The BELLE Project: Toward a National Digital-Content Repository

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Abstract: A key component of Canada's commitment to the emerging information age has been the extension of broadband Internet connectivity to institutions of higher education. However, the design and implementation of broadband applications that could support the goals of higher education has proved challenging for these institutions. This article introduces the BELLE (Broadband Enabled Lifelong Learning Environment) Project, an interprovincial initiative to prototype a national shared-digital content repository—a potentially transformative application for education. It outlines the goals and components of BELLE as well as the promises and challenges of digital-content infrastructures for educational and research activities, contextualized within current discourse about the information age.

Introduction
BELLE, the Broadband Enabled Lifelong Learning Environment project, will develop the prototype for a nationally networked system across Canada. It is a $3.4-million project jointly funded by CANARIE (Canada's advanced Internet-development organization, the Canadian Advanced Network for Research, Industry and Education), Netera Alliance (Alberta’s Regional...
Advanced Network), and 10 Canadian educational institutions. This report provides a brief overview of the project to date and in so doing invites other researchers and institutions to participate in this study.

BELLE has three core aims:

1. To develop the prototype for a national digital-object repository;
2. To develop a test-bed infrastructure for high-end desktop-to-desktop video conferencing, repository-content repurposing, and access;
3. To promote an understanding of the ways in which particular educational activities can be enhanced by the broadband applications we are investigating.

The project came to life in 1999 in response to a CANARIE funding opportunity called the Learning Program. In the spirit of this program, the BELLE project addresses some of the institutional and structural barriers that have so far stalled the productive uptake of broadband technologies in education.

This brief report examines our conception of and rationale for BELLE within the larger context of Canada’s vision for the information age. It addresses the key project components (the ways in which the BELLE design will initially address structural barriers inherent to broadband-technology uptake) and briefly outlines the future of this project and its related initiatives.

**Internet connectivity and the Canadian context**

In 1995, the Canadian federal government announced its commitment to the “information society” in a vision document it called the *Information Highway Advisory Council Report*, within which the extension of Internet access was a vital element. A follow-up report in 1999, *Connecting Canadians*, encouraged Canadian public- and private-sector interests to make the linkage of homes, businesses, and institutions a priority in the next millennium. Since then, Canada has become one of the most “wired” nations in the world; federal, provincial, and private-sector interests have rallied to extend telecommunications infrastructures and to further define Canada’s role in the information society through application development, funding opportunities, and user trials.

Broadband networks have been available to research institutions in Canada for some time (since the original CA*net inception in 1990) through the Industry Canada–funded, CANARIE-managed, CA*net national network. The most recent upgrade, a world-class fibre optic trunk line called CA*net 3, stretches between Canada’s coasts, linking up research institutions through provincial Regional Advanced Networks (RANs), which enable the extension of high-speed networks within the provinces. The Quebec RAN, RISQ, in its attempt to circumvent high telecommunications costs, has built its own dark-fibre networks to carry Internet traffic for public schools in the province. In Alberta, Netera Alliance completed the world’s longest gigabit Ethernet corridor between provincial education and health institutions in the summer of 2000.
Residences and businesses are also increasingly enjoying enhanced high-speed Internet delivery in some parts of Canada. Alberta’s SuperNet, a forward-looking joint initiative between the provincial government and private-sector telecommunications companies, promises at least 10 megabits per second to 400 communities by 2004. These innovative public and private telecommunications initiatives are evidence of the strong Canadian commitment to bring high-speed broadband Internet connectivity to Canadian citizens, businesses, and public institutions.

Although the extension of high-speed Internet access has meant various things to many different areas of Canadian society, the potential that broadband connectivity holds for private, commercial, and public use is becoming clearer. Ever-increasing applications (and the exponential growth of e-commerce) have resulted in unprecedented Internet use and a need for far greater bandwidth in both the public and private sectors. For educational institutions, however, the scope for productive use of bandwidth is less clear, in part because of the far-reaching sociocultural interests and responsibilities of education. This mandate, along with the complexity of institutional change, diversification in the student body, and growing competition among institutions (compounded by increasing demands upon these institutions to integrate technology and improve the quality of education), has made the immediate and intelligent adoption of broadband applications a greater challenge in this sector.

