

# *Science & Technology*

## Summary

Globalization stands head and shoulders above all other trends as the driving force of technological development. Flourishing “virtual communities” across disciplines and geographical boundaries, the mounting repercussions of international terrorism, and the challenge of ensuring sustainability represent some of the by-products of our increasingly interconnected world.



Underpinning our ability to make the most of this emerging landscape will be our ability to create and manage intellectual capital.

## In this section

- knowledge management – central “technology” of innovation, intellectual capital, and global competitiveness
- virtual communities, international standards, and vulnerabilities – fine-tuning the machinery of globalization
- linking environment, markets and technology in strategic business planning – taking a more comprehensive view
- networks and users – the “hard” and “soft” of the global community

# Science & Technology – Global



- knowledge management - central component of knowledge-based economy
    - **more than information technology** – a set of practices and approaches facilitated by IT tools
      - challenge – make accessible and actionable both “hard” decisions that are made, and “tacit” how decisions were arrived at knowledge of an organization
      - opportunity – most organizations already have some degree of knowledge management in place – appropriate technologies are required to bring the “right knowledge to the right people at the right time”
    - **most organizations have yet to formally implement KM strategies** – fewer than 1% of industry year-end reports contain KM terms
      - analysts are only now developing hard data to demonstrate ROI of KM
      - KM has yet to become embedded in day-to-day management
    - **dangers of un-managed knowledge are clear**
      - shifting demographics leading to workforce turnover = corporate memory erosion
      - “information overload” of knowledge economy means that employees are spending unprecedented amounts of time looking for stored information
      - Western economies are increasingly dependent on knowledge as primary commodity
- recent UN research has estimated value of intellectual capital as a proportion of financial capital of Middle-Eastern countries at 20.9%
- at the same time, clusters of intellectual capital “have” and “have-not” countries
  - “haves” – enjoy strong educational and research systems, as well as high literacy – tend to be oil-rich (Kuwait, Oman, Saudi Arabia)
- future research will focus on other key regions (Americas, Europe, Asia)
- expectations are greater economic diversification will result in greater importance of intellectual capital

# Science & Technology – Global ...



- globalization creating need for standardization across research communities
  - **international research requires consistency, process standardization**
    - growing need to ensure transparency of processes through internationally-recognized audit, evaluation
    - announcement of global genetic guidelines (April 2002) a significant milestone
  - **challenge - create international benchmarks across disciplines**
    - accreditation, certification increasingly significant in research, development
    - cost implications yet to be determined

## Vulnerabilities of “community” approach emerging for research, computing

- security challenges for researchers - data protection, network integrity
- data integrity and verification potentially challenged by lack of international standards
- DDOS attacks demonstrate application of approach through use of multiple networks
- growing potential for use of networked computers to “hide” illicit activities

- direct impacts to be felt in policing
  - forensic analysis, treatment of evidence require international standards
  - enhanced cooperative efforts across jurisdictions to result in examination of legislation, practices relating to investigations and use of technology

# Science & Technology – Global ...



- research “clustering” an emerging by-product of interconnected global community
  - **information technologies reducing impact of geographical constraints** on scientific communities
    - virtual communities flourishing across disciplines – communications channels are means of sharing, compiling, analyzing results
    - clustering helping to create new synergies among research communities formerly isolated by geography
  - **“distributed research” projects** leveraging power of international volunteers in science
    - growing number of medical, mathematics, physics, etc. research projects capitalizing on distributed virtual processing power of volunteer computer users
- “distributed computing” – consolidating power through innovative network structures
  - **linking components, networks to harness existing power** a means to creating customizable, “virtual” computers
    - major firms (Sun, Hewlett-Packard, IBM, Compaq) experimenting with integrated distributed computing
    - intent to link “bits and pieces” scattered throughout existing networks to create a task-tailored computer

*Many of the researchers who have constructed [distributed research applications] as largely academic projects brush aside possible risks as unimportant given the value they potentially bring to society. That includes the directors of SETI@Home, which analyzes data from a radiotelescope for signs of alien life and, with 3.5 million users, is probably the largest distributed computing project. In June of last year, when hackers gained access to its volunteer database and escaped with information about 50,000 users, the administrators said they would not rewrite the software to add more security because it is a nonprofit project without the time or resources to do so.*

~Ariana Eunjung Cha  
Washington Post 21 Feb 2002

# Science & Technology – Global ...



- global consumption, demographic trends highlight importance of sustainability as business/market issue
  - **global environment, society linked to strategic market and economic trends**
    - current trajectories could potentially undermine both supply and demand over long term
  - **keys to long-term business survival**
    - integrating sustainability, environmental responsibility into business practices
    - ensuring more informed policy directions
  - **depletion of natural resources** - increased waste will impact on business strategies due to global economy's dependence on non-renewable resources

