Management Thrusts at NRC

In the fall of 2000, NRC established a senior management level KM working Group tasked with addressing KM issues at NR%C and considering if and how NRC should deal with KM from a corporate perspective. In 2001, a second Working Group was formed to study NRC Information Management / Records Management. Their task is to develop a high-level policy that sets out broad direction for IM / RM at NRC including paper based material, electronic information and other media. The group is also investigating the feasibility of implementing an Electronic Document Management System at NRC. NRC has organized, hosted, sponsored or contributed speakers to many KM related conferences over the past 3 years.

A number of new programs or business practices at NRC formalize the organization's commitment to creating an excellent work environment that embodies a culture of learning, collaboration, trust and sharing of information. NRC's new Employment Philosophy sets out the organization's intent and describes the culture that they hope to achieve. Competency-based human resources management is similarly being introduced, with the goal of enhancing and sustaining excellence in employees. To support that element of the Employment Philosophy, NRC recently launched LearnNet, an intranet-based NRC-specific tool for learning and development. LearnNet features detailed information for each competency grouping, a self-assessment questionnaire, a template for individual learning plans, and such learning tools as formal training courses and workshops, relevant literature, Web sites and suggested on-the-job learning opportunities.

NRC has made use of collaborative technologies to increase the efficiency of internal and external knowledge sharing. The organization was an early adopter of e-mail and now virtually all employees have e-mail access. Efforts to standardize on common hardware platforms and software programs have met with some success. Sending and receiving information through attachments is certainly far less complicated and daunting for some than it was five years ago. NRC also supports an integrated technology platform, making use of Microsoft Exchange servers. Some institutes share documents and data through public folders while other groups have adopted commercial software such as Lotus Notes / Domino because of its web interface, greater flexibility and security.

In 1998/99, NRC introduced Sigma, a SAP solution that provides an integrated business system. The SAP modules for finance, material management, fixed assets management, human resources and sales and distribution are used throughout the Council and the project management module is used within some Institutes. The process of replacing the old legacy systems was disruptive and many lessons were learned during the project. Because the first year of operation after launch was a year of sudden change for staff – with an imperfect system – Sigma is not highly regarded by all even yet. Despite the initial problems, NRC now does have an effective integrated business system with a single entry point for data. Benefits include less paperwork, decentralized access to financial, human resource, and project related information and the capability to generate reports.

During 2000/2001, NRC employees together crafted the NRC Vision to 2006, updating the earlier V ision to 2001. The process was consultative and collaborative and involved workshops and meetings with employees from across Canada, both in their home locations and in co-located cross-institute sessions. Links to the vision can be seen at http://www.nrc.ca/corporate/vision06 . The vision: "Recognized globally for research and innovation, NRC will be a leader in the development of an innovative knowledge-based economy for Canada through science and technology" is founded on five strategic pillars, all of which have a KM-related theme. Key themes mentioned include the value of NRC's intellectual capital, the integration of that strength to create new opportunities, innovative capacity and to foster technology transfer, knowledge dissemination and increase global reach.

Another example of NRC sharing knowledge and learning can be seen in the establishment of Special Interest Groups (SIGs) and in Technology Clusters. In the Special Interest Groups NRC researchers together with industry counterparts work in a model that benefits all members and focuses exclusively on pre-competitive research associated with the improvement of fundamental manufacturing processes. Each SIG targets a specific branch of manufacturing.

Innovation at the local level based on public and private sector relationships and networks is the essence of technology clusters. Their goal is the development of the innovative capacity and the socio-economic potential of Canada's communities. NRC has already been a player in Canadian clusters formed in Saskatoon (agricultural biotechnology) and Montreal (biopharmaceuticals).

According to NRC President Dr. A. J. Carty, the key components of clusters are:

- R&D, done either within firms or accessed through an organization such as NRC;
- a highly skilled workforce;
- venture or investment capital from knowledgeable sources;
- a government milieu favorable to growth (tax incentives and regulations);
- information programs and tools to effect knowledge and technology transfer;
- incubators and mentors to nurture new enterprises and provide them with management and marketing skills

The key to clustering is an efficient linkage among all these building blocks. The technology-driven firms thrive on the synergies they derive from associating together and from their access to resources and information. See the following advertising supplement in Maclean's Magazine for more information on NRC's approach to clustering: http://www.nrc.ca/corporate/supplement/macleans.pdf

