NRC·CNRC

Canada's Approach to Science, Technology & Innovation

PICMET, Portland, Oregon

John McDougall, President
National Research Council of Canada
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National Research Council Canada | Conseil national de recherches Canada

Canada

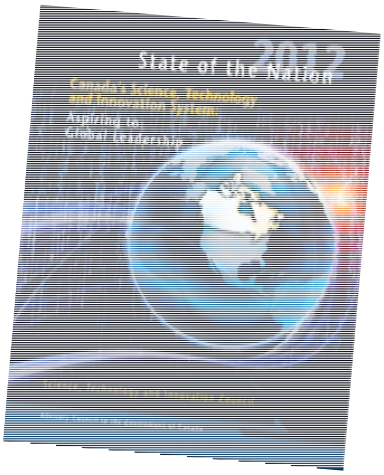
Outline

- Historical basis for economic growth, competitiveness and wealth creation
- Forms of innovation and their essential differences
- Key challenges confronting developed economies
- Canadian challenges and emergent ideas for building a globally competitive future
- Canada's technology and innovation policy response
- Managing Technology Development and Innovation

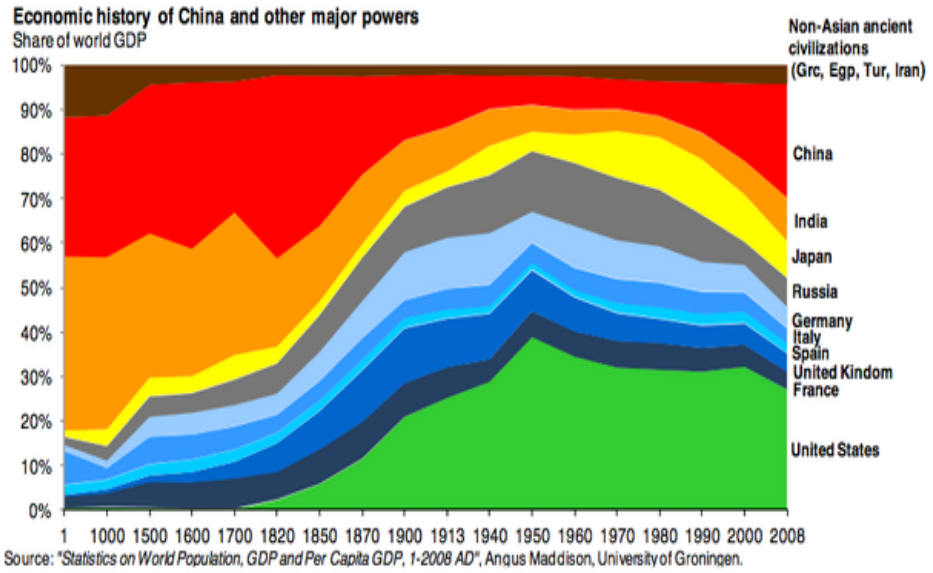
Canada's innovation challenge

"Canadian firms are not sufficiently harnessing innovation to meet competitive gains. In international rankings related to business and innovation, Canada continues to place in the middle of the pack on most measures and, on some indicators Canada's rank has declined. "

STIC State of the Nation 2012



Economic History of the World



Source: "Statistics on World Population, GDP and Per Capita GDP, 1-2008 AD", Angus Maddison, University of Groningen.

Schumpeter

- "Business Cycles" - 1939
  - technological innovation leads to economic instability
  - Radical innovation results in clustering of related innovation
  - Innovations cannot be decomposed into infinitesimal steps
- "Capitalism, Socialism and Democracy" – 1942
  - Value of innovation - "perennial gales of creative destruction sweeping away old industries producing old products"

Hierarchy of Economies

ROLE	Any Job / Low End / High End / Value Add — MANUFACTURING	INNOVATION	INNOVATION PLUS
	PROGRESS ⟶		
PLAYER	Under developed regions	Lesser "developed" regions	Highly developed regions	Knowledge Economies
STRATEGY	COPY	PRODUCTION EFFICIENCY	VALUE CREATION	GLOBAL LEADERS
COMPETITIVE ADVANTAGE	Cost	Quality and cost (Value)	Innovation Models Insight and Opportunity	Foresight Innovation Systems Culture
OUTCOME	Survival	Wealth	Sustainable development	Quality of Life

Knowledge Economy requires a substantial domestic capability in education, technology and product development and innovation.