In an emerging information age, educational institutions are increasingly being forced to demonstrate agility, flexibility, and, ultimately, even their own value (Brown & Duguid, 2000). BELLE aspires to help Canadian universities design broadband technologies that will assist them in meeting these challenges, while helping all of the provinces become more effective participants in the emerging information age. The BELLE vision for Canada and its educational institutions relies on several key concepts associated with an information society.

**Information productivity: The key to success in an information society**

Most of us can identify such essential support technologies of the information age as internetworking, connected databases of digital information, and synchronous or asynchronous communication. We can also identify several of its anticipated outcomes, such as better education and access to it, enhanced opportunities for business, and harmonious global communities, whereas a coherent vision for their effective implementation is rather more difficult to picture as of yet. What we do have at hand is exploration and leadership guided by larger discourses (which may help refine our present understanding of the inherent potential for the technologies we are in the midst of developing). Lastly, although globalization is outside the scope of this paper, its inevitable framing of any social issue—and ultimate relevance to this project—also requires our most serious investigation.

The following provides a rough outline for a postsecondary response to the challenges and potential that the full-blown information age represents for our altered relationship with information. All previous societies have been characterized by information scarcity, wherein the goal was to acquire as much information
as possible, as it represented a useful commodity. Today we are experiencing an information surplus. Rather than its acquisition, we focus on devising strategies to distinguish between information that is useful to us and that which is not. At the heart of an information society we do not find technology, or information, but strategies by which to sift volumes of unwanted material for information of value to us (which we may apply to specific objectives).

In the 1970s, scholars began to sense the centrality of information within a future society. What emerged was a view of postindustrial society based on “information” (Bell, 1973, 1976) and “information systems” (Masuda, 1981), systems that would function as databases of value to industries and individuals. It was felt that a society based on information values, as opposed to material values, might bring about, among other things, individual self-actualization, participatory democracy, and global harmony. Optimistic about the potential of information, researchers in the eighties devised measures to determine a country’s level of “informatization” (Nora & Minc, 1980). Informatization was the measure of a given country’s information workforce (the number of its communications, public-service, public-relations, and education-related jobs and industries) (Organization for Economic Cooperation and Development, 1981), in addition to that of its information infrastructures (number of telephone lines, newspapers, radios, televisions, fax machines, computers, etc.) (Johoka Index, Ito, 1981; JIPDEC Index 1988). The higher a country’s level of informatization, the closer it would be to realizing the benefits of the information age.

Research from the 1990s gives us a clearer view of the importance of information and information technology (IT) to modern society. Dordick & Wang’s (1993) studies arrive at two very important conclusions. The first shows a positive relationship between information infrastructures and economic growth (and one also between growing information workforces and economic growth) but indicates that the expansion of these information infrastructures and workforces has caused disparities among nations (pp. 122-127). The second and more interesting finding is that the economic benefit First World nations have been enjoying from their use of information technology is the result of “transaction productivity” (p. 130)—using IT, instead of people, to mediate business transactions at the clerical level, thereby taking labour costs out of production. Moreover, their research showed that new technology was being used only to make existing processes—or old technology—more efficient (i.e., automation of work, ATMs replacing tellers). They argue that the most powerful aspects of information and information technology have not yet been utilized to any significant degree (p. 131).

Dordick and Wang equate true participation in an information society with “information productivity,” not “transaction productivity.” They define information productivity as “the ability to decide what information is required, and when, and to devise search strategies that select and simplify” (p. 131). They also characterize a true information society as one “aware of the importance of information in every aspect of its work, an attitude of mind that makes for the efficient, productive, broad utilization of information in every aspect of life” (p. 128). Instead
of using information and information technology to simply make existing processes more efficient, as in the transaction productivity approach, the information productivity approach looks creatively and continuously at the new information generated by information technology.