NRC is now helping several communities in Atlantic Canada to develop clusters focused on e-commerce (New Brunswick), ocean technologies (Newfoundland), life sciences (Halifax, Nova Scotia), wireless technology (Sydney, Nova Scotia) and bioresources and the environment (Prince Edward Island). Still other potential cluster opportunities could take place across Canada if resources become available. NRC's role in clusters is as a magnet, a catalyst and a connector. Because the innovation clusters are both social and economic phenomena, network building is an essential element. Within a cluster, government departments at all levels work in partnership with academic institutions and the private sector. The structure provides the capacity and flexibility for groups to act and innovate rapidly, and the system leverages access to important resources and information.

In early 2001, IRAP introduced SONAR, a client relationship management system. Described as a corporate memory system, SONAR creates a complete record of IRAP's interactions with clients and the software will allow staff to record, access and, in some circumstances, to share knowledge about their clients, with appropriate protection of confidential business information. IRAP staff is dispersed across the country and this system, managed by information-sharing principles and guidelines should greatly improve administration of client information. The system will contain information on funding agreements, meetings, and progress reports; all in one easily accessible place.

NRC has a strong presence on the Internet, internally and externally. Pages describe institute programs, focusing on opportunities for NRC – industry collaborations. The sites often share past successes the groups have had. The external web sites are vehicles to promote NRC services, programs and expertise throughout the world. The central intranet site for NRC, called Zone, brings together information from groups that provide services to NRC or have a need to communicate with all staff such as: Finance, Human Resources Branch, Information Management Services Branch, Offices of the two Vice Presidents and CISTI. From the site, links provide NRC employees with easy access to a wide range of knowledge sources including the full text of the Human Resources manual, travel and training-related information, access to internal directories, organization charts, and to CISTI's Virtual Library. The Virtual Library, in turn, provides a portal to CISTI's electronic journals and reference tools, plus a range of database and current awareness sources available for end-user searching. It also offers links to non-NRC sites related to various research areas.

KM practices / initiatives at CISTI

Formerly Canada's National Science Library, CISTI is now one of the world's most comprehensive collections of scientific, technical and medical information. The organization of knowledge and access to it is a key objective for CISTI. With new technologies, the focus is on bringing information to individual desktops, putting the power of information in the hands of those who need it every day. NRdc employees have the opportunity and ability to search for themselves. CISTI information specialists ae now knowledge partners, leveraging the power of information.

Expertise Database. For a number of years before web technology was available, CISTI maintained a database and a batch-produced index known as the Knowledge Source Index (KSI). The database included expertise within NRC, other government departments and some academic institutions in Canada. The KSI activity ceased, at least in part, because the program was labour-intensive and searchability within the index was very limited. In 1998, CISTI began work on a project to create a web-accessible database of expertise available at NRC. The database http://www.nrc.ca/expertise/ was released the following year and now has over 1,600 entries reflecting NRC expertise. NRC has roughly 3,000 total employees located in 17 research institutes and 4 technology centres across Canada. All institutes are now contributing to the database. Participation is voluntary and each institute determines eligibility for submission. Some institutes may decide to include only continuing staff, for example, while others include terms, guest workers and any other expertise they feel is relevant and available. For many institutes the participation rate is in the 80-85% range. Because e-mail and web-based forms assist the process, CISTI keeps the currency of entries at close to 90%.

Approximately 3,000 individuals and organizations from around the world access the Expertise Database each month. The database strengthens communication within NRC by helping researchers and technical officers identify colleagues in other parts of the organization who can contribute to current or future projects. It also helps promote NRC research and expertise externally to potential collaborators and partners. CISTI's long term plan for the Expertise Database includes adding links to authored publications. NRC is also a partner within the National Expertise Index on Industry Canada's Strategis web-site. Entries from NRC's database can be accessed through the Strategis index, so that someone who finds Strategis and searches the National Expertise Index will also learn of NRC areas of expertise.

Publishing and indexing. A publisher of Canadian and international scientific research results since 1929 and the foremost scientific publisher in Canada, the NRC Research Press helps researchers to share their knowledge through the process of scientific publication (books, conference proceedings and journals). Through funding from the Depository Services Program of Public Works and Government Services Canada, 14 (15 beginning in Jan 2002) peer reviewed journals published by the Press are now available electronically without charge to anyone with a Canadian IP (Internet Protocol) address. The full text of journal issues published in the past few years is searchable on the site and current and older publications are also indexed and searchable through traditional abstracting/indexing tools.