## A Sustainable Global Market? Telling signs...

- **long-term supply and demand jeopardized by current trends, undermining economic sustainability**
  - money spent on global household consumption increased 68% between 1980 and 1988
  - food purchases account for as much as 70% of family income in some regions
  - global energy production and consumption could rise by up to 230% by 2050
- **sustainable development programs are most common in countries with democratic governments**
  - UN points to importance of corporate responsibility in selecting countries for investment
  - while number of democratically-elected governments continues to rise, the trend does not extend to many oil-rich nations

Source – United Nations Environment Programme, Freedom House



- key scientific concerns emerging in post-9/11 research environment
  - **developing general understanding of CBRN issues** a key research priority
    - post-9/11 security focus demonstrated limits of knowledge on CBRN issues
    - supporting preparedness through scenario-building, scientific research, infrastructure protection central to general security matters
  - **safe, sufficient food** – impacts both at home and abroad
    - food supply potential security risk in wake of 9/11 – inspection, protection stepped up and sustained – community of security players tested by new requirements across Western countries
    - application of genetic research to developing world food supply bearing fruit – discovery of rice genome to allow for “fast-tracking” of new species development
  - **geopolitics as key driver** in search for alternate fuel sources
    - dependence of West on fossil fuels a significant influencer of anti-western terrorism in developing world
    - pressure for “green” transportation growing but new technologies yet to break into mainstream

*By October 14, more than 7,000 individuals had visited various treatment sites for health concerns related to the World Trade Center events. Specific data on the severity of these injuries were difficult to gather, however. The lack of perimeter control at the World Trade Center site made it difficult to monitor the extent of injury and illness. In effect, the “denominator” is unknown, as it was impossible to track how many people were at the site or measure their levels of exposure. It may be years before the true health effects of the disaster are known.*

~RAND Corporation  
*Protecting Emergency Responders: Lessons Learned from the Terrorist Attacks*

# Science & Technology – Global ...



- global demand for security driving innovation in identification technology
  - **accurate identification tools** – growing demand for next-generation “smart” identification tools
    - focus on multiple redundancies as key to proving positive identification
    - examples include microchip fingerprint-embedding technology, incorporation of fingerprint information in bar-codes, use of digital photography in passports, biometrics
  - **facilitating travel, trade and ensuring security** a challenge for identification card innovators
    - “trusted traveller” practices growing in popularity – National Business Travel Association (USA) cites 66% support among frequent travellers for pre-clearance technologies, “smartpass” identification cards
  - **focus on new identification tools** also highlights important challenges, need for further analysis
    - civil rights groups challenging increasing use of identity cards as means of prying into private habits
    - critics demand “measured” approach – warn of sustained “reactionary” implementation

- **US *Enhanced Border Security and Visa Entry Reform Act* to pave the way for tools to enhance border security**
- **US \$3.2B to be dedicated to purchasing, implementing new technologies at borders, including:**
  - **new database to be created to link immigration, law enforcement information**
  - **foreign travel documents to require biometric information fingerprints, retinal scans**
  - **foreign student tracking system to be created**
  - **new Border Patrol, INS personnel to be hired**

# Science & Technology – Global ...



- cyber-security increasingly part of mainstream security matters
  - US government considering **options for future of cyber-security infrastructure**
    - placement and structure of key units National Infrastructure Protection Center, DoJ Intellectual Property division critical to effectiveness of cyber-security teams
    - creation of new Cyber-Security division in FBI to look at key criminal and terrorism vulnerabilities
    - regionalization of US Secret Service Economic Crimes Task Forces to improve assistance to corporations
    - growth of issues taxing existing system – challenge to maintain service without overextending capacity
  - **lack of standardization** in security technology, consistency in applications across jurisdictions, sectors remains critical challenge

- front-line security of passwords “weakest link” in network security, as well as easiest to strengthen
- of 15,000 European and American computer users at 600 major companies
  - over 50% base password on name of a family member or pet
  - 30% use name of a celebrity, such as a pop idol or sports hero
  - 25% use a simple, easy to remember word
- at the same time,
  - close to half have never received formal security awareness training
  - 1/3 of companies surveyed did not require employees to read security policies
- worst offenders tended to be from communications industry

