



THE FUTURE ISN'T WHAT
IT USED TO BE...

**TECHNOLOGY
AND THE FUTURE
OF LEARNING**

"If you don't know where
you are going, you will wind
up somewhere else"

—Yogi Berra

Challenge Paper



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TECHNOLOGY AND THE FUTURE OF LEARNING

Challenge Paper

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ISBN 0-9734545-3-9

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FORWARD

Technology and the Future of Learning

In 2006, *Contact North/Contact Nord*, Northern Ontario's Distance Education & Training Network, marks its 20th anniversary of facilitating access to education and training opportunities for residents of small and remote communities in Northern Ontario. This milestone is an opportune time to reflect on the how we have used technology to improve access to education and training over the past twenty years and to speculate on how technology will affect access over the next twenty years.

In 1987, the first group of students began pursuing their education and training goals at a distance using the *Contact North/Contact Nord* Network. As was noted by the then Ministry of Colleges and Universities in a news release, "Distance education enables students to take post-secondary programs off campus using new teaching media such as computers, fax machines, electronic classrooms and teleconferencing, as well as traditional methods such as tapes, television and correspondence courses."

Those pioneering students primarily utilized audioconferencing, or teleconferencing as it was known back then, to participate in their programs. As new technologies became available, *Contact North/Contact Nord* expanded the number of distance delivery options to accommodate the evolving needs of students and institutions, and provide a quality learning environment.

Today, through our Network of Distance Education & Training Access Centres, students can access full-time and part-time programs and courses offered by Northern Ontario's colleges, universities and a school board via videoconferencing in 24

communities where infrastructure exists, via audioconferencing and via our e-learning platform in each and every one of the 66 Northern Ontario communities served by *Contact North/Contact Nord*.

In 2006, *Contact North/Contact Nord* makes use of a variety of telecommunications infrastructure including traditional telephone lines, integrated services digital network (ISDN) lines, high-speed broadband connections such as the Ontario Research and Innovation Optical Network (ORION), and high-speed wireless connections such as the Crescive Network in Northwestern Ontario to deliver programs and courses.

As we have experienced over the past twenty years, technology has played a critical role in expanding access to education and training opportunities in small and remote areas as well as improving the overall quality of the learning environment.

In 2006 and beyond, access to education and training is critical to Ontario's and Canada's future prosperity. In order to maintain Canada's current level of prosperity, it is projected that 70% of Canadians aged 25 to 34 will need to have completed post-secondary education. A recent Statistics Canada Labour Force Survey, which looked at employment growth and educational attainment between 1995 and 2005, reported employment grew by 43 percent for those with postsecondary qualifications. During that same period, employment declined by 19 percent for those who had not completed their high school qualification.

One of the three components of *Contact North/Contact Nord's* mandate is

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to support innovation in education and learning through testing and applied research of new modes of “delivery” using technology and to share information in Northern Ontario, nationally and internationally.

In keeping with our mandate, Contact North/*Contact Nord* has developed this Challenge Paper on Technology and the Future of Learning to encourage a thoughtful and intellectual discussion on the future role of technology in learning.

Our goal with this paper is not to advocate for any one particular technology or technology path but rather to inform, to think about what the future will look like and how we can best use technology to ensure Ontarians and Canadians have quality access to the education and training opportunities that are critical to our future prosperity.

I invite you to join us in this important discussion and I look forward to your comments and feedback on this paper.

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2006

CHAPTER 1

Setting the Scene

Imagine that you could travel back in time to the year 1900. Imagine that you stand on a soap box on a city street corner in 1900 and you say to the gathering crowd, “By 1955, people will be flying at supersonic speeds in sleek aircraft and traveling coast to coast in personal vehicles.” In 1900, these predictions would have sounded very strange. In 1900, airplanes did not exist. Orville and Wilbur did not make the first flight until 1903. The Model T Ford did not appear until 1909, making mass purchase and use of cars possible.

During the period 2006-2025, there will be a number of developments in technology that will have a far-reaching impact on learning, teaching and the organizations which design, deploy and assess learning for students. This paper seeks to capture the most likely developments and look at their implications for access, quality and cost.

The intention is to inform and encourage discussion. It is not to champion one technology over another or to recommend a specific course of action. The idea is to understand how the technologies now emerging could provide opportunities to transform or improve educational “delivery” at the post-secondary and lifelong learning ends of the learning experience.

Developments in technology will have a profound effect on a number of areas of society — health care and education in particular. It will not be possible for policy makers to avoid grappling with the potential of technology to rethink and redesign educational experiences, change the cost structure of the educational services provided and yet engage learners in a new and more active way in the design of their learning.

There will be challenges: new roles for faculty, new quality assurance and credit recognition systems, resistance from vested interests, ethical issues raised by some of the technologies. But there are more opportunities than challenges.

The question is: how much of a leadership role does Ontario wish to take?

Five assumptions inform this paper:

1. That the technologies addressed in this paper should be in design or test stage at the time of writing this paper. That is, nothing in this paper speculates beyond what is in the laboratory or early stage of development right now.
2. That the technologies in development may not necessarily be designed with learning in mind, but have properties which can be utilized to support a learning agenda.
3. That the technologies build on our current infrastructure — institutional infrastructure, networks, systems, models and people.
4. That the technologies described in this paper have to have an application to several fields of learning, not just one — that is we are looking here at system wide technologies, not just technologies specific to, say, biology or media studies.
5. That the purpose of describing these technologies is to seek to identify elements of an emerging paradigm for learning systems which leverages technology, but is not seeking to “do away with” institutions or replace people.

Setting the Scene

The challenge is how can technology help increase access, improve quality and lower cost?

ONTARIO IN 2006

Ontario has done many things to lead in the areas of improving access, educational quality, innovative teaching and community-based networks for adult learning. It has been a thought leader in the past. But six circumstances require Ontario to imagine a new and different future for post-secondary education and adult learning. These are:

- 1. An accelerated move towards a strong, knowledge economy** which is much more diversified than it has been in the past. To ensure that this shift occurs, Ontario needs a higher number of science, technology and engineering graduates (STE's), more trades personnel with higher qualifications and constant opportunities to upgrade. Within the Ontario workforce, some 6.4% of the workforce has degrees in science, technology and engineering (STE) compared to 15% of Finland, 10% in US and 7.5% in Alberta. To position itself, Ontario needs to double the proportion of STE's by 2025.
- 2. The war for talent taking place globally.** To compete, Ontario needs to offer attractive services. Access to educational services and resources are key drivers in attracting immigrants, especially when set alongside affordable healthcare. Given the demographics of Ontario, access to quality education is critical to attracting and retaining an effective immigrant workforce, a key to Ontario's economic future.
- 3. Demand for education outstrips supply.** Increasing supply within the framework of existing models of institutions is a prohibitive proposition. Access is a political and cost issue.
- 4. Rural and northern development issues.** Rural depopulation challenges the viability of institutions and communities. Aboriginal peoples do not perform as well as their counterparts in the post-secondary system, yet are amongst the fastest growing communities in the North with a demographic profile which is much younger than their counterparts. Thinking differently about educational services is not simply "interesting", for these communities it is essential.
- 5. The imperatives for lifelong learning.** As the global economy changes the nature of competition, continuous upgrading and lifelong learning will no longer be slogans or nice to have — they are economic necessities. So as to lead in lifelong learning, Ontario needs to leverage technology to give anywhere, anytime access to learning and support learners through local and regional networks of mentors, coaches, guides and instructors. A first degree or diploma is just that — the first of many learning experiences.
- 6. The growth of cities** forecast for the next 15-20 years challenge many long-held assumptions about economic diversification and the provision of services. Ontario will have¹ a population of around 15.5m by 2025 (up from approximately 11.9m in 2001), mostly concentrated in the GTA (approximately 7m) and Central Ontario (approximately 3.4m). With 70% of the population of

¹ Data in this section comes from <http://www.acaato.on.ca/home/research/environmental/primaryInternalContentParagraphs/00/document/2.Demographics.pdf>

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Ontario in these two regions and around 5% in the North, there are real issues of infrastructure, equity, access and cost to be considered.