Sector-specific research supports this view of information productivity. Studies in the areas of business and knowledge production clearly suggest that the most powerful uses of information and IT are rarely employed. Michael Scott Morton, in his 1996 study of information technology and business, identifies three stages of IT application: automate, informate, and transformate. His research shows that business is well under way in using information technology to automate (replace labour with technology) and informate (analyze information generated by automation), but rarely uses IT to achieve transformation (that is, to develop new strategic business functions and practices through meta-analysis of all information generated in the automate and informate stages).

Luciano Floridi (1996), in his study of knowledge production, argues that scholarship has just scratched the surface of information technology. He presents as an example the untapped potential of digital libraries. Traditional paper-based methods of storing information restrict the kinds of queries that might be made of the body of human knowledge. Digitization of all forms of information media coupled with more extensive ways of describing data (metadata) will make it possible for far more sophisticated methods of inquiry (such as ideometric analysis) to navigate the entire body of human knowledge. However, the tools and skills necessary to make information productive in all sectors are not yet broadly understood.

We are beginning to realize some preliminary benefits of IT. But just as the industrial revolution, by the mass production of goods, has not fulfilled the basic needs of all people, the information revolution by its endless production and collation of information will not naturally engender a redesign of socioeconomic practices and values. If we continue to direct informatization in much the same the way as we have industrialization, we simply fulfill old goals in new ways, and will fail to comprehend or make use of the potential that information and information technology hold, not just for change but for transformation.

If information productivity is the key enabler of success in the information society, technology projects require the experience and commitment of those institutions who have traditionally been the caretakers, disseminators, managers, and producers of information and knowledge. Despite populist rhetoric, the future of networked information technology will not reduce us to independent information workers holding various palettes of information (Brown & Duguid, 2000). More than ever, society needs legitimate information intermediaries—educational institutions, libraries, publishers, and systems of peer review. As traditional intermediaries become obsolete and new ones emerge, our need for information productivity within certain contexts will become increasingly critical.

The BELLE project does not attempt to solve the information-productivity problem (an ongoing and somewhat organic sociotechnical process), but will
instead research ways and means by which to build sophistication into networked information-technology infrastructures. The project is directed toward providing educational institutions with new processes to make more productive use of information and information technologies.

**Tools and processes to enable information productivity in educational institutions**

The central feature of the Broadband Enabled Lifelong Learning Environment is a multidimensional concept called the *shared digital-object repository*. The following sections describe several ways in which digital repositories will enhance information productivity, primarily in the realm of academic research and educational activities.

**Quality control**

In academia, the integrity of knowledge is ensured through scholarly review during the publishing process. Although quite obviously the Internet is not yet amenable to quality control with the exception of certain isolated pockets, a shared academic digital repository *must* be constructed in such a way as to ensure the integrity of its collective materials.

**Ideometric analysis**

The strength of the Internet is presumed to lie in its ability to provide us with unprecedented amounts of readily available information by means of synchronous and asynchronous communication, eliminating the barriers of time and space between co-respondents. According to Floridi (1996), this may be mere novelty compared with the fact that it allows us to pose an entirely new range of questions within the domain of human knowledge. Interconnecting databases of digital information (text, sound, image, video) enable new kinds of qualitative and comparative analysis of human knowledge, called *ideometric analysis*—a multidimensional method of inquiry that has not been possible with print-based data storage and retrieval systems. Printed documents restrict the queries that can be made of the domain of human knowledge to linear print-based information-management techniques. Shared digital repositories and information-management techniques designed for digital data allow users to access, compare, query, and retrieve information in many ways simultaneously.

**Refined searching**

Interconnected digital repositories allow us to ask more sophisticated questions of knowledge domains; they also help us get to the right information more efficiently. Digital repositories address the problem of information surplus with the use of metadata, which describes and provides links to a given resource in much the same way that a library card indicates the nature and location of a specific book (Friesen, 2001). The application of metadata within the digital realm creates a precision tool that can query an infinite number of databases with a standardized yet extensible set of descriptive elements.
Research visualization and dissemination
One stumbling block in realizing the full benefit of research has been an inability
to effectively disseminate and communicate that research to the rest of society.
Traditionally, research has been published in journals, a medium that does not
serve to best express certain kinds of information. The digital realm can represent
visual ideas as well as text with ease and sophistication through images, animation,
and virtual reality. Digital repositories will make research available in all
media to students, educators, and other researchers.

