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(Source: Industry Canada TRM web site)

TECHNOLOGY ROAD-MAPPING: YOUR PATH TO INNOVATION

Submitted to the Canadian Civil Engineer
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Introduction

Innovation is an essential element of today's industry success. Innovation can take different forms, all of which have their own challenges and rewards. Innovative business processes can result, for example, in improved client services or reduced overhead costs, while technology innovation can help in increasing product quality or in reducing production times.

However, the development and implementation of innovation does not come free and, if not properly planned and validated, can result in costly mistakes. The solution is then to predict the needs in the near to medium term futures and identify the key challenges to address in order to fulfill those needs. This can be done at various levels: for a whole industry sector, for a sub-sector of a particular industry, or for a specific product or process.

Road-map vs. forecast vs. foresight

Readers may have heard of the terms technology *road map*, *forecast* or *foresight* used in the context of innovation and R&D. Although these activities are generally similar in nature and process, they greatly differ in terms of timelines. *Road-mapping* usually looks at a 5 to 10 year horizon within which market needs and technology challenges can be fairly accurately predicted, while *forecasting* has a timeframe from 10 to 25 years. *Foresight* usually is applied to timeframes of more than 20 years and is used to express what could be considered “technology revolutions” in terms of changes and new developments¹.

What is a Technology Road Map

The development of a technology road map (TRM) provides stakeholders a tool to identify, evaluate and select technologies for achieving technological objectives.

Technology road mapping integrates a number of tools and follows a number of principles²:

1. Driven by “Market Pull”, that is the technology organizations to serve anticipated future market needs. Road mapping is not a “technology push” exercise. It can be done with the existing stock of technology.

TECHNOLOGY ROAD MAPPING . . .

- helps an industry predict the market's future technology and product needs
- defines the "road" that industry must take to compete successfully in tomorrow's markets
- guides technology R&D decisions
- increases collaboration, shared knowledge and new partnerships
- reduces the risk of costly investment in technology
- helps the industry seize future marketing opportunities

Source: Industry Canada

¹ See APEC Centre for Technology Foresight at <http://www.apectf.nstda.or.th/>

² <http://strategis.ic.gc.ca/epic/internet/intrm-crt.nsf/vwGeneratedInterE/Home>

2. It builds on a vision of where the industry (or a company or organization) wishes to go and what technologies are needed to get there.
3. It provides a route for achieving the vision, going from today to tomorrow, by helping companies or organizations identify, select and develop the right technology alternatives needed to create the right products for future markets.



A technology road map is the first step towards technology innovation and it provides the basis for action plans to achieve the desired results.

A technology roadmap presents the industry's consensus on a number of topics:

- a vision of the industry at a set time in the future;
- what new types of products (or services) markets will require;
- the enabling technologies to create those products or provide

- those services;
- the feasibility of creating the needed technologies;
- the technological alternatives for achieving the needed technologies;
- and how to address these technology needs through R&D.

The road map in many cases also clarifies the broad context in which the industry operates, identifying non-technological issues, constraints or pressures that influence the development of the industry. Although these issues are beyond the scope of the TRM, some may be facilitators of innovation while others may be barriers, and therefore form important knowledge for future implementation. The roadmap also addresses the role of an industry's suppliers in creating the desired future, as well as human resources needs and other topics.

Technology road maps are used in different contexts for different purposes. The principles are similar (e.g., needs driven, consultative, action oriented) but their orientations may differ in significant ways. Following general guidelines, a company, industry, organization, or government department will create its own roadmap by adapting one of the models to meet particular needs or challenges. The types of roadmaps in use today are:

- **industrial sector technology roadmaps**, used to assess and extrapolate the direction of market-driven requirements within an area of technology, and then identify R&D strategies to meet those requirements;
- **science and technology roadmaps**, used to select from among emerging technologies;

- **product roadmaps**, used by companies to identify the technical processes, and accompanying opportunities and risks, associated with the development of a specific product or service;
- **program roadmaps** used by government or private sector organizations to evaluate how emerging issues might affect the strategic direction of a long-term program.

Role of Technology Road Maps

Companies face many challenges in today's global markets. Products are becoming more complex and, at the same time, more customized. Time-to-market for products is shrinking and product life is shortening. R&D is expensive, and reduced budgets are making it impossible for individual companies to independently develop all the technologies they might need to meet future market imperatives. Competition is global and fierce, especially from countries that are both technologically advanced and have lower labour costs than Canada.

In this context, companies must use effective tools to plan their future. Technology road mapping is a way to identify product or service needs, map them onto technology alternatives, and develop plans to ensure the required technologies will be available when needed.