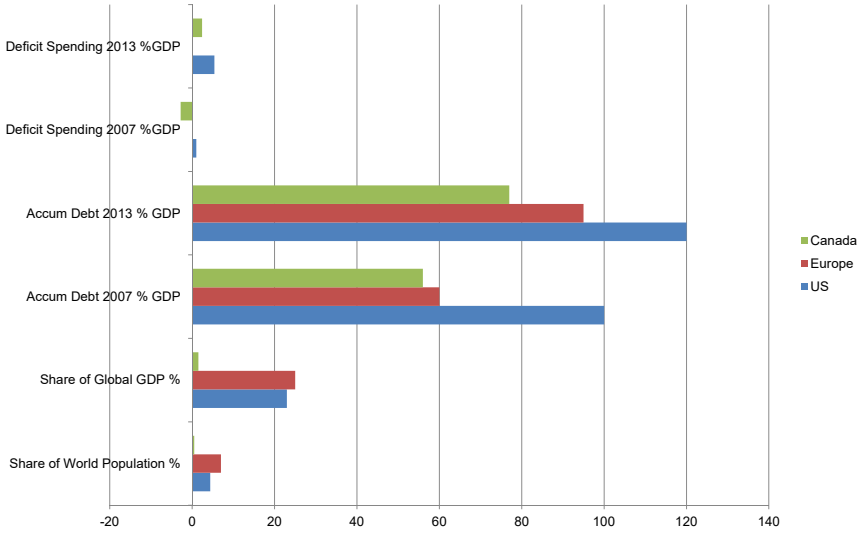
Forms of innovation

Outcome	Disruptive (Create New Opportunities)	Evolutionary (Build the Future)	Incremental (Exploit what we know)
Time Horizon	**5 - 50 years**	**2-10 years**	**0-3 years**
Driving Force	Curiosity, Serendipity - push	Mission – pull and push	Customer – market pull
Business Focus	**Blue sky Research Discovery - Ideas**	**Product & Technology development**	**Production & Sales**
Activities	Basic Research, Applied Research, proof of concept	Applied research, demonstrations, prototypes, standards development	Problem solving, adaptation, testing, manufacturing, consulting
Key Knowledge	Foresight, research processes	Competitive intelligence, science & engineering methods	Markets, production processes, standards, management
Success Factors	**Expertise, reputation**	**Experts, IP, management**	**Efficiency, quality, cost**
Level of Risk	High	Medium	Low
Share of Investment	5-10%	20-30%	60-70%
Funding Source	**Grants (Public)**	**Contracts + Equity + Grants (Industry + Public)**	**Contracts - Customers (Industry and Government)**
Business Return	Knowledge, HQP	Social and Economic ROI	Gross margin
Impact	**Jobs, quality of life**	**Wealth, jobs, quality of life**	**Wealth, employment**

TECHNOLOGY TRANSFER

"Innovation remains a frustrating pursuit. Failure rates are high, and even successful companies can't sustain their performance. The root cause is that companies fall into the trap of adopting whatever best practices are in vogue or aping the exemplar innovator of the moment" – *Gary P. Pisano, HBR June 2015*

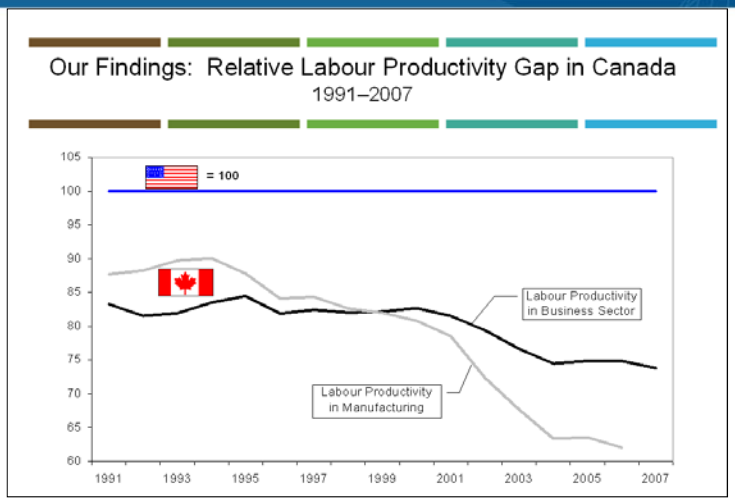
Developed World Faces Growing Debt



Canadian Resource Base

minerals - northern BC, Yukon, NWT, Ontario "Ring of Fire", Quebec Plan Nord and Labrador; **oil sands** - across northern Alberta; **uranium** - Saskatchewan; **oil and gas** - west, north and east coast; **hydro & boreal forest**