The point is simple: Ontario cannot get to where it needs to be by doing what it has always done or by doing just more of the same. It has to think differently to be successful. The good news is that Ontario has a long history of doing so. Innovative networks, imaginative uses of technology for learning, and pioneering new approaches to aboriginal education are all a part of the province's history.

But it is time to make history again. Many of the implications reviewed in this paper are significant and challenging. That is the point. By reviewing emerging technologies and their potential use for post-secondary, adult and continuing education, we are looking at opportunities which could bring significant rewards to learners and those seeking to leverage learning to support the knowledge economy, if risks are managed.

Here are some examples:

1. By removing classroom and time constraints through competency-based programs supported by powerful learning technologies, students could complete programs in less time — up to one third or a half of the time currently taken, thus increasing access.
2. By changing the role of instructors and professors from being (in part at least) information providers and focusing their work on mentoring, coaching and guiding, access is no longer such a strict function of teacher:student ratios — over time,

technology can replace many current functions of instructors, freeing them to focus on personalizing learning.

3. Quality can be improved by the rigorous development of competency frameworks, the use of simulation and knowledge engines to create more powerful learning experiences, more standardized assessment on a regional scale and more consistency in approach. Quality experiences can also be personalized through the work of instructors and professors.
4. If Ontario can achieve a doubling of its SET educational outputs by 2025 and do so by leveraging innovative technologies, it will provide the basis for a robust economy but will also stimulate the technology sector — biotechnology, ICT and nanotechnology. If Ontario uses public private partnerships to stimulate new work on the learning technologies, it will help to build a powerful learning industry sector for Ontario — a sector which had global sales of (approximately) \$23b in 2005 and is slated to rise to \$100b by 2025.

YOUR CHALLENGE

Imagine this paper as equivalent to someone on a street corner in 1900 describing what is about to happen. This is the challenge for the reader — suspend judgement. It is time for smart, brave action. Just imagine...

CHAPTER 2

Four Major Changes

There are four major changes that will occur between 2006 and 2025 which inform all aspects of this paper. They relate to: (a) the nature of digital devices; (b) the nature of the World Wide Web; (c) the relationship between information technology and the human body — what we refer to here as the human-technology interface; and (d) the users of devices.

A. THE NATURE OF DIGITAL DEVICES

Most people, when asked to describe a computer, will describe a box for the “hardware”, a keyboard, monitor and a mouse. They do not describe their car as a computer aided device (any car has several on board), or their Blackberry, cell phone, television, iPod — all of which are digital devices. The GPS system, which aids navigation in a car or through a handheld device, uses digital devices.

During the next twenty years, we will see new devices which permit many tasks to be undertaken with the support of digital technologies. For example, it will soon be possible for a voice activated message from a cell phone to be received by the nearest ATM machine which will then allocate funds to that cell phone which will be used as the basis of individual financial transactions with speech recognition and other bio-metric security systems.

Home entertainment systems will be wirelessly connected to devices which will permit the off air recording of television and radio programs from around the world and the downloading of music, movies and other forms of network broadcast media — thus creating personalized media centres in the home — independent of the broadcast schedules of

organizations like CBC, CTV, and CNN. These can be wirelessly transferred to a car, a handheld device, cell phone or iPod and be viewed by that person, wherever he or she is.

As voice recognition and activation becomes more dominant (2010), and simultaneous digital translation more efficient (2012), new devices permitting individuals to interact with others who speak different languages will emerge so that simultaneous translation is possible.

IMPLICATIONS:

Don't think of computers as boxes, keyboards, mouse and screen — think of devices. Don't think of computers as in a particular place, they are wherever we are. Don't think of devices as hand-held or lap top, think of them as biological implants, very small devices added to watches or spectacles or as part of one's clothing. All of these are available now. What will happen between now and 2025 is that they will be more widespread, more varied, less expensive and able to handle very complex processes.

B. THE NATURE OF THE WORLD WIDE WEB

The World Wide Web (WEB) is currently a very big collection of randomly organized materials, some of which is helpful. It contains many accurate and helpful pieces of information, and a larger number of unhelpful, inaccurate and often misleading pieces of information. Given its open nature, anyone can post anything on the web at anytime and, with current technology, few technical skills are needed to do so.

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When we think of the web we think of search engines like Google, Yahoo and others. Without these, we would be unable to narrow our search of the materials available. But these are very inefficient ways of getting at the information and, depending on which search engine is used; they search the web in different ways with very different results.

Three things will change the way we experience the World Wide Web. These are: (a) software agents; (b) developments in artificial intelligence; and (c) the semantic web.

SOFTWARE AGENTS

Software agents are computer programs capable of acting autonomously and whose awareness of their environment and apparent goal-oriented behaviour make them “seem” intelligent. Many visions of the expanding role that computer technology will play in every aspect of life to 2025 implicitly assume there will be major breakthroughs in our ability to design, build, and manage intelligent software agents².

The steady growth in Internet usage and the movement of businesses to the web to connect with customers, suppliers, and partners have created an opportunity for agent technology to play an important role in automating processes, bringing intelligence to the network, autonomously carrying out mundane tasks, enriching application-to-application communication, and improving decision-making.

IMPLICATIONS:

The web will shift from being a “minefield” of information to being a knowledge repository which continually updates and corrects itself and provides knowledge “packets” (custom built, intelligent packages of knowledge) that users want to help with learning, understanding and decision-making. Rather than searching the web, the web will be proactive and prompt us whenever new knowledge is available on topics it knows we have an interest in. It will therefore become more personalized.

C. DEVELOPMENTS IN ARTIFICIAL INTELLIGENCE

To achieve its potential by 2025, software agent technologies must capture intelligence in software and to use this intelligence to allow programs to reason like humans. To this end, software agents must rely on techniques in learning, reasoning, planning, problem solving, and related areas. This artificial intelligence will provide the techniques and algorithms that are used to model the environment in which an agent operates, define the agent’s goals, and specify the plan and associated actions the agent undertakes to achieve its goal. In particular, contributions from several fields of artificial intelligence will be used in developing agent and agent-based systems:

- **Reasoning system** — In planning their actions and making decisions, agents require the ability to reason about what to do and when to do it, particularly for actions they have not been instructed

² The EU has commissioned a range of studies of agents. Sony is working on a major project, the aim of which is the development of a new generation of embodied agents that are able to interact directly (i.e., without human intervention) with the physical world and to communicate between them and with other agents (including humans). This will be achieved through the development of new design principles, algorithms, and mechanisms that can extend the functionality of existing technological artefacts (mobile phone, WI-FI devices, robots and robotlike artefacts, etc.) and can lead to the development of new artefacts.

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- specifically to perform, requiring algorithms and techniques for reasoning.
- **Natural language processing** — The capacity to interact with humans to receive tasks or directions or to relay information in natural language — that is, using statements in a human language rather than requiring a specially defined command language with a rigid syntax — requires ongoing research to improve the accuracy and effectiveness of these systems.
 - **Neural networks** — Information processing systems use a large number of highly interconnected processing elements that are analogous to neurons and are linked with weighted connections analogous to synapses. As a result, neural networks can be used for “on the fly” learning, particularly where it involves the identification and application of patterns.
 - **Machine learning** — Machine learning techniques are used to develop systems that are capable of acquiring knowledge and integrating it with what they already know, resulting in autonomous learning.