Here are some of the indications that an industry needs to produce a roadmap³:

- Demands made by the markets the industry serves are changing dramatically.
- The industry has reached a strategic juncture with regard to entering new markets, seeking out new technologies or acquiring new skills.
- Companies within the industry are losing market share, failing to increase market share as new markets open, or facing a competitive threat.
- Companies within the industry have a vision of their place in future markets but no strategy for making that vision tomorrow's reality.
- Companies, or the industry, are facing uncertainty about what technologies and applications future markets will demand, and when new technologies will be needed.
- There is no consensus among companies, or within the industry, as to the best technology option from among the choices for future development.
- Each company within the industry is conducting separate R&D efforts devoted to technology problems, that all have in common.
- Individual companies within an industry sector lack the resources and skills needed to boost innovation, and would benefit from joint efforts in R&D, sourcing, or supply-chain arrangements.

³ Industry Canada "Technology Road mapping: a Guide to Government Employees"
<http://strategis.ic.gc.ca/epic/internet/intrm-crt.nsf/vwGeneratedInterE/Home>

Producing the Technology Road Map

A technology road map is usually comprised of 3 phases: a number preparatory activities, the development of the map, and follow up actions. The actions under each of these phases vary slightly depending on the type of mapping exercise, the industry involved, the existing knowledge available, etc. The steps described below give a general sense of the activities required for each phase.

Preparatory activities

The preparatory stage is critical in identifying the objectives, scope and context of the TRM, the lead organisations, and the stakeholders that will be involved and consulted throughout the process. Also, background information on the industry sector needs, challenges and opportunities is collected at this stage. Depending on available information, a sector study may be commissioned to establish where the industry sees itself in 5 to 10 years and the key technology challenges associated with that positioning. The analysis of these data serves as the basis of the TRM consultations.

Prior to launching the road mapping process, the organisational structure is established as well as the funding requirements and sources for the project identified and committed.

The development of the technology Road is the responsibility of an industry lead committee. In the case of the current Civil Infrastructure Systems (CIS) TRM⁴ a Steering Committee composed of representatives from the sponsor organisations (CSCE, CCPE⁵, CPWA⁶ and NRC⁷) created an Expert Panel composed of cross-Canada, multi-stakeholder representatives (academia, governments, municipalities, consulting engineers, contractors) and lead by an infrastructure engineering consultant. A team including a Project Manager, a Research Coordinator, a Technical Advisor, and a number of contracted specialists supports the CIS-TRM process.

Developing the Technology Road Map

The goal of the TRM is to establish the enabling technology or technologies necessary to realize the vision. Participants consider what attributes a technological system must possess to enable the industry to best address future market opportunities. Participants consider major categories of technology and the factors driving the development of these various categories. They assess the technological alternatives and their development time horizons. Finally, the participants make recommendations as to which alternative(s) merit R&D work.

⁴ See www.csce.ca

⁵ Canadian Council of Professional Engineers

⁶ Canadian Public Works Association

⁷ National Research Council Canada

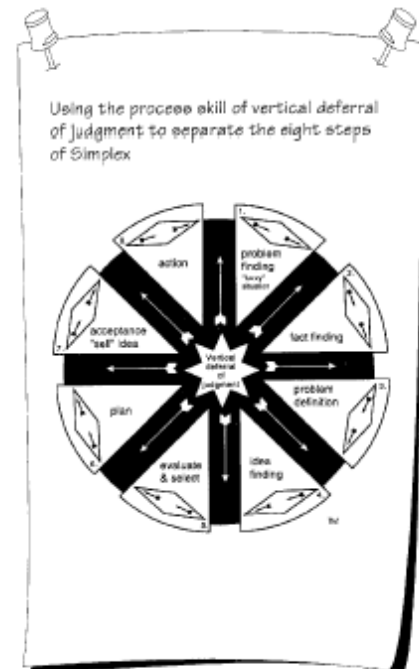
The key steps in this process are:

- Define the industry and the needs of its customers at a particular point in the future
- Identify the product(s) or enabling technology (ies) that will be the focus
- Identify the critical attributes of the target future system(s)
- Specify when the technology will be needed if the industry is to meet future customer demands
- Specify the technology drivers and their targets
- Identify technology alternatives and their development timelines
- Recommend technology alternatives that should be pursued
- Define what skills and knowledge the industry's future work force will require developing and implementing the new technologies

The process should be CONSULTATIVE and INCLUSIVE.