Jenkins Report 2011
Poor Relative Productivity Performance



75% of the productivity gap is attributed to lack of investment in ICT

Key innovation indicators to Canada

- **Entrepreneurship** – consistently rated in the top 5 by Forbes 'best countries for business' rankings
- **Capacity for innovation**: 25th worldwide; company spending on R&D: 26th (World Economic Forum 2012-13)
- **Productivity growth**: 95th of 132 countries; 24th among 33 advanced economies (International Institute of Management Development)
- **Scientific research institutions quality:** 16th globally (WEF 2012-13)
- **Federal S&T investment**: $100B over 10 years to stimulate competitiveness, productivity, economic growth
- **BERD** - stuck at about 1% for 25 years and declining

Canada has research strength – global competitiveness a challenge

S&T Strategy research priority areas

Environmental Science and Technologies
- Water (health, energy and security)
- Cleaner production and use of hydrocarbon fuels
- Agriculture

Natural Resources and Energy
- Oil sands energy production
- Arctic (resource production, climate change adaptation and monitoring)
- Biofuels, fuel cells and nuclear energy

Health and Related Life Sciences and Technologies
- Regenerative medicine
- Neuroscience
- Health in an aging population
- Biomedical engineering and medical technologies

Information and Communications Technologies
- New media
- Animation and games
- Wireless networks and services
- Broadband networks
- Telecom equipment

Advanced Manufacturing

Ideas and Initiatives to Strengthen Canadian Economy

High impact ideas emerging with specific and direct impact:

- **Emerging technologies** – adaptive optics, photonics, quantum encryption and computing, and nanotechnology
- **Manufacturing** – Factory of the Future, UAVs, designer bio and composite materials
- **Infrastructure** – state-of-the-art rail and pipeline transportation, east/west hydro grid, ports
- **Internet of Things** – printable electronics, machine learning, big data heuristics
- **Genomics and Bio-economy** – wheat, biomaterials, algal-carbon conversion

Factory of the Future — Rejuvenating Industries

24 key technologies - Source : MIT "Production in Innovation Economy"

Manufacturing Process Innovation
- Rapid Prototyping
- Coatings
- Continuous Process Control
- Flexible Electronics
- Semiconductors
- Printed Electronics
- Manufacturing / refining of biofuels
- Pharmaceutical and Medical
- Optoelectronics and Photonics

New Materials and Multi-Scale Mfg
- Material Genomics
- Composite Materials
- Lightweight Materials
- Meta-Materials

Automation and Precision Manufacturing
- Smart Automation
- Advanced Robotics
- Precision Manufacturing

Manufacturing Systems
- Supply Chain and Logistics
- IT for Manufacturing
- Adaptive and Flexible Manufacturing
- Mfg Simulation and Visualization

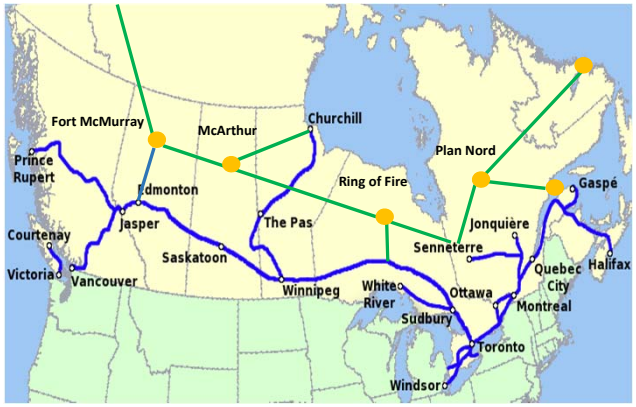
Sustainability in Manufacturing
- Mfg using recycled materials
- Energy efficient manufacturing