IMPLICATIONS:

The web will make increasing use of artificial intelligence to gather, package and refine knowledge related to user needs and will begin to anticipate these needs and automatically personalize them for the user. For example, a student known to be having difficulty understanding one concept will be able to access thirty examples of this concept in action linked to all of his or her past web searches. We will increasingly be able to use natural language (both text and

voice) to interact with digital devices and this will enable us to build a different kind of relationship with the web — it will become a personalized knowledge utility.

THE SEMANTIC WEB

The majority of content on the web is meant to be read by humans, not by software. However, the web’s capabilities would be augmented significantly if content were represented in such a way that software could understand it as well. Understanding, in this case, means recognizing the intended meaning of content on a collection of web pages — having a contextual or semantic understanding. Put simply: we need our web agents to be able to read, understand both the words and their intentions, and then provide a summary/analysis and interpretation of these resources to us.

Significant work is underway to permit such semantic use of web-based information resources³ — turning information into knowledge. For example, the software product “Autonomy”⁴ permits a user to begin typing a document and the “system” will match the ideas (not the words) in the document to relevant materials either on that organization’s own servers or the World Wide Web and make them available to the user, constantly adjusting them as the “ideas” the user is typing emerge. Another example would be someone trying to understand three different interpretations of a historical event — the semantic web could offer a summary of the three different views, using all of the available materials on the web.

³ See <http://infomesh.net/2001/swintro/>

⁴ See web.autonomy.com

⁵ For a review of the most recent developments here, see <http://web.nature.com/nature/journal/v440/n7083/full/440409a.html>

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THE HUMAN-TECHNOLOGY INTERFACE

At some point (2025-2030), the power of the semantic web will exceed the power of small human teams working on a problem⁵. In part, this will be because we are using nanotechnology⁶ to speed the power of computational work and in part, because some simple computers will be inside the body — implants for complex work and “nano-bots”⁷ for other work. We will be able to use these resources to support decision making, learning and well-being. A few examples:

- Human memory is equivalent to around 10^{13} “bits” of memory — for example, Shakespeare used 29,000 words to create some 100,000 meanings which is equivalent to around 10^{13} bits. By 2018, we will be able to buy carbon memory tubes able to store this amount of memory (equivalent to a person’s lifetime memory) for around \$1,000. By 2020, we will be able to create devices that can replicate the functioning of the human brain (using reverse engineering) for about \$1,000. By 2050, this same \$1,000 will buy the equivalent of the computing power of all of the people on earth⁸.

IMPLICATIONS:

Rather than listing over 10.7m documents on diabetes available on the web, the “system” will “read” them, summarize them and make recommendations about diabetes based on the user’s natural language query. This provides a basis for the web to be an intelligent partner for all learning activities and may, especially at an instructional level, provide an opportunity for the web to replace some basic teaching.

- When coupled with artificial intelligence and instant access to the semantic web through very fast, global wireless networks — implants and nanobots will support such things as thought driven access to information (you think – “what film was Denzel Washington in recently?” and the list appears in your mind, culled from the web and delivered by a nanobot located near the memory area of the brain) – and skills transfer to the brain, permitting skills to be transferred technologically from one generation to another. Translation between languages will become ubiquitous, through either devices or implants (or combinations of both)⁹.

Most people, on reading these descriptions, think “science fiction”. All of these systems are in development at this time — thought based computing, nano-bots, intelligent implants, etc. – are in development or test at this time.

It is not being suggested here that technology will replace human interaction. Rather it is saying that a new set of interactions between technology and a person will be possible. As we start to replace damaged tissues, damaged neurological functions with digital devices and nano technologies, we will make breakthroughs which will change the relationship between knowledge, technology and biological persons.

IMPLICATIONS:

Knowledge (as opposed to just information) will be accessible in a usable form anytime, anywhere and be able to be

⁵ Nano tubes are tubes made up of a hexagonal network of carbon atoms which have been “rolled up” to make a carbon circuit which are self-replicating and work very fast – likely to be around 1,000 times faster than existing “chips” – and using less power to do so.

⁷ A nano bot is a nano sized robot which is made from nano-tubes and can undertake basic functions from inside the blood stream. Scientists at Rutgers suggest that these will be commonplace by 2020.

⁸ See Kurzweil, R (2005) *The Singularity is Near*. New York: Viking at pages 122-142.

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accessed directly by the brain or by small devices (combinations of glasses and headphones linked to a wireless jacket receiver or hat). Knowledge will be packaged by intelligent agents, working to meet the needs of their user. If the user has a clear need for knowledge (e.g. to master a given set of competencies), then agents will work out how best to deliver these. At some time in the future (probably mid century) we will have mechanisms to upload and download knowledge and skills from and to the brain directly – at this point, skills and ideas can be transferred quickly from one person to another or from one group to another.

(iPods, GPS receivers, portable hand-held computers, earpieces that carry data, music and images beamed onto sun glasses) and being able to voice summon information which is location specific — e.g. “where’s the nearest Chinese restaurant to where I am right now?” or “where is the nearest free parking space?”. The point here is simple: as devices become more ubiquitous, they will become more integrated into daily life. Just as the cell phone seems a requirement for modern living today, so will many knowledge devices. What is more, students entering kindergarten today will use devices and three dimensional games and simulations as utilities — setting a new standard for learning experiences and access to knowledge (as opposed to just information).

D. THE USERS OF DEVICES

The current 10 year olds, who will be entering their 30’s by 2025, will have never known a world without digital devices and the World Wide Web (which began fully functioning in 1993). They will see digital devices, the web and data ports as utilities, not “add ons” or “aids to work or learning”. They will expect such a utility to be integrated into all that they do and all that their children do, in the same way that the boomers assume personal transport (cars) and international travel is a normal part of life. They will therefore be demanding access to effective, powerful technologies that support information gathering, learning and global interaction.

The current 2 year olds, who will be 21 in 2025, will have experienced powerful graphical simulations as a natural part of growing up through gaming technologies and 3D technologies, which will become ubiquitous by 2015. They will also be used to digital devices

IMPLICATIONS:

Demand for powerful, effective knowledge technologies is most likely to be student driven rather than institutional driven. Students born after 2000 will have experienced in their social and domestic situations, powerful technologies which challenge the way information, knowledge and skills are currently delivered in post-secondary institutions.

Yogi Berra said “the future isn’t what it used to be” and he was right. The future isn’t just more of the same. It’s a refinement, expansion, continuous rebirth as well as dislocation and transformation. A cell phone will still connect one person with another, but will be able to offer translation services – a person can speak in German and be heard in Italian (or Spanish, or English or French) as well as being able to share live video, insights through thought patterns as well as skills.

⁹ Thought based computing is now being displayed at several computer trade shows – see http://www.mg.co.za/articlepage.aspx?area=/breaking_news/breaking_news__international_news/&articleid=265991 for an example from Germany.

Access to Knowledge and Skills

The previous chapter outlined changes which are or will shortly have a major impact on learning technologies. This next chapter looks at emerging technologies which are fast moving into commercialization and are the likely contenders for primary technologies in the period to 2025. All of these are either in development or have already reached the market place.

SIMULATION

Simulation technologies are in widespread use, including in use by many of Northern Ontario's colleges and universities. They are used by military organizations to simulate battle conditions, air assault and specific maneuvers. They are used by planners to simulate traffic conditions, driving conditions and are at the heart of computer games. They are used in teaching to simulate managerial challenges, medical conditions, engineering or mathematical problems.

Simulations are becoming more powerful and effective. Building on gaming technologies and artificial intelligence, an individual can now experience a range of simulated environments in which they can practice and demonstrate skills and competencies "safely". For example, doctors can "practice" surgery using the MRI images of their patient before the patient comes in for surgery and forecast and simulate the consequences of that surgery¹⁰. A student learning how to assemble a turbine can do so in a simulated environment and "test" the simulated turbine under a range of conditions, all in the safety of a three dimensional laboratory, using super fast computers.