CISTI digitized many of the older series of publications from NRC's Institute for Research in Construction (IRC) and those are available to clients through the Internet. IRC also has created a database of all publications ever authored by researchers within the institute and published in the open literature or

issued through NRC. It is available at http://www.nrc.ca/irc/publications.html . Claickable links in the database lead to the full text if it is available in electronic format. The publications database is u0pdated weekly and is a very efficient means of transferring IRC knowledge and technology to the Canadian construction industry.

Electronic Publications. Electronic journals and reference tools, available to RNRC clients from their individual desktops are the core of the NRC Virtual Library. First launched in 1997, the Virtual Library currently provides NRC with licensed access to about 3,500 full-text electronic journals, databases and books. Because an increasing amount of scientific, technical and medical information is delivered from publishers electronically, CISTI is acting to ensure enduring access to these critical resources. In 2001, groundwork for what is being called the e-Infostructure initiative was put in place. Included are a high capacity server, software (ScienceServer) that performs the functions of data loader, full text search engine and hypertext contents manager. CISTI's goal is now to negotiate with publishers for the rights to operate a Canadian site, separate from those of the publishers and to retain electronic copies of journals. As content is negotiated it will be made available through an aggregated site that will allow for cross-publisher searches.

Intranet and Internet Development. CISTI was a pioneer in web development at NRC and after establishing its own intranet and Internet presence, it went on to share expertise and lessons learned by helping other parts of NRC to develop web sites, by hosting the sites and then by developing other web-based applications that help facilitate information and knowledge management.

CISTI has worked extensively with the Canadian Technology Network (CTN) http://ctn.nrc.ca in the development of their web sites. The CTN Intranet is a good example of knowledge management. It incorporates Lotus Notes / Domino features that facilitate shared document libraries and shared information on client-related activities. The site also has an electronic discussion board that provides another route for questions and answers among member organizations and advisors.

CISTI does some Internet development and web hosting for non-NRC clients, including ICSTI. A recent collaborative effort between NRC's Canadian Police Research Centre (CPRC), the Canadian Police College (CPC) and CISTI resulted in a new, public view of the CPC Library catalogue. The CPC Library serves the College personnel and also is a research and reference center for the entire Canadian police community. Making their comprehensive catalogue available to all from an RCMP site was impossible due to the strict security protocols surrounding networks. The internal catalogue was already web-enabled, written in Cold Fusion code, but in order to be accessible to non-RCMP personnel, it had to be transplanted, with the catalogue database, to a machine outside the network. In the end, both the database structure and code underwent significant change, and a method was established to allow regular weekly updates. The project succeeded and the catalogue can now be reached by anyone interested at http://www.cpc.gc.ca/library_e.htm from the 'Library Catalogue' link.

Another collaborative NRC initiative recently culminated in the launch of a web-site for the APEC Technology Foresight Network at http://www.apectf.net . The idea of developing a web-based Network came from Jacques Lyrette, NRC's VP Technology and Industry Support, a member of the International Advisory Board of the APEC Technology Foresight Center. He could see advantages in building a network both to promote the Center and to enhance the connections between the group of individuals engaged in technology foresight activities. The CTN National Office with its experience in network building, was approached to develop the concept further. Once a prototype was developed and approved, NRC agreed to lead the project by developing a web site with an expertise database. CISTI's Research and Innovation Support group developed the site, which includes database-driven applications – featuring profiles for experts in technology foresight activities, as well as profiles for recruited organizations (such as the NRC), and countries/economies. Experts are encouraged to identify their areas of expertise and elaborate on their publications and projects in Technology Foresight activities both in science / technology areas, as well as in unrelated areas such as economics or philosophy. There are also Events and Discussion areas. At some point in the future, the system will be transferred from its current NRC home, to Thailand, the home of the APEC Technology Foresight Center.