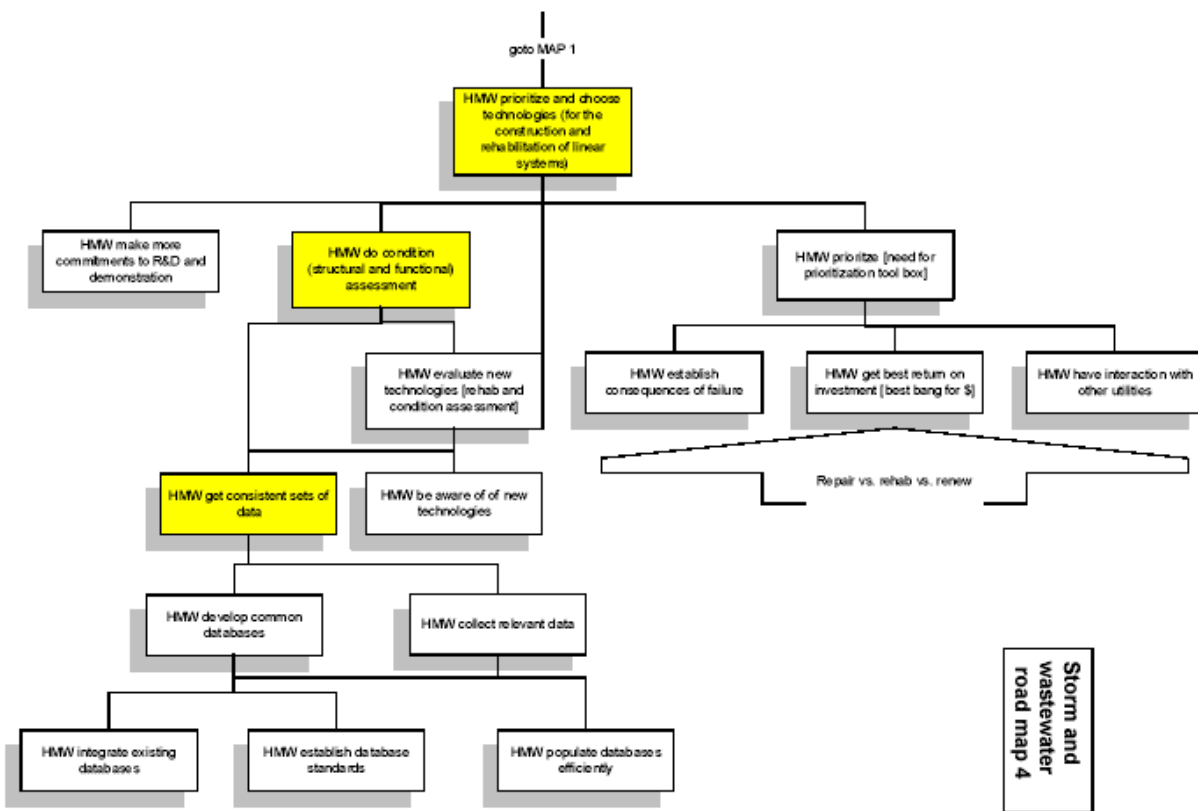
In order to bring the most out of the experts consulted, a facilitation process such as the Simplex™⁸ can be used. This process, used by the author in similar exercises (for example, in developing the best practices priorities for the National Guide to Sustainable Municipal Infrastructure (NGSMI)⁹.

The SIMPLEX process, illustrated in the figure, revolves around the key question: "How Might We" (HMW). To create a road map, participants look at each HMW question and further question WHY (do we need to do this) and WHAT'S STOPPING US (from doing it). Participants afterwards choose (vote) the priorities from the map. One of the NGSMI maps shown below illustrates the results of a session.



⁸ **SIMPLEX: A flight to Creativity**, by M. Basadur, The Creative Education Foundation Inc. publisher, 1994

⁹ Félio, Guy, "Defining Priorities: report on July/August 2001 Guide Workshops", National Guide to Sustainable Municipal Infrastructure, October 2001
<http://www.infraguide.gc.ca/docs/priorities.pdf>



Conclusions

Technology road mapping is a powerful tool to provide technology direction and leadership for an industry. It brings together the industry stakeholders in defining a common vision and in identifying the technology steps necessary to achieve this vision.

A number of TRM have been developed in Canada and internationally for various industries. Many of these reports are available through Industry Canada's TRM web site¹⁰.

WHY PRODUCE A TECHNOLOGY ROADMAP?

- Technology and markets are changing more and more rapidly.
- Industry needs solutions that address today's pressing needs and tomorrow's market goals.
- Many solutions are beyond the ability of individual firms.
- Companies want and need new partnerships to support their own technology strategies.
- Common needs demand leveraged solutions.

Source: Industry Canada

¹⁰ http://strategis.ic.gc.ca/epic/internet/intrm-crt.nsf/vwGeneratedInterE/h_rm00051e.html