As three dimensional visualization (virtual reality) becomes more available and more commonly used, emerging technologies, such as highly interactive and immersive virtual reality will become an important part of many learning and work processes. Virtual reality simulations will provide unparalleled power to explore ideas and experiences and to communicate what we learn in very new ways. A student will be able to practice all of the skills of, say, a registered nursing program or an electrical engineering degree in a virtual simulation environment before being able to practice on human subjects or in a construction project. A historian will be able to recreate historical events and students will be able to interact with the characters in these events. By 2025 it will be possible to undertake a wide range of simulated activities and look at a range of different outcomes (if I had chosen X, then....instead of what actually happened when I chose Y...). For example, new product testing (including drug testing) will involve simulation, looking at the impact a drug will have on a range of different conditions in simulated "people" with different symptoms. Many skills-based simulations will be available – "want to know how to change an engine in a car?" – then go to the simulator and practice. The quality of the learning experience — it will be an experience, not just a lecture or an account in a text — will be enriched.

IMPLICATIONS:

There are several: (a) trades education could be significantly improved and the time taken to secure a "ticket" reduced by the effective use of complex simulations; (b) professional education could be enhanced by real time simulation (simulators for dentists, doctors, psychologists, nurses,

¹⁰ This technology is already in use at the University of Calgary medical school and is being explored by the Northern Ontario School of Medicine. It will be in widespread use by 2012 and related technologies, with low cost, will appear in other fields from 2009 onwards. It makes possible this scenario: a doctor has to operate on an individual's tongue as part of a facial reconstruction due to an accident. The simulation provides the doctor with a precise assessment of the impact of the choices he or she makes on future speech, swallowing and other behaviours which require the tongue – where he or she cuts will impact these things.

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teachers, lawyers, accountants, fire fighters and many others); and (c) continued education for professionals (skills updating) can be enhanced and made available 24x7 through simulations of increasing complexity. Simulations can be shared within and across jurisdictions – Ontario could specialize in some medical conditions, Québec in others and engage in exchange arrangements so as to quickly make available simulations to improve medical education. Simulation will become an expectation of students, especially those just born who will play 3D games and become used to holographic gaming in 2020 and beyond.

KNOWLEDGE ENGINES, NETWORKS AND HUBS

With very fast access to the semantic web, accessing complex knowledge will be easy. An individual, anywhere and at anytime, can use the web to gather the knowledge and demonstration of skills they need to complete a task — say, undertake a journey, plan an activity, create a web page, solve a common mathematical problem, or understand an aspect of history. Currently a teacher may present such knowledge with varying degrees of reliability (currency of information, quality of presentation, links to competencies and skills), a more reliable source will be the knowledge engines on the semantic web.

The web will not just present a list of items on a topic such as those now received from a “Google” search, but will be a teacher-like knowledge package on a topic using the latest information. The web will intelligently review the information, create a presentation, present this information in short, medium or long versions and use a range of methods for this

presentation — audio, video, text, images, virtual reality simulations. Since the web will be intelligent — not just a repository — it will continually update these knowledge packages as knowledge changes or improves. If the knowledge responded to a well-designed set of questions, then the knowledge package can be standardized and re-used by many students anytime, anywhere. Open source activities of people will continuously refine these knowledge packages¹¹.

Making sense of the semantic web will be a task for peer networks and adult coaching. The semantic web’s knowledge engines will provide “packaged” knowledge (making sense of weighted, aggregated information sources using artificial intelligence) and learning experiences (simulations, virtual reality activities) – people are needed to give meaning to this knowledge, to connect it to the personal experiences of the learner and to provide opportunities to refine and expand it. Just as children use chat rooms and peer-to-peer networks now for personal activities, such networks of peers and adults will be increasingly used to support learning.

Schools, colleges and universities will focus less on “instruction” (sic) and more on making sense of the learning experiences individuals create for themselves via these knowledge engines on the web. As we shift from “information exchange” to “personalized knowledge networks” as the basis for learning, our institutions will become hubs for sharing, coaching in the use of knowledge and places to experience simulation — hubs in which knowledge is experienced, rather than just acquired.

As the costs of digital devices fall, access to education will be less about teacher:

¹¹ Rather as they do with the Wikipedia. See web.en.wikipedia.org where 500,000 articles have been deposited by unpaid users and edited by others since October 2004. The Wikipedia is available in a range of languages. Imagine this as a multi-media experience linked to skills simulations.

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student ratios as it will be about bandwidth, networks of peer support and the capacity for adult coaching and competency assessment. Since these resources are global resources, the existing learning system paradigm will gradually be replaced through the choices made by learners acting as consumers of the knowledge products and services available on the web. These changes may look something like those featured on the next page.

FEATURE	OLD PARADIGM (2006)	NEW PARADIGM (2025)
Learning Unit	The Class	The Individual
Information	Lectures and Textbooks	Semantic Web
Knowledge	Seminars, Classes, Professors working with groups of students	Semantic Web, Simulation and Nanobot Technologies
Learner Support	Professors, Peers and Other Adults	Other Adults, Global Peer Networks, Certified Assessors, Robots
Learner Assessment Assessors,	Assignments, Lab Work	Simulations, Peer to Peer Certified Competency Assessment, Robots
Speed Of Completion of a Program	Institutionally Determined	Individually Determined
Accreditation/ NAFTA) and Global	Local	National, Multinational (e.g. Certification

Table 1: From One Learning Systems Paradigm to Another

IMPLICATIONS:

Students will leverage technology, peer networks, robots and artificial intelligence in support of their learning challenges before institutions adopt them – acting as consumers, they will drive some changes in the system. They will access knowledge from global knowledge engines available through the semantic web. They will seek credit

recognition for their work. They will demand acknowledgement of learning from a variety of sources. The opportunity thus exists to shift to a new paradigm for the management of learning outcomes – a paradigm likely to be resisted to those committed to the old paradigm, which has a strong and successful six hundred year history.

Access to Knowledge and Skills

LOCATIONAL LEARNING

A number of companies are working on learning projects where learning is linked to location. As you walk through a location with a hand held device or cell phone connected to a wireless network the learning system provides information (“you are standing on the spot in which the oldest dinosaur on the world was found”), pose questions or provide knowledge relevant to learner needs. The information can be presented in the form of a game (e.g. “Lost”) and will generally be highly interactive. A person walking through an old mine can learn about its history, be challenged about safety issues or specific incidents that happened in the mine or can interact with a range of characters using simulation.

There is no reason that such a set of learning objects, tools and resources could not be deployed initially for key locations for learning and then everywhere in the world. It would be invaluable for safety education (“six feet in front of you is a red handle — do not touch this, it opens a door to an area you are not certified to enter”) and other forms of learning.

It will soon be possible to walk in downtown Toronto and ask “where is the nearest Scotiabank ATM?” and your cell phone will give directions. It is a small step to make this proactive rather than reactive — as systems can begin to understand thought patterns, the knowledge hub can respond (“I hear you thinking about Indian food, there is a highly-rated Indian restaurant two blocks east from here...” or “remember two weeks ago you were wondering what an isosceles triangle was, if you look at the design of the office building in front of you and to your left, you will see six of them — want me to show you?”).

IMPLICATIONS:

Learning linked to location will be a fast growing phenomenon in 2008 and beyond. As more locations begin to have 3D facilities and more opportunities to connect local content, learning “layers” will emerge where the learner can choose what topics (layers) they wish to experience in which locations. They will be able to “rehearse” their experience in simulators before getting there. One obvious application is in an art gallery or museum, extending the current audio “tour” into location-specific audio-visual tours where the artist can speak about the painting you are looking at or respond to questions you may ask (simulated). But other locations may be in food stores where you can ask how to prepare a particular vegetable or meal, and your cell phone will show you.