Education delivery
University students who work and have families often prefer the asynchronous
flexibility of on-line courses through the Internet. With competition increasing for
on-line courses, universities are expending time and resources in order to make
high-quality courseware attractive to students (often enhancing courseware with
multimedia objects). Shared digital repositories can store, organize, and deliver
multimedia courseware components effectively and efficiently using maximum
bandwidth.

The metadata available in a particular repository can also describe and point
to resources available in other repositories and collections, allowing commercial
content vendors to manage and control access to their resources and allowing
others to search these and other databases from a single access point. When a user
searches the central metadata “store,” he or she is able to get single-point access
to resources that are otherwise scattered across the Web, in proprietary and public
databases that may have a wide variety of access protocols and paths.

Innovative teaching and learning
Instructional designers and educators are continually trying to find new ways to
make teaching and learning processes more effective—this is the foundation of
information productivity. One such experimental teaching and learning process
centres around the learning object (or educational object). A learning object is any
digital resource with a demonstrated pedagogical value, which can be used,
re-used, or referenced to support learning (Friesen, 2001). It may include text and/
or images along with such resources as Web sites, videos, animation, audio, pho-
tographs, projections, or other presentations. These objects are housed in digital
repositories for unlimited access by educators and students.

The economy of educational objects lies in the formalization of a process that
was historically an informal one—the sharing of teaching and learning materials
among academics. Making these digital objects easily searchable and accessible
through digital repositories creates an “economy of educational objects” for a
range of uses.
Project components
During the next two years, the BELLE project will examine the critical aspects involved in constructing its prototypical learning repository. The six main areas we shall initially focus on are:

- knowledge management
- content repurposing
- peer review and faculty reward
- test-bed infrastructure
- evaluation
- communication and training

Knowledge management
Someday we may be able to conduct ideometric analysis on large databases of digital information. The largest database of digital information to which we currently have access is the World Wide Web; however, it is becoming increasingly difficult for educators to find relevant and useful educational content on the Web (Magee, 2001). World Wide Web mechanisms for searching and accessing digital information have proven inadequate for effective academic research. The BELLE project is examining the theoretical and practical aspects of creating a repository specifically designed to index the digital assets held by institutions and providing the tools for their discovery.

The key to knowledge management is metadata. Metadata is the structure used to describe and organize digital assets once they are housed in a repository. Refined searches require a consistent set of fields or categories that describe digital assets. To deal with this issue, controlled vocabularies or sets of keywords must be used. BELLE’s work on metadata will address these issues, as well as training in the development of tools and techniques to index, search, and filter the content of repositories.

Content repurposing
The concept of repurposing is based on the assumption that a single digital asset may have several different pedagogical contexts (Magee, 2001). The work of compiling object repositories must be addressed with regard to many considerations, including the following:

- Who should index these objects? (Their creator, someone with specific domain knowledge, or someone with cross-disciplinary knowledge?)
- Can educators and students continually add descriptors to these objects as they are found to be useful in other educational contexts?
- How and by whom should materials be translated into other languages?
- How should the object’s copyright or provenance be considered/protected/cleared for use?
There are as yet no good answers to any of these questions. Although it appears that there is no shortage of content available, getting it into a useable form will be difficult. BELLE is currently setting up content-repurposing facilities at five of its partner institutions, which will be fully equipped to explore these issues.

**Peer review and faculty reward**

There are two dominant problems in the adoption and acceptance of digital-content repositories in the postsecondary setting. The first is a problem we are familiar with in using materials from the Web: how can we be sure of the integrity of content? This has become known as the “tree frog” problem. Simply put, how do we know if an on-line photograph of a tree frog is, in fact, a tree frog? Who verifies this? Who has the power to change its description (metadata) if it turns out to be something else?

