

**PROCEEDINGS OF THE
CANADIAN RAILWAY RESEARCH SYMPOSIUM**

28–29 November 2007
Toronto, Ontario

Prepared for Transport Canada
under the auspices of the
Railway Research Advisory Board

November 2007

**PROCEEDINGS OF THE
CANADIAN RAILWAY RESEARCH SYMPOSIUM**

28–29 November 2007
Toronto, Ontario

by:
Railway Research Advisory Board

November 2007

NOTICES

This report reflects the views of the authors and not necessarily those of Transport Canada.

Since some of the accepted measures in the industry are imperial, metric measures are not always used in this report.

Une traduction de ce document est également disponible en français : *Compte rendu du symposium sur la recherche canadienne en transport ferroviaire*, TP 14818F.

Transport
CanadaTransports
Canada

PUBLICATION DATA FORM

1. Transport Canada Publication No. 14818E	2. Project No. 5747	3. Recipient's Catalogue No.		
4. Title and Subtitle Proceedings of the Canadian Railway Research Symposium Toronto, Ontario 28-29 November 2007		5. Publication Date November 2007		
		6. Performing Organization Document No.		
7. Author(s) Railway Research Advisory Board Working Group		8. Transport Canada File No. 2450-140-3		
9. Performing Organization Name and Address Railway Research Advisory Board 800 René Lévesque Blvd. West, Suite 600 Montréal, Quebec Canada H3B 1X9		10. PWGSC File No.		
		11. PWGSC or Transport Canada Contract No.		
12. Sponsoring Agency Name and Address Transportation Development Centre (TDC) 800 René Lévesque Blvd. West Suite 600 Montréal, Quebec H3B 1X9		13. Type of Publication and Period Covered Proceedings		
		14. Project Officer S. Vespa		
15. Supplementary Notes (Funding programs, titles of related publications, etc.) Co-sponsored by Canadian Association of Railway Suppliers, Canadian National Railway, Canadian Pacific Railway, HPB Association Management Services Inc., National Research Council Canada, Railway Association of Canada, Railway Research Advisory Board, Transport Canada, and VIA Rail Canada.				
16. Abstract <p>To help create a strategic direction for innovation and technological development of the Canadian railway industry over the 5 to 15 year horizon, the Railway Research Advisory Board held a by-invitation-only symposium November 28-29, 2007, in Toronto, Ontario. The event was attended by 53 senior executives and experts from industry, government, universities, and research centres.</p> <p>The symposium opened with two keynote speakers, after which were sessions addressing each of six key theme areas: services and demand; network connections and capacity; impacts of litigation, liability, and regulation on technological change; human resources; environmental stewardship; and security and borders. Each session started with an environmental scan to provide an overview of current issues, followed by a discussion in which all symposium participants were encouraged to provide their points of view and recommend specific priority issues and topics for research.</p> <p>The symposium concluded with stakeholder feedback on the results achieved and their particular perspectives on priority research issues. An evaluation form was also distributed for anonymous, on-site feedback on the conduct and results of the symposium.</p> <p>These proceedings are intended to help mobilize the principal stakeholders to develop and implement specific R&D programs in a collaborative effort aimed at enhancing the performance of the railway sector and better serving the needs of Canadians.</p>				
17. Key Words Railway research and development, R&D, priority areas, technology innovation, strategic direction		18. Distribution Statement Available online at www.tc.gc.ca/tdc/menu.htm		
19. Security Classification (of this publication) Unclassified	20. Security Classification (of this page) Unclassified	21. Declassification (date) —	22. No. of Pages x, 30, apps	23. Price Shipping/ Handling