ROBOTICS

Robots are extensively used in manufacturing systems (especially automotive manufacturing) and are rapidly developing, especially as artificial intelligence continues to develop and new substances solve mechanical problems in the durability and flexibility of robots as machines. We have a “science fiction view of robotics” based on a number of different movies, but the actual elements of the next stage of robotic development are gradually appearing. These are:

- Artificial intelligence machines that can use natural language to access the semantic web, package information into intelligent forms and use this knowledge to shape the robot’s behaviour.

Access to Knowledge and Skills

- The ability of machines to “see” – take visual images, process them, “understand” them (interpret) and then act accordingly.
- The ability of machines to use logic and reasoning engines to make decisions.
- The ability of machines to patiently learn from its iterations of an activity or group of activities.

At the University of Wales, Mike Young has built and is using a scientific robot that can originate a hypothesis to explain a set of observations, carry out experiments in a laboratory, undertake measurements, analyze and interpret results. The system is able to improve its performance by learning from its experiences and by pulling information from web. The robot has designed a range of experiments which, apart from being completed faster than a “rival” human scientist, were also a third less expensive. By 2015, the first machines that can see, hear, move and manipulate objects at a level roughly equivalent to human beings will have made their way from research labs into the marketplace¹². These robots could well be able to “think” as creatively as many human beings. Humanoid robots will cost less than the average car, and prices will continuously fall. A typical model will have two functioning arms, two legs and the normal human-type sensors like vision, hearing and touch. Power will be provided from small, easily recharged fuel cells. Equipped with powerful devices, the robot will gradually replace many “people” functions in many organizations — check outs in supermarkets, banking activities, forestry, construction, mining, hotel and restaurant service, financial advising, teacher aids in schools, coaching for some sports. Some airlines are looking at robotic pilots

(as already used by the some military forces) as a way of lowering costs and improving reliability.

By 2025, many functions currently performed by people in universities and colleges could be performed by robots — advising, financial services and registry functions, teaching of basic skills and competencies, assignment marking (and not just for multiple choice assignments) and supporting students as coaches, guides and mentors.

IMPLICATIONS:

Robots will have a major impact on social and economic activity sometime after 2015-2020. Some predict they will gradually find their way into many areas of life, whether they are physical robots (doing manual labour, repetitive tasks, intelligent tasks which require complex knowledge) or non-physical robots, like agents or learning networks. For education, key roles in administration could be undertaken by robots – advising, financial services, registry — and gradually more demanding functions requiring a high level of intelligence (instruction, coaching, assessing) could be undertaken by people-friendly robots. They are coming. The issue is how we wish to use them. One other implication quality. By setting standards for all instruction through robots and by training robots to be thorough, we can ensure that standards are applied and maintained

¹² See Honda’s work on ASIMO at <http://world.honda.com/ASIMO/> and see also Sony’s work at <http://web.csl.sony.fr/Research/Topics/DevelopmentalRobotics/>

Competency Based Learning

The previous chapter looked at some of the rapidly emerging technologies which will have a major impact on learning – simulations, the ability of the World Wide Web to intelligently assemble knowledge packets, virtual reality and robotics. But how will these resources be used? In this chapter, we look at the design of learning experiences through competency based learning as a framework for leveraging these technologies.

Most educational institutions — colleges and universities — resemble their “guiding” monastic institutions founded in the fourteenth century. They use the same basic methodologies — the professoriate, the tutorial, access to recommended texts and materials and the assignment — as a basis for determining whether or not a particular student has “mastered” an area of knowledge and understanding. At this time, technology augments this model and does not seek to replace it. One reason for this is that the technology for learning is still at an early stage of development and another is perceived cost.

By 2025, cost will not be a barrier to the widespread use of devices which give fast, location independent access to the semantic web, supported by intelligent agents and other technologies. Translation services will be automated — presentations given in Chinese (already the dominant language of science), will be translated on the fly with a very high degree of accuracy and can be read (or heard) in real time. Robots can be used to support a range of learning support and learning functions.

The implications here are that teachers will not be required to provide the bulk

of information or knowledge to a learner — learners can access such resources themselves. So what are teachers for?¹³

They will have five primary tasks in 2025:

1. The design of authentic learning tasks¹⁴ – meaningful challenges which require a student to master a body of knowledge and skills.
2. Being a mentor, coach and guide for a learner and their learning tasks — rather than being an “instructor”, the task of the professor or teacher will be to connect learning to the person — to make the learning personal and to support learners who are struggling with their mastery of a skill, competency or challenge.
3. Developing a competency map for these tasks and integrating these maps into an accredited competency based program.
4. Providing a systematic framework for competency assessment and feedback to individuals on their competency.
5. Overseeing a process of assessment, such that all can have confidence that someone who is accredited with a competence (a lawyer, nurse, doctor, journalist) actually does have the skills required.

The design of authentic tasks does not mean that the teacher supervises every step of the process a learner or group of learners uses to master the task — they may chose to do so or may chose to be a coach or mentor to the process. What is key is that the teacher becomes a coach to the learner and makes the learning experiences meaningful to the student or group of students.

¹³ This paper makes no reference to the important role of faculty in basic research and in community service. It focuses solely on their teaching role. This is not intended to denigrate these other roles; it is simply a matter of focus.

¹⁴ See David Jardine, Pat Clifford, Sharon Friesen (2003) *Back to the Basics of Teaching and Learning: Re-thinking the World Together* New York: Laurence Erlbaum.

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Competency Based Learning

Fundamentally, their instructional work will be largely replaced by their work in “framing” learning challenges and creating a process by which a student’s competency can be assessed. They will also provide support for a learner to make intelligent choices as to where to look for appropriate competency-based learning opportunities from a global network of providers. They will coach, guide and mentor rather than instruct.

We can take this further. Competency can be assessed independently of the institution which the student is attending and at which he or she undertook some or all of their work on authentic tasks. That is, there could be regional or national centres for the assessment of competency which used artificial intelligence engines and robots to undertake independent, objective competency assessments. Appropriate degrees, diplomas or recognition could be awarded by agreed combinations of competencies.

IMPLICATIONS:

If technology can be used to provide basic instruction, simulate real life conditions so as to provide a “test ground” for students to practice skills and competencies, then we can begin to imagine a different role for the faculty and instructors. This role is about design of competency frameworks, design of assessment and oversight of the learning process, coupled with coaching, guiding and mentoring. Many routine functions (some marking, for example) can be undertaken by robots. Competencies can be assessed regionally or nationally so as to better ensure quality.

Better Learning in Half the Time

Some of the major constraints for learning systems access and performance are: (a) institutional structures and costs; (b) collective agreements; and (c) the way in which time is used and managed by institutions. In this section, we focus on the way in which the use of time can be made more flexible in a technology supported learning system.

The average undergraduate student is expected to: (a) complete 120 credits — usually 40 courses — over four years; (b) attend an average 40 hours of instruction per course, usually offered in the form of lectures or seminars (or lab work in the case of sciences) — or 1,600 hours of time over 4 years; and submit an average of 3 assignments per course — 120 assignments. Most students take over 5 years to finish a 4 year degree. Time is constrained not because of the student's willingness to work, but because of the limitations of physical plant, capacity of individual instructors and collective agreements. Degrees, diplomas, certificates and accredited courses could be completed in significantly less time than we use currently.

With continuous access to knowledge through the semantic web, competency-based programs (rather than time-serving programs), anytime anywhere competency assessment (assessment takes place when the student is ready, not when the institution chooses to hold an examination), peer-to-peer and peer-to-adult support networks, and robotic coaching and assessment — learning can be completed at the learner's pace and is not dependent on institutional timetables. The learner is never alone — he or she has real and virtual networks of peers to support them and can use professors and instructors for mentoring, coaching and guiding.

What is more, quality can be improved. If competency is clearly specified and examined rigorously as we move from time-serving systems with modest (sometimes cursory) competency assessment to systems which are rich in competency assessment, irrespective of time. Quality is built into the learning experience, competency framework and assessment processes — it is continuous.