Current awareness and Document Delivery. CISTI Source is a fully integrated current awareness and document delivery service offering up-to-date information in science, technology, medicine and other related fields. The product includes an Articles database that covers more than 15 million articles in 17,000 different journals. Tables of contents for these journals are accessible from both CISTI Source Articles and the companion database CISTI Source Journals. Users with subscriptions to the corresponding electronic journals can view the full text of the articles online, or the articles can be ordered directly from CISTI. Clients can create their own Alerts which will notify them by email every time a new article or table of contents in their specified areas of interest is added to the service. CISTI source also provides access to the CISTI Catalogue. Source and similar current awareness tools help both intermediaries end-user clients stay on top of new developments in their field without the burden of maintaining subscriptions to all the journals involved. CISTI's services are all web-based. Clients searching the catalog or the current awareness system can place orders online and receive them by fax or through electronic technologies permitted by copyright legislation.

Collaborative software. Within CISTI, Lotus Notes / Domino is being used for business intelligence and project management to a limited degree. Several applications have been created and some are used as document libraries associated with large projects. Other applications track progress on project related activities. Further work on collaborative software that may benefit CTN, CISTI and other groups will e carried out over the next year.

A Lotus Notes / Domino application was developed for CISTI's Marketing Group who wanted to capture any information impacting on CISTI business lines. The application may be populated more in the future but the group involved found that because the information is received by email most of the time, staff prefer to share information simply using email rather than going into a separate application that was new to them. Currently information is collected, analyzed but not stored in an application. Email summaries are sent out to the rest of the organization. Tools need to meet the client needs as well as their work habits or they may not succeed.

Trips, Conferences and Discussion lists. CISTI is one of several NRC groups that attempts to increase the return on investment from staff attendance at conferences or from work-related trips by sharing reports on their Intranet site. The idea is that trip reports contain a wealth of knowledge not written down anywhere else, and that the organization can be more effective and efficient when employees are aware of each other's activities, what key contacts are being made and what the latest technologies are.

E-mail or web-based Newsgroups or discussion groups are in use within several institutes, including CISTI and IRAP. These 'virtual communities of practice' provide a forum for questions and answers, exchanging of ideas and sharing of information. Currently e-mail discussion lists help to link people with common interests, regardless of their geographical location. At CISTI, the VL-Info-BV is an electronic mailing list used for disseminating information about the NRC Virtual Library. It informs staff and clients of new or changed resources, alerts users to system problems, and in general, keeps users up to date on the Virtual Library. The NIC-Info list brings CISTI staff in the regions into closer contact with the staff working at M-55. Through it, NRC Information Centre (NIC) information specialists can make their colleagues aware of projects they are initiating, or can elicit advice/discussion on issues related to services to clients. The list attempts to encourage communication and minimize potential duplication of effort, and helps to ensure consistency in the application of policies.

Competitive intelligence. There are several initiatives related to competitive intelligence within NRC. One partnership is in place between IRAP, CISTI and the Canadian Institute for Market Intelligence (CIMI) in British Columbia. A second partnership involving IRAP, the Canadian Technology Network (CTN), CISTI and the University of Manitoba's Asper Centre for Entrepreneurship has recently been established in Winnipeg. Both are focused on helping IRAP Industry Technology Advisors (ITAs) access information and expertise and on providing IRAP SME clients with competitive intelligence assessments / analyses.

A few KM activities / initiatives in other parts of NRC

The Industrial Research Assistance Program (IRAP). IRAP's goal is to increase the innovation capabilities of Canadian small and medium-sized enterprises (SMEs). Through a network of public and

private research and technology-based organizations across the country, IRAP's team of more than 260 Industrial Technology Advisors (ITAs) helps industry to access expertise, financial assistance and facilities needed to carry out research and pre-competitive development activities. They share skills and knowledge about all aspects of innovation and also work to establish links with other key players within the innovation process, drawing on the expertise of technology-oriented organizations and NRC institutes. ITAs, who have both business and technical expertise, connect SMEs with the right expertise, resources, technology, sources of capital or potential partners and save SMEs time and money.

IRAP has now established 11 Technology Sector groups (Agri-food; Biotechnology; Chemical processing; Communications; Construction; Electronics and Signal Processing; Manufacturing Aerospace; Manufacturing Integrated Technology; Manufacturing and Materials Processing; Software; and Sustainable Development). The sector groups are teams of ITAs, and their roles include information sharing, fostering collaboration, provision of connections to Canadian technology sources, professional development and networking. Participants in sector groups are geographically dispersed but are linked through e-mail lists, and web-related resources are under development. Each group meets face-to-face at least once annually. Questions from members are posted to the mailing list and are answered by those who can contribute to an answer or want to make a comment.