1. N° de la publication de Transports Canada 14818E	2. N° de l'étude 5747	3. N° de catalogue du destinataire		
4. Titre et sous-titre Proceedings of the Canadian Railway Research Symposium Toronto, Ontario 28-29 November 2007		5. Date de la publication Novembre 2007		
		6. N° de document de l'organisme exécutant		
7. Auteur(s) Groupe de travail du Conseil consultatif de recherche en transport ferroviaire		8. N° de dossier - Transports Canada 2450-140-3		
9. Nom et adresse de l'organisme exécutant Conseil consultatif de recherche en transport ferroviaire 800, boul. René-Lévesque Ouest, Bureau 600 Montréal (Québec) H3B 1X9		10. N° de dossier - TPSGC		
		11. N° de contrat - TPSGC ou Transports Canada		
12. Nom et adresse de l'organisme parrain Centre de développement des transports (CDT) 800, boul. René-Lévesque Ouest Bureau 600 Montréal (Québec) H3B 1X9		13. Genre de publication et période visée Compte rendu		
		14. Agent de projet S. Vespa		
15. Remarques additionnelles (programmes de financement, titres de publications connexes, etc.) Coparrainé par l'Association canadienne des fournisseurs de chemins de fer, Canadien National, Canadien Pacifique, HPB Association Management Services Inc., le Conseil national de recherches du Canada, l'Association des chemins de fer du Canada, le Conseil consultatif de recherche en transport ferroviaire, Transports Canada, et VIA Rail Canada.				
16. Résumé Pour donner une orientation stratégique à l'innovation et au développement technologique dans l'industrie canadienne du transport ferroviaire sur un horizon de 5 à 15 ans, le Conseil consultatif de recherche en transport ferroviaire a organisé un symposium sur invitation seulement, qui a eu lieu les 28 et 29 novembre 2007 à Toronto, Ontario. La rencontre a réuni 53 cadres supérieurs et experts de l'industrie, du gouvernement, d'universités et de centres de recherche. Deux conférenciers d'honneur ont ouvert le symposium, après quoi ont suivi des séances de discussion, où chacun des six thèmes a été abordé : services et demande; liaisons inter-réseaux et capacité; incidences des questions juridiques, des responsabilités et de la réglementation sur le changement technologique; ressources humaines; gérance environnementale; et sûreté et frontières. Chaque séance commençait par une analyse de la conjoncture, qui faisait le survol des enjeux courants, suivi par une discussion au cours de laquelle tous les participants étaient encouragés à exprimer leur point de vue et à recommander des sujets prioritaires de recherche. Finalement, les intervenants ont exprimé leurs commentaires sur les résultats obtenus, et leur vision particulière des sujets de recherche prioritaires. Également, un questionnaire d'évaluation a été distribué aux participants. Ils étaient invités à donner sur place, en toute confidentialité, leur avis sur le déroulement et les résultats du symposium. Ce compte rendu vise à amener les principaux intervenants à développer et mettre en œuvre des programmes de R&D spécifiques, dans un effort commun pour améliorer la performance du secteur ferroviaire et pour mieux répondre aux besoins des Canadiens.				
17. Mots clés Recherche et développement en transport ferroviaire, R&D, sujets prioritaires, innovation technologiques, orientation stratégique		18. Diffusion Disponible en ligne à www.tc.gc.ca/cdt/menu.htm		
19. Classification de sécurité (de cette publication) Non classifiée	20. Classification de sécurité (de cette page) Non classifiée	21. Déclassification (date) —	22. Nombre de pages x, 30, ann.	23. Prix Port et manutention

ACKNOWLEDGEMENTS

The RRAB would like to thank all symposium participants and their sponsoring organizations for contributing their valuable time and resources to attend. The support of the following organizations, without which this event would not have been possible, is also gratefully acknowledged:

Canadian Association of Railway Suppliers
Canadian National Railway
Canadian Pacific Railway
HPB Association Management Services Inc.
National Research Council Canada
Railway Association of Canada
Railway Research Advisory Board
Transport Canada
VIA Rail Canada Inc.

The RRAB also gratefully acknowledges Transport Canada's Transportation Development Centre for the editing and production of these proceedings.

EXECUTIVE SUMMARY

Introduction

The Railway Research Advisory Board (RRAB)* was created by Transport Canada to provide advice and facilitate industry participation and collaboration in the formulation and implementation of railway-oriented research and development programs in Canada. To help create a strategic direction for innovation and technological development of the Canadian railway industry over the 5 to 15 year horizon, the RRAB held a by-invitation-only symposium November 28-29, 2007, in Toronto, Ontario. The event was attended by 53 senior executives and experts from industry, government, universities, and research centres.

Symposium Organization

The RRAB constituted a Working Group to oversee arrangements for the event.

The Working Group developed a program encompassing six key theme areas on which to focus deliberations:

- services and demand
- network connections and capacity
- impacts of litigation, liability, and regulation on technological change
- human resources
- environmental stewardship
- security and borders

All participants were provided with a guide document in advance of the event explaining the objectives, the roles of various participants, and the conduct of the sessions for preparation purposes.

Two keynote speakers provided a 10-year look ahead at research and technology issues and a global perspective on manufacturing and intermodal logistics opportunities. This was followed by a session addressing each of the six themes.

Each session started with an environmental scan to provide an overview of current issues. This was followed by a discussion in which all symposium participants were encouraged to provide their points of view and recommend specific priority issues and topics for research. The discussion was professionally moderated, and issues and comments were hand-recorded and summarized at the conclusion of each session. Participants were also given a presentation of the results of a similar event, the Workshop on Research to Enhance Rail Network Performance, held in Washington, D.C., in April 2006. The symposium discussions concluded with stakeholder feedback on the results achieved and their particular perspectives on priority research

* RRAB is made up of representatives from: Canadian National Railway; Canadian Pacific Railway; Railway Association of Canada, representing the collective interests of Canadian railways; VIA Rail Canada Inc.; Association of Regional Railways of Canada; Association of American Railroads/Transportation Technology Center, Inc.; Canadian Association of Railway Suppliers; the university research community; National Research Council Canada; Transport Canada, Rail Safety Directorate; Transport Canada, Transportation Development Centre; and Industry Canada, Automotive and Transportation Industries Branch.

issues. The event was not electronically recorded to allow participants to conduct a free and open discussion.