Further, as authentic learning tasks are designed to gradually increase in complexity as the learner nears the completion of competency milestones, the interaction and interdependence of competencies can be assessed through life-like virtual reality simulations and challenges which stretch the learner's skills. What would this look like? Chris wants to qualify as a carpenter. He is provided with a competency learning passport which requires him to complete real tasks, simulations, self-study, peer-supervised work and achieve customer satisfaction scores in his work-based activities. He works with Simeon (his robot advisor) who connects with him in person, on the web and via a cell phone and coaches and guides him. His personal coach is Angela, who he meets every three weeks. Immersing himself in simulations, he begins to complete key tasks in the simulator, goes to a workshop anytime to complete the assigned and assessed task under the supervision of Simeon and then goes onto a job site where this particular competency is required. He repeats this process for the 43 competency sets he has to master, getting stamps in his passport for the work. When he has completed these 43 tasks, he gets his ticket as a carpenter.

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Better Learning in Half the Time

Chris chooses the speed at which he completes the authentic competency tasks in his passport — he happened to do it in 21 months, while Jack took 37 and Mary 15. Time isn't the issue — competency is. One thing technology can do is to make quality learning and assessment resources available 24x7. The challenge is for us to imagine how we can leverage these resources, when coupled with peer-to-peer and adult:peer coaching and support networks for a new kind of learning organization.

Many educators decry attempts to shorten the time taken to learn. In part, this is connected to concerns over job security and in part it is linked to a view that learning at college or university is about more than mastery of knowledge, understanding and competencies — it is about the experience of community and the building of peer networks, many of which will be career-long or lifelong. Institutions are designed on the assumption it is the public duty to provide for such opportunities for social networking and community based support. An alternative view is to let the student decide how quickly or slowly they wish to learn and how much social interaction (or sports activity or club activity) they wish to engage in. As they pay for an increasing share of the costs of their education, they should be given choices about the time (and cost) to graduation.

IMPLICATIONS

Technology permits learning and assessment 24x7. This fact can be a major driver for change in our thinking about time to completion, the role of institutions in managing the student's time to completion and the barriers to the effective use of time. The technologies outlined in this paper will change the time-cost equations.

CHAPTER 6

Student Support Services

Faster learning will be more demanding for students and will have new roles for technology, robots and support personnel in the learning system. There is a danger of a more open door being a revolving door and of students “slipping” through the cracks.

In this chapter, we will discuss:

1. What kind of challenges students will be facing in the future?
2. How will current student support and services need to evolve to meet the future?
3. How will financial support need to change?
4. The role of instructors, mentors, coaches and guides.
5. What will the growth of technology mean for equitable access?

THE STUDENT CHALLENGES

As group-based learning and classrooms become more optional, and learning becomes more individualized and self-organizing, students can feel:

- Lost or confused in terms of where they “are” or “should be in their pursuit of competencies” (“what am I supposed to be doing?” or “where am I in terms of my program?”).
- Isolated from others sharing similar experiences (positive or negative) about their learning.

- Uncertain as to whether they have secured the right knowledge or information from their sources.
- Unable to cope with a learning challenge.
- Unable to access resources which others appear to have no difficulty accessing.

Students may also have financial concerns, practical problems (living accommodation, career uncertainty) or psychological issues (coping, stress).

In other words, all of the problems a student has now will also be present in the future world described here, perhaps exacerbated for some by a sense of isolation — something they may well have grown up with.

STUDENT SUPPORTS 2006 — 2015 — 2025

Right now, most students are supported by peer networks, both in person and virtual (chat rooms, text messaging, cell phone conversations), by some access to online support services (careers services online like Workopolis, learning support services designed by institutions) and by limited access to adults skilled in particular services — counselling, guidance, financial advising, program planning, information retrieval specialists. The balance of these services at this time favours peer networks over adults, supported by limited web-based resources and services.

Enhanced web services (such as those listed at WCET’s site dedicated to online student services¹⁵) are rapidly emerging to support students including:

¹⁵ WCET is the Western Co-Operative for Educational Technology and the site mentioned here is at <http://www.wcet.info/resources/publications/guide/guide.htm>

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Student Support Services

- Career Connections at Colorado State University
- Disability Supports and Services at the University of Illinois
- Psychological services at the Help.Your.Self. site used by a number of institutions

There are also a growing number of professionally serviced online counselling sites (psycho-social problems)¹⁶, some of which are now making extensive use of artificial intelligence engines to support meaningful dialogue with individuals.

By 2015, such artificial intelligence supported counselling; guiding and mentoring services will be more widespread and will be found both through personal support devices (your pocket mentor) and robots¹⁷. Students will use both robotic tools, peer networks and much better artificial intelligence supported knowledge engines on the web to resolve some of their difficulties.

But two things will remain highly personalized and very human — resolving the challenge of isolation and personal coaching when a learner is “stuck”. Students will make better use of human resources, since they will be better prepared for their effective use.

FINANCIAL SUPPORT

While the general technology outlined in this paper will be ubiquitous, it does not follow that this means everyone will have access to the technology they need whenever they need it. What is more, the technology will stale date faster than it does now — with the keys being

processing power, broadband and wireless access and the ability to network.

Governments need to imagine the new technology as affording substantial opportunities to increase access while lowering the unit cost of education and shortening time to completion. They should support learners by letting funds flow with them for their learning passport activities, part of which will be needed to buy and maintain appropriate technologies.

To some extent, the technology will push the argument for individual learning credits as the basis for funding students and institutions — a voucher based system. The attractiveness of such vouchers could be increased for the individuals and the organizations they chose to support their learning by:

- Making the vouchers sizeable enough to attract sufficient numbers to want to move from secondary to post-secondary.
- Linking vouchers to loans as well as grants — a single funding mechanism.
- Differential vouchers — students with disabilities, students in remote communities, Aboriginal students get more than others.
- Permitting students to complete their competency requirements at any institution, with voucher funds flowing to the institutions which provide support for their learning.

Providing more funds to institutions to expand their physical campus, add faculty and capacity is less attractive than permitting

¹⁶ For example, see <http://www.asktheinternettherapist.com/>

¹⁷ For a discussion of likely developments see: <http://www.rider.edu/~suler/psyber/futurether.html> There is also an International Society for Mental Health Online

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Student Support Services

funds to follow the student, especially when students have global choices to make for quality learning¹⁸.

THE ROLE OF INSTRUCTORS, MENTORS, COACHES AND GUIDES

Leveraging technology to improve the learning experience of students, quality and access while at the same time lowering unit cost does not imply that there will be a lesser role for instructors or professors. It does imply that their role will be different.

Now, a great deal of instructional staff time is spent preparing and conveying information, generally in passive learning settings (lecture rooms, small classrooms) or minimally interactive sessions (seminars and tutorials). Significant time is also spent marking assignments. A great deal of these activities could be replaced by authentic learning tasks using simulation, and rich learning experiences using learning devices and robots.

The valuable and expert knowledge of instructors and professors can be better spent coaching students who are “stuck” or “confused”, guiding students through their learning passport activities — advising them on sequencing, suggesting good resources, pushing them to perform — or mentoring students so as to connect their learning to their ambitions and hopes.

Rather than being an instructor to a class of 250, they may well be working with 10-15 students at a time, each at different stages of their learning path and each struggling with different aspects of their competency challenges.