The Canadian Technology Network (CTN). An IRAP initiative, the Canadian Technology Network (CTN), is another knowledge integrating contact for small and medium sized enterprises. CTN member organizations link federal and provincial labs and agencies, universities, community colleges, industry associations, technology centres and economic development agencies. This network of over 1,000 members provides Canadian companies with access to expertise, advice and information associated with technology and related business challenges. CTN is a people network connected by a shared information system. It is the people who make the difference. CTN Intranet has a web-based Help Wanted message board area, where CTN advisors can post requests for assistance. The initiative is new to their public web site, but already there is evidence of the value of sharing expertise. Related success stories are posted at http://ctn.nrc.ca/ctn/hss_e.html .

Institute for Information Technology (IIT). IIT, an Ottawa-based institute that works on knowledge management-related tools, has an overall goal of assisting industry through collaborat6iv e research and development projects. IIT is one of several NRC institutes that holds a regular series of colloquiums or seminars designed to share information related to current or past projects. The projects that IIT has worked on over the past few years are varied and numerous. Products resulting include: EXTRACTOR, a new software module that automatically summarizes any document by scanning the text to select several short phrases which best describe the topic of discourse; and CUSTIFIER, which addresses the problem of organizing a collection of documents into groups having similar topics. In supervised mode, a person defines the topics by manually grouping 10 percent of the documents and CLUSTIFIER does the rest. In automatic mode, CLUSTIFIER automatically discovers a set of topics around which to group. BIRD is a totally new type of Internet search engine providing a superior solution to the problem of searching by topic. A person provides BIRD with one or more web pages on a topic of interest; BIRD then returns a ranked list of other web pages on this topic. BIRD is built on algorithms adapted from bibliometrics, making it an excellent complementary technology for integration into Internet search products. ACORN (Agent-Based Community Oriented Retrieval Network) is a product that can distribute documents to all people in an organization to whom the content is relevant. ACORN solves a problem typical of large, dynamic organizations; the people to whom a particular document is relevant are not easily determined. ACORN is designed for inclusion into intranet products, maintaining profiles of each individual's relevant topics, and updating these profiles based on their responses to documents read and recommendations for forwarding them. These are a few samples, rather than an exhaustive list, of work being done within the Institute for Information Technology and it is quite likely that other institutes at NRC are also working on tool development.

Summary

NRC has a number of good knowledge management-related practices, although at this point there is no formal strategy for KM in place within the organization. Corporate KM thrusts include the formation of a senior management level Knowledge Management Working Group and an Information Management /

Records Management Working Group. Other efforts have involved the introduction of new programs or business practices such as competency-based human resources management, NRC's new Employment Philosophy, LearnNet, use of collaborative tools and technologies to increase the efficiency of internal and external knowledge sharing. All these elements help to build a sharing culture, and create a work environment that helps staff grow professionally and be rewarded for that growth.

For many years CISTI has shown leadership in technologies that provide clients with timely access to science-related information. In recent years, the focus has been on bringing information to individual desktops. KM-related initiatives include the Expertise Database, publishing activities, and research into digitization and electronic publications. CISTI has strong involvement with Intranet and Internet development, and makes use of those to share information. CISTI is also working with collaborative software to further extend information and expertise sharing, and participates in competitive intelligence initiatives. Other parts of NRC are also involved in initiatives leveraging NRC's intellectual capital internally and externally. The few examples mentioned, including networks in IRAP and CTN and the tools developed through the Institute of Information Technology, are by no means an exhaustive list. NRC is also involved in initiatives such as technology clusters and special interest groups, as well as partnerships between NRC institutes and industry groups – and these benefit all involved. NRC knowledge is shared and a valuable international network of technical and scientific intelligence helps to bring external knowledge into the organization. This knowledge and expertise can be used to transfer S&T information back to Canadian firms and universities and to leverage new innovation opportunities for Canadian industry internationally.

Much of NRC's current focus is on building linkages and working with other players who can make things happen. No one group can do it all on its own. NRC has found that being known through the success of a partner in innovation is a very positive situation. Stories that illustrate the success of sharing information and expertise are now being gathered. There is evidence that NRC knowledge-sharing practices are having an impact on growth of firms and new business ventures. They are also positively affecting local employment, increasing innovation and client satisfaction, reducing re-work and accelerating product introduction.

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