Source – Pentasafe Security Technologies Ltd., BBC



# Science & Technology – Canada



- federal innovation strategy to foster Canadian leadership in global knowledge-based economy
  - **emphasizes improving Canadian standing in global competitiveness**, with innovation as national competitive edge
  - **Canada fares poorly against other highly developed countries** in key innovation benchmarks
    - R&D spending as percent of GDP – currently in middle of OECD countries
    - (14th out of 29) -- Canada ranks 11<sup>th</sup> in competitiveness
    - number of external patent applications, number of researchers relative to size of labour force both rank low among developed countries
  - **strategy focal points**
    - leveraging knowledge and intellectual capital resources through R&D
    - meeting intensifying skills needs through lifelong learning, building on Canadians' high level of education and training
    - creating an environment that enables innovation through improved public policy, good stewardship, investment incentives
    - partnership approach – strategy is a “call to arms” to business, other governments to partner on innovation
- industry leaders give innovation strategy mixed reviews
  - **viability of multisectoral partnership concept questioned** in context of economic recession
    - see need for funding to enable local initiatives to meet national challenge
    - point to government role in making Canada attractive place for investors, entrepreneurs – cite regulatory, tax frameworks as areas for improvement

*It is time to take what Canada has done well and ask ourselves: How do we do more of this, faster? It is time to galvanize a truly national effort to achieve excellence in all we do: to be the best and nothing less. If we succeed, the reward will be an improved quality of life for all Canadians. We will need a partnership among all levels of government, researchers, academia, businesses and all Canadians.*

~The Hon. Allan Rock  
Minister of Industry  
February 12 2002

# Science & Technology – Canada ...



- broadband implementation demonstrates need for multi-sectoral approach to research and development

- **broadband infrastructure - key enabler of**

- competitiveness** through real-time business access to knowledge - challenges unique to Canadian geography and society

- covering broad geography
- ensuring rural access
- providing equal access

- **emphasis on multi-sectoral, multi-jurisdictional partnerships**

- federal, provincial governments as builders and enablers of country-wide infrastructure
- municipal governments, private partners to enable access and tools through local initiatives, “last mile” infrastructure

- **estimated cost of e-infrastructure \$4.6B** – to be shared by public, private partners

## Canada online – Key Facts

- **#1 in Internet use across G7 (2000), #2 in connectedness**
- **among lowest communications costs in the West**
- **IT sector contributes close to half of Canadian private sector R&D**
- **15,600 schools, 3,400 libraries online**

*Source – National Broadband Task Force*

- broadband growth to test limits of security – potential threats to privacy, e-commerce, data integrity to increase with connectivity
  - increased access could grow potential pool of hackers, cyber-criminals
  - key weaknesses of “always on” high-speed systems to be increasingly exploited by criminals:
    - denial of service attacks (DDOS) – crippling websites
    - e-mail worms and “Trojan horses” – restricting communication, data security

# Science & Technology – Canada ...



- intellectual property management and protection - significant challenge to research in Canada
  - growth of cross-functional research communities creating **need for standards, security measures**
  - **cost of patents, research exchange processes prohibitive** to many small to medium enterprises – system bias toward large corporations
  - **facilitating knowledge-sharing, technology transfer from Canadian hospitals, universities to broader research community a key step**
    - new federal funding aims to improve knowledge management between communities
  - **knowledge, intellectual property management growing** in application across Canada – Statistics Canada research into knowledge management practices reveal significant trends
    - larger corporations and organizations quickest to implement knowledge management
    - loss of key personnel seen as main trigger for implementing or improving knowledge management practices – increasingly important role of intellectual capital recognized in positive impact on market share, productivity
    - knowledge management also seen as key to retaining employees
- information-sharing, network and database integration resulting in new pressures to enhance, protect privacy
  - **DNA, forensics research and database collaboration** seen as potential vulnerability
  - **interjurisdictional integration** accelerating post-9/11

# Science & Technology – Canada ...



- skills, demographics - key vulnerabilities of scientific community
  - **federal knowledge, innovation agendas point to growing shortage of PhDs** – vacancies among post-secondary faculty members to peak between 2004 and 2010
  - **student performance in science has improved since mid-1990s** – maintaining learners' interest remains challenge for learning institutions
    - Canadian students demonstrate drop-off in interest for science subjects throughout high-school
    - by end of high school, less than half are enrolled in both math and science programs

- **Canada's overall level of innovation capacity is near the bottom in the G-7**
- **as early as 1995, the OECD referred to Canada's situation as an "innovation gap"**

*Achieving Excellence: Investing in People, Knowledge and Opportunity, 2002*

## Research and Development: Setting the Canadian Context

- **Canada ranks 6<sup>th</sup> out of 7 of G7 countries in research and development per capita – only Italy ranks lower**
- **invests only 0.21% of its Gross Domestic Product in research**
- **Canadian businesses spend US\$358/worker on R&D, while US counterparts spend US\$1,065**

*Source – Save British Science*