EQUITABLE ACCESS

By personalizing education through technology with the new roles for instructors and a new system of financing learning through vouchers, four forms of equity can be “managed” within a learning system. These are:

1. **Equity of price** — vouchers of differential value reflecting need (higher vouchers for disabled students versus those without disabilities, for example) ensure students are not disadvantaged.
2. **Equity of access to quality learning experiences** — the technology disconnects quality from geographic place. A student with access to broadband networks, appropriate devices, simulation tools and robots will have just as much access to quality learning experiences as the student who lives next door to a major research institution.
3. **Equity of access to quality supports** — the widespread use of digital counselling, career guidance and support systems coupled with effective help and support networks of peers and others will ensure students get quality advice and support, anywhere and anytime. When coupled with localized networks of mentors, coaches and guides, learners can be assured of effective support systems.
4. **Equity in assessment** — Using a common competency framework and regional or provincial competency assessment frameworks where assessment is using artificial intelligence and systematic modeling of best practices for a competency as the basis for assessment practice means all students will receive

¹⁸ For a discussion of voucher based financing see Levin, H. 2001. *Privatizing Education: Can the Marketplace Deliver Freedom of Choice, Efficiency, Equity and Social Cohesion*. Boulder, CO: Westview Press. Institutions continue to need base funding and capital financing, but there are opportunities to create competition so as to improve productivity and quality

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equitable assessment for their work. Right now, it is highly variable and idiosyncratic.

Some students will still require additional supports to ensure equity — but these additional supports are technological, not institutional. Access will no longer be defined in terms of a seat in a specific classroom, but in terms of being able to leverage available technologies, assessment and support networks.

IMPLICATIONS:

We are already thinking differently about student support systems, leveraging technology to provide guidance and advice and some support for decision making – e.g. in the area of career guidance.

Technological developments here are already moving quickly and their pace will accelerate – artificial intelligence, simulation and robotics will all aid virtual student services. When coupled with new roles for instructors and a different funding regime, learners will have more access to more learning at anytime throughout their careers.

CHAPTER 7

Cost

Costs of educational institutions are growing faster than budget allocations in many jurisdictions. Student fees are rising, leading to issues about accessibility and debt. Several institutions across Canada — colleges and universities — are running operating deficits. The system as we now know it across Canada is unsustainable, especially given the speed at which health care costs are rising. In this chapter we look at how technology can change the cost equations for post-secondary and adult education.

There are a range of cost related issues, in addition to those just mentioned:

PEOPLE COSTS

1. Health care costs across Canada are rising between 6% and 8% each year. If no changes are made, many jurisdictions will find health care consumes 60% or more of provincial government revenues by 2017. When education (K-PhD) is added to these amounts, most jurisdictions will have close to 90% of their revenues in these two baskets by 2020. Health care costs become a barrier to employment when they rise faster than inflation — especially given the extent to which individuals pay for health care services (dentistry, drugs, insurance) from after tax dollars, the fastest rising component of Canada's public:private health care system. Starbucks already spends more on health care than on coffee and GM more on health care than steel.
2. Pension costs are rising and will rise significantly from 2015 on, as boomers retire in larger numbers.

3. Costs of recruitment are rising, especially when there is a shortage of qualified people available to occupy academic positions. There is a world wide “war for talent”, so retention of staff is also a key issue.

COST OF QUALITY

4. Peer review of individual programs, maintaining oversight of a vast array of programs, organizations and activities both within a jurisdiction and coming into a jurisdiction from an increasingly globalized learning resource and instruction market is expensive.
5. Quality is in part about “product” (learner outcomes) and in part about process. Few of the current quality assurance designs really look at technology as a central resource — in fact, many quality assurance systems for learning minimize technology and focus on time, staff: student contact and access to learning resources. These models for quality assurance will quickly stale-date.

INFRASTRUCTURE

6. Costs of physical plant and infrastructure rise, both in terms of legacy maintenance costs and in terms of the cost of construction of new buildings.
7. Technology legacy systems are expensive to transition from.

This puts tremendous pressure on governments, both in terms of funding but also in terms of balancing contributions to public education to be made by students and the community.

CHAPTER 7

Cost

Changing the delivery assumptions of the system by leveraging emerging technologies over the next 20 years can have a substantial impact on costs, especially if cost to graduation is examined. These decisions would all have positive cost implications:

- Moving from an institutional located program basis for learning to a provincial competency framework for learning programs would lower costs of duplication and improve quality.
- Permitting the student to choose the time they wish to be assessed for a competency and using technological systems to manage this assessment, will lower the cost of education by speeding completion and reducing duplication.
- Moving to regional or provincial assessment systems for competency assessment will lower costs, especially when robots and technological systems are used to undertake much of the work.
- Moving from group-based learning admissions based on limited entry points to continuous entry and competency passports for learning, supported by technology will increase access and lower unit costs.
- Changing the role of instructors and professors from a predominantly information/assessment role to a mentor, coaching and guiding role can significantly increase the volume of students associated with a group of learning professionals, thus lowering costs.
- Not seeing lecture theatres and seminar rooms as the core capital, but broadband

networks, WIFI networks, 3D simulation centres and access to digital devices as “classrooms” changes the capital cost structure of post-secondary education and opens significant opportunities for public:private partnerships.

- Using robots for many functions in the post-secondary system will stabilize staff costs over time and increase access — robots do not need vacation, sabbaticals, research time or meeting time.

The key cost drivers are time and the limitations imposed by physical plant and collective agreements. When the impact of these variables are removed or dramatically changed, all cost equations change.

IMPLICATIONS:

In many institutions, technology is seen as a cost not as an investment or an opportunity to change the delivery model for learning. Technology, as outlined here, could change the cost structure of institutions through increasing access, adding capacity through changing the delivery model and support model (knowledge engines, robots, simulation, competency based learning) and making time to completion an individual matter. Indeed, the fundamental cost shift technology makes available is to individualize learning rather than maintain it as a group based delivery.

Idea Consolidation

This is a foresight paper, not a policy or planning paper. It seeks to imagine what could happen for learning systems with technologies currently in various stages of development. It does not address how change could be made or what these changes may be. But we can speculate about what kind of shifts we are likely to see:

- **Educational users will expect more technology** in use during the next twenty years. More, they will demand it.
- **Educational users will shop globally for education.** Students may well look to university or college in Australia or Sweden or Kenya that becomes the source for some skills and competency-based learning.
- **Time will become a critical factor in learning** — knowledge will stale date faster as the web moves to its semantic form. Continuous, lifelong learning will be an imperative.
- **People are key to the learning experience** — students want interaction with teachers and adults, technology may permit this to take place in ways very different from the current experience and to make such interaction much more personal.
- **Skills (and the demand for them) will change rapidly** as technology integrates with work processes through robotics, the semantic web and the human-technology interface.
- **Learners will create peer-to-peer networks** to support their learning agendas.

- **Competency assessment and modularized learning will become the dominant form** of learning design.
- **The faculty will become increasingly expensive**, making technological opportunities more attractive, especially robotic and artificial intelligence driven technologies.
- **There will be significant resistance** to the introduction to semantic technologies and artificial intelligence — quality will be the “smokescreen” for these objections.

The technologies outlined in this paper will not find their first use in the education system¹⁹. They will first be used in the private sector, where cost and competitiveness are the natural allies of innovation.

As they become more widespread, governments can wait to see what adoption rates by educational institutions look like or force the pace through support for innovative technologies for learning which is systematic, focused and courageous. Demonstration projects, followed by new funding frameworks and quality frameworks which can only be achieved by the widespread adoption of new technologies will both spark resistance and be the harbinger of change.

The barrier to widespread adoption of intelligent technologies will be behavioural and attitudinal. The technology will emerge, find its way into the market and be used for a range of activities outside of the institutions. Some 2-3% of instructors will begin to adopt technology early, while many will refuse to do so. Within 5 years of a technology being introduced, some 13-16% of the instructors will be utilizing the technology in one way or

¹⁹ The irony is that they all have their origins in the R&D labs of universities and colleges.

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Idea Consolidation

another, but only 3-5% will do so with a commitment to using the technology to make a change in the “business model” for learning. Within a decade, a given technology will be used by some 30-40% of instructors.