The second problem relates to academic culture. Currently, academic publishing is the only real avenue for faculty to achieve academic recognition and credit. The creation of learning objects or the verification of digital content (although comparable to any form of expert consultation) is not yet viewed as academic work by many university faculty, as these activities take away from the research activities critical to their careers.

Through the CAREO (Campus Alberta Repository for Educational Objects) and PRITI (Peer Review for Instructional Technology Innovations) projects, BELLE is involved in the creation of peer-review guidelines for assessing educational objects. These guidelines may also provide a standard through which faculty members may receive academic recognition and credit within their disciplines and institutions.

**Test-bed infrastructure**

BELLE is working with all its partners to establish a broadband network of Client Learning Environments, Content Repurposing Facilities, and a digital repository. Client Learning Environments are mobile workstations that turn any classroom with a broadband connection into a distance-learning centre with H.323 video conferencing, application sharing, and multimedia content. Content Repurposing Facilities digitize and describe content. Content from a variety of servers may be accessed and managed through a sophisticated software repository interface developed by the CAREO project.

The actual technologies are the least important aspect of the BELLE project, and we fully expect that by the end of the project much, if not all, of our hardware will be approaching obsolescence. Prototyping and experimenting with potential applications is the only sensible way to build a viable network. BELLE’s most important contribution will be to make a large number of mistakes, quickly and inexpensively, and share them with other projects across the country.

**Evaluation**

BELLE is fortunate to be partnered with a highly qualified evaluation team at the University of Alberta working under Dr. Terry Anderson at Athabasca University. Our collaboration is designed around a five-stage method in which inputs,
activities, outputs, impacts, and outcomes are measured, shared, and collaboratively reported. At each of these stages, the activity logs filled out by partners in their pilot projects will very likely lead to significant revisions to the project—particularly in its approach to user support and communications.

**Communications and training**
BELLE is committed to ensuring that its geographically broad community of users share best practices, lessons learned, and solutions. Communications and training play a major role in this regard. Site visits, a 1-800 number, evaluation instruments, training workshops, and a weekly e-mail bulletin have all proven effective in letting the members of these educational communities stay in touch and share knowledge; and most recently, small-group meetings are being held through video conferencing.

Communication outside of the BELLE community is just as crucial to the purpose of this project. Too many educational-technology projects in Canada remain islands, in a sense, operating with individual and thereby incompatible standards. We wish also to share this work with the Canadian public, recognizing that, without being apprised of the actual work being done, it is difficult for most people to see why projects such as BELLE are of importance to the future of the country. Through documentaries, Web sites, and articles such as this, we continue our efforts to raise public awareness about the importance of broadband digital-content infrastructures to education specifically, and to Canada’s emerging role in the information age generally.

**Looking ahead**
BELLE continues to evolve in a number of different directions. The Learning Program is about to embark on its Phase 2 projects, and new partnerships and sub-projects, such as content delivery through satellites and digital-rights management, are being explored.

The most important aspect of BELLE, however, is that it serve as a springboard to new national initiatives. While the CANARI Learning Program has been the vehicle for an unprecedented level of co-operation between institutions, agencies, and organizations, it is now being suggested that this co-operation be formalized into a coherent project called the Canadian Repository Action Group, or CRAG.

The group intends to create a standards-based, bilingual, national learning-content metadata directory with supporting infrastructure that would link existing and potential pan-Canadian and international distributed-learning-object repositories. There is no doubt that this project would provide Canada with a significant competitive advantage in a critical market, but more than that, it could provide learners of all ages with an invaluable tool that is accessible to everyone, anywhere, regardless of their geographical location.

**Note**
1. The participating institutions are, from west to east, the Vancouver Film School, the University of British Columbia, the Banff Centre, the University of Alberta, the University of Calgary, the Uni-
versity of Lethbridge, the Northern Alberta Institute of Technology, Secceca@York, Sheridan College, and McGill University.

References