Measurement and Testing
- Advanced Sensing
- Advanced Metrology

Northern Corridor — Economy Game Changer

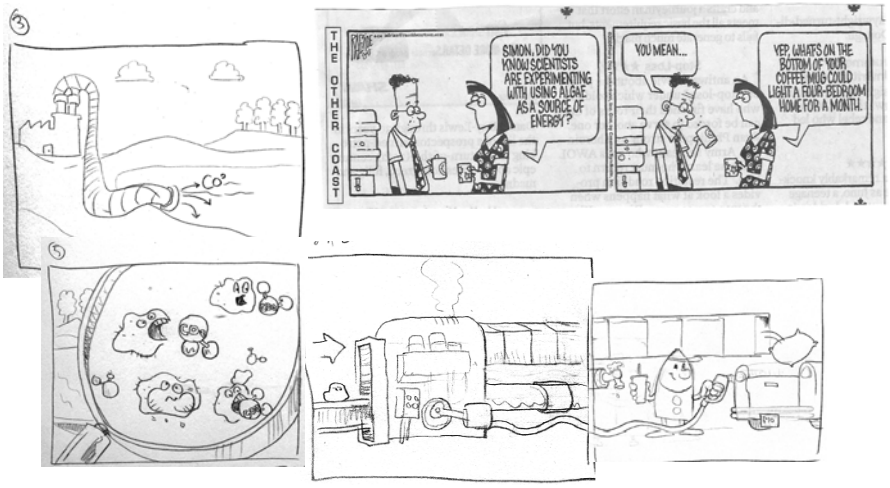
Northern Corridor

Green is the proposed new corridor. Blue is the existing corridor.



- Magnetic levitation high speed rail,
- Safe, smart reliable pipelines
- East-west power grid
- High capacity communications backbone

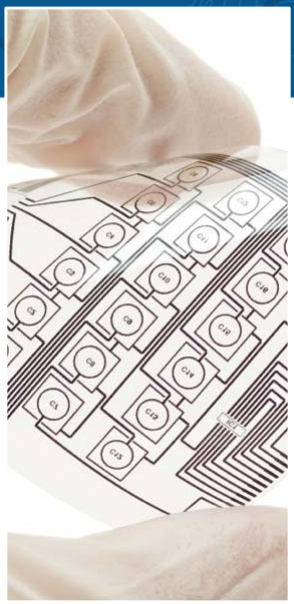
Solving Problems
CO2 Recycling Through Algae



Developing New Technologies
Printable Electronics

Success story - Printed Antennas to Speed up Border Crossings

- NRC and its partners have developed a solution to print antennas within RFID-enabled ePassports (an encrypted Radio Frequency IDentification system designed to speed up border crossings)
- NRC transferred the technology to an industrial partner who started manufacturing passports for Passport Canada starting in Summer 2014



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Canada's S&T Strategy: Mobilizing S&T to Canada's Advantage

2014 update of 2007 strategy to guide federal investments
- **3 Pillars** to build national competitive advantages

People Advantage
Knowledge Advantage
Innovation Advantage

S&T as a tool to promote economic well-being
- **4 Principles** for helping industry derive benefits

World class **Excellence**
Targeted **Priorities**
Fostering **Partnerships**
Enhanced **Accountability**

Research priorities that will transform industries and yield strong economic benefits
- **5 Targets** based on national strategic needs

Environment and Agriculture
Health and Life Sciences
Natural Resources & Energy
Information & Communications
Advanced Manufacturing

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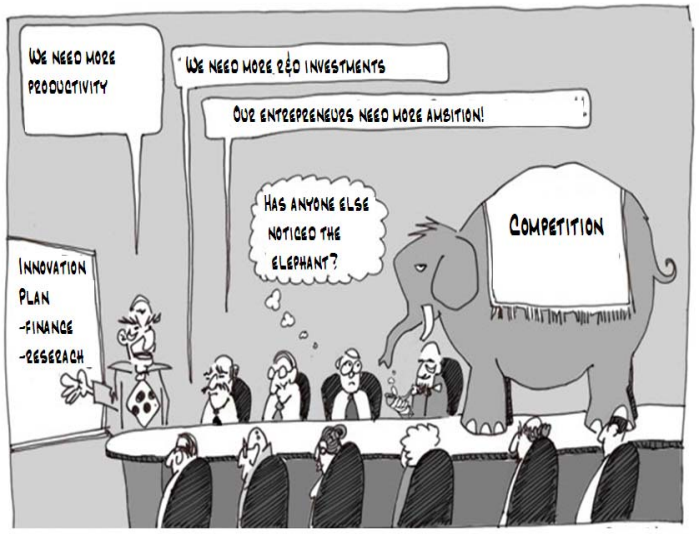
Competition: The Elephant in the Room