No significant change in the business model will result from such a low level of adoption — something very clear at this time, despite the world wide developments in online learning²⁰.

When governments or a specific institution boldly take risks and create or enable the adoption of a different business model which fully leverages technology, the speed of adoption across other organizations increases. The question for a government — any government — is “what is the “upside” for such a bold move?”

The key here will be partnerships — who will partner with government to adopt new ways of working? In the trades and professional skills areas, the technologies described here present opportunities for different ways of working and learning. A focus on these areas may provide a basis for early adoption of leading technologies which provide a basis for changing the business model for some aspects of post-secondary education. Others may follow, depending on how change (and the speed of change) is linked to budget allocations and measurements. A shift from looking at the cost per student per course to cost to graduation from a program and setting systematic targets for the reduction of these costs, may lead to more system wide changes involving technology adoption.

The point here is simple. The technology will make a difference. The technology will be used in a range of enterprises. Its adoption in post-secondary education will be linked to

incentives, costs and opportunity. The danger is that adoption will be left to chance.

²⁰ Based on the extensive literature on adoption of innovative technologies.

Challenges

When the opportunities and ideas raised in this paper are reviewed, remember this is a challenge paper, intended to challenge readers to think that the future will not just be a continuation of the past. What challenges does it create for a Minister of Training, Colleges and Universities or a Minister of Research and Innovation?

There are many. So as to focus thinking, we have created a list of issues that arise from this paper. These are selective, biased but address some of the challenges this paper gives rise to. They are:

- 1. What degree of innovation do I want to facilitate in the way in which learners and teachers leverage technology to improve access, quality, and lower cost?**
 - a. Do I want to be a leader in North America and carry risk, challenge but be the beneficiary of the opportunity? or
 - b. Do I want to share the risk with others in a systematic way — through partnerships and alliances (both with other jurisdictions and public:private partnership)? or
 - c. Do I want to let the system evolve in response to emerging technologies?
- 2. How will the emerging technologies improve access when technology is also a barrier to access at this time?**
 - a. Is one implication of this paper that we need to do much more to guarantee a students access to digital devices, broadband wireless networks and other key technologies?
 - b. What are the implications here for student supports and loans? Should we be expanding the list of technology items we will provide loans/support for?
- 3. How could the use of the technologies and the competency based learning framework outlined in this paper improve quality?**
 - a. To what extent will the use of robotic and artificial intelligence improve consistency in assessment of competency and skills?
 - b. To what extent will leveraging the range of technologies outlined here improve and enrich the learning experience of students?
 - c. How will the use of technology better enable teachers to personalise learning and act as a mentor, coach and guide?
- 4. What will these technologies do for the cost structure of the post-secondary and adult training system?**
 - a. If they were all to be pursued at once, would cost rise or would they be lowered?
 - b. Does leveraging of technology presuppose fundamental changes in the system of delivery — e.g. competency-based learning and regional/provincial assessment?

Challenges

5. Given that many institutions will resist fundamental changes to the design of learning delivery, student assessment and support, what can I do to encourage experimentation?

- a. Would an innovation initiative aimed at leveraging technology, supporting competency-based assessment and the use of robotics, artificial intelligence and other technologies mentioned in this paper help?
- b. Are there flagship institutions, networks or organizations that could be seen as pioneers and early adopters?

6. What are the opportunities to change the teacher:student relationship?

- a. Will technologies “distract” teachers or free them from tasks better done by “smart” technologies so that they are able to spend more time personalising learning?
- b. What are the implications for staff: student ratios?
- c. Will anywhere/anytime learning make it possible for us to increase access without increasing the size of the post-secondary teaching force?

7. How will we keep a systematic track of what is happening in these various technology areas reviewed in this paper?

- a. These technologies are emerging quickly, who is accountable for tracking their emergence and impact on education?

- b. How do we know we are getting reliable information, not biased or vendor driven information?

8. How do we address the infrastructure challenge and ensure that all learners have access to high-speed connections whether they be wired or wireless?

- a. What is the role of government at all levels in ensuring access to high-speed broadband for students in all communities?
- b. Will broadband become an essential service for all residents?

No doubt other issues occur to readers as they work through this paper. From a policy perspective, we can think of policy choices in terms of (a) framework policies — policies that provide broad encouragement through single instruments, e.g. an innovation fund; (b) blanket policies — policies aimed at a broad-based single need, e.g. a commitment to a provincial competency based assessment framework for all of post-secondary; and (c) focused policies — policies aimed at a defined local need or aimed at addressing some specific issue or failure, e.g. giving computer access to every student in every institution everywhere in Ontario. The issues raised in this paper and through these questions require a mixture of all three kinds of policy choices.

It will not be easy. There will be challenges. There are opportunities. Risk is involved. Change is always messy. But the future is different from the past. Yogi Berra had another saying that may be helpful here: “When you come to a fork in the road, take it!” Now might be the time to act.

About Contact North/*Contact Nord*

Contact North/*Contact Nord* is Northern Ontario's Distance Education & Training Network.

MANDATE

1. To improve access to formal education and training at the secondary and post-secondary levels, and to informal education opportunities, for residents of Northern Ontario.
2. To collaborate with Aboriginal peoples, Francophones and communities in Northern Ontario to facilitate response by educational providers (working with Northern Ontario institutions specifically) to meet identified needs.
3. To support innovation in education and learning through testing and applied research of new modes of "delivery" using technology and to share information in Northern Ontario, nationally and internationally.

Through a unique combination of audioconference, videoconference, and Internet technologies, Contact North/*Contact Nord* facilitates access to the credit and non-credit courses offered by Northern Ontario's colleges, universities and school boards as well as other publicly funded educational institutions outside of Northern Ontario.

In 2003-2004, Contact North/*Contact Nord* completed the introduction of a leading edge e-learning platform that allows residents of small, remote and rural communities to bring the rich potential of the Internet into their distance education experience. Coupled with audioconference and videoconference capabilities, the Internet is transforming the

distance education experience and providing a higher quality learning experience for users of the Contact North/*Contact Nord* Network.

Fourteen post-secondary institutions — known as Contact North/*Contact Nord*'s Educational Partners — offer close to 600 credit programs and courses at a distance via the Network. Residents of small and remote communities access the programs and courses via audioconference, videoconference and the Internet through a local Distance Education & Training Access Centre maintained in 66 communities by Contact North/*Contact Nord*. There is no charge for local residents to access their programs and courses via the Contact North/*Contact Nord* Network. They pay the normal tuition fees levied by the post-secondary institution.

For many individuals in these 66 communities, Contact North/*Contact Nord* is the only option to pursue their post-secondary goals and continually upgrade their skills.

CHAPTER 10

About Contact North/*Contact Nord*

AT A GLANCE

- Facilitated 12,662 course registrations in 2004-2005.
- 589 credit full-time and part-time programs and courses available from fourteen educational institutions.
- Current Educational Partners include:



**Keewating-Patricia
District School Board**



**Lakehead
UNIVERSITY**



**NIPISSING
UNIVERSITY**



- Approximately 5,000 unique learners.
- More than 85% of all course registrations come from outside of the five major centres of North Bay, Sault Ste. Marie, Sudbury, Thunder Bay and Timmins.
- 66 small and remote communities served.
- At Access Centres in each community served, learners gather to link with other learners and instructors in other locations via a virtual classroom. Contact North/*Contact Nord* staff provides support to learners, informs them about programs and courses, invigilates exams and acts as the face of the Educational Partners in each community.
- Private sector partners include Bell Canada, IBM Canada Ltd., Telus Corporation.
- Services available in English and French
- Contact North/*Contact Nord* is organized as a not-for-profit corporation governed by a volunteer Board of Directors comprised of the Presidents of Northern Ontario's colleges and universities and community representatives including the private sector and Aboriginal representatives.
- Distance delivery technologies include audioconference, videoconference and e-learning platforms.