At the end of the symposium's technical program, an evaluation form was distributed for anonymous, on-site feedback on the conduct and results of the symposium.

Report Preparation

Following the symposium, the recorded discussions and priorities were compiled into a draft "as-it-was-heard" synopsis. The RRAB Working Group review and assessment of the results led to the development of a draft list of the top 10 priority areas that were then integrated into a draft report. The draft report was issued to all symposium participants along with a survey questionnaire. This provided an opportunity for participants to indicate whether they were satisfied with the content of the draft report and the identified priorities, to provide additional information and/or request that information be removed, and to indicate specific projects in which their organizations could take a pro-active/funding role. The feedback submitted by participants was reviewed and integrated into the draft report. The resulting document was then submitted to the RRAB for review and comment, after which it was lightly edited and finalized. These Proceedings of the Canadian Railway Research Symposium constitute the final document produced and released.

Results: Top 10 Research Issues

The following 10 priority areas, listed in no particular order, were identified for R&D aimed at technological innovation and development of the Canadian railway industry over the 5 to 15 year horizon:

- ***Service monitoring and expediting:*** automated tracking of movement, condition, and safety of goods, and their clearance at border crossings and gateways
- ***Modal transfer points:*** automated and efficient interchange of goods, people, and data to support innovative business models
- ***Harsh and changing environments:*** cold weather, mountain operations, and ground hazards
- ***Human resources:*** performance in the workplace; safety management; education and training tools/models
- ***Energy efficiency and emissions (CO₂) reduction:*** fuel consumption and efficiency; energy alternatives
- ***Urban footprint:*** mitigating community impacts
- ***Crossings and rights-of-way:*** risk management and operating efficiency
- ***Infrastructure:*** monitoring and management of risk; deterioration of track and bridges; and renewal practices
- ***Rail capacity in urban regions:*** alleviating constraints of mixed traffic, and maximizing scheduled services and train speeds
- ***Intercity passenger service:*** transit time, service frequency, and reliability

Next Steps

In its role as an advisory body, the RRAB will submit this report to Transport Canada and the industry for consideration. The report is intended to help mobilize the principal stakeholders to develop and implement specific R&D programs in a collaborative effort aimed at enhancing the performance of the railway sector and better serving the needs of Canadians.

TABLE OF CONTENTS

INTRODUCTION	1
KEYNOTE ADDRESSES	3
Keynote Address #1	
Dr. Stephen Millett, Founder, Futuring Associates LLC	3
Keynote Address #2	
Dr. David Fung, CEO, ACDEG Group	4
THEMATIC SESSIONS	6
Theme 1:	
Services and Demand: Outlook and Implications for R&D	6
Theme 2:	
Network Connections and Capacity: Growth Through Innovation	8
Theme 3:	
Litigation, Liability, and Regulation: Driving Technological Change	11
Theme 4:	
Human Resources: Challenges and Opportunities.....	13
Theme 5:	
Environmental Stewardship: Powering the Business Model.....	16
Theme 6:	
Security and Borders: Risk Management and Competitive Advantage.....	19
STAKEHOLDER PERSPECTIVES	21
Environmental Scan.....	21
Railway Industry.....	21
Government.....	23
Research Community.....	23
PARTICIPANT FEEDBACK	26
Symposium Evaluation Form: Conduct of Symposium and Results.....	26
Participant Survey Form: Draft Final Report and Results	28
RESULTS: TOP 10 RESEARCH ISSUES	29
NEXT STEPS	30
APPENDICES	
A	List of Participants
B	Symposium Program
C	Guide Document for Participants
D	Symposium Evaluation Form
E	Participant Survey

INTRODUCTION

Background

The Railway Research Advisory Board (RRAB)^{*} was created by Transport Canada to provide advice and facilitate industry participation and collaboration in the formulation and implementation of railway-oriented research and development programs in Canada. To help create a strategic direction for innovation and technological development of the Canadian railway industry over the 5 to 15 year horizon, the RRAB held a by-invitation-only symposium November 28-29, 2007, in Toronto, Ontario. The event was attended by 53 senior executives and experts from industry, government, universities, and research centres (Appendix A).

Symposium Organization

The RRAB constituted a Working Group to oversee arrangements for the event.

The Working Group developed a program (Appendix B) encompassing six key theme areas on which to focus deliberations:

- services and demand
- network connections