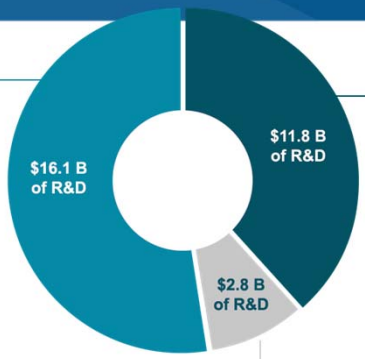


Canadian R&D performers

Business

- Product and process development
- Commercialize new knowledge

In absolute terms, Canadian businesses are the largest performer, as well as source, of R&D funding in Canada.



Higher Education

- Scientific discovery and publications
- Graduate and Post-graduate research

Nearly $1B of R&D in higher education is funded by business and over $1.1B from the private not-for-profit sector.

Government

- Policy and regulatory mandates
- Support to industry and academic partners

The federal government is second largest source of R&D funding ($5.9B) and also performs R&D ($2.4B, or about 8% of the R&D performed in Canada), with provincial government performing $343M.

Total R&D Performed in Canada in 2012: $30.7B

NRC's unique value proposition

- State of the art technology
- Draw expertise and know-how from across NRC for multidisciplinary solutions-tailored to client needs
- Combine strategic R&D and technical capabilities with innovation support & unique and specialized infrastructure as well as experts to optimize its use
- Help industry manage risk to develop innovative ideas, reduce start-up costs, and shorten time to market

Solving innovation and competitive technology problems. Developing, adapting and transferring technology.

innovation system is a complex eco-system with many players and stakeholders

- **Skills** - high quality, accessible education and training system.
- Supportive **environment** - policy, regulation and tax structure.
- Access to **capital** – governments, companies, not-for-profit agencies, venture capitalists, angel investors, etc.
- An efficient **communications** infrastructure.
- **R&D performers** – High quality universities, provincial and federal agencies, private companies, other research organizations.
- Clusters of **innovators** – start-ups, established firms, individuals, entrepreneurs.
- **Culture** – leadership, entrepreneurship, risk tolerance.
- **Markets** - customers
- Organizations and **networks** that facilitate knowledge and technology transfer and services related to innovation and technology commercialization

Canada's innovation paradox

Canada has multi-player ecosystem with strong S&T capacity

- A strong knowledge and basic research base
- A highly skilled workforce
- Industrial R&D strengths (e.g., aerospace products and parts manufacturing, ICT, oil and gas extraction, pharmaceutical and medicine manufacturing)

However, these strengths have not translated into strong business innovation

- 'Linear' research push model of innovation rarely applies

Many factors influence business strategies…

- Market opportunities
- Structural characteristics
- Competitive intensity
- Climate for new ventures
- Public policies

… but some are more directly related to Canada's poor business innovation performance

- Canada's comparative advantage in an integrated North American market
- Strength of commodity market
- Profitability of current business models
- Attitudes to business risk

Ultimately, Canadian business has been as innovative as they need to be

four exploitation factors key to overcoming the "valley of death" between research outcomes and access to market.

- **Technology Readiness**: factors related to the exploitability of the technology that was developed, or its level of development. The TRL process is very useful for a singular technology but may be less applicable to complex systems in which several technologies must be integrated. However, it may still be usefully applied to components and subsystems and/or to tightly specified problems.
- **Market Readiness**: factors related to the market-pull, regulation, standards, IPR protection, environment etc.
- **Leadership Readiness**: factors related to the partnership such as the presence or absence of any critical exploitation partner, management specificities, relevant skills, training etc.
- **Venture Readiness:** factors related to the availability (or not) of funding for exploitation, industrial RD etc. Irrespective of the financial 'strength' of the exploiters

Seven requirements for managing innovation

1. **Clarity about the problem** or opportunity.
2. **Understanding of the market** in which the innovation will be deployed and the critical issues that will determine if and how deployment will happen.
3. Continuing **competitive intelligence**.
4. **Collaboration** with the best capabilities and knowledge around the world.
5. **Funding model that reflects and incorporates the risks** and risk tolerance of key players.
6. **Disciplined plan**.
7. **Real accountability**.

In Conclusion

Competition

leads to

Innovation

leads to

Productivity

leads to

Competitiveness

NRC is playing a significant role to make this a greater reality for Canada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Thank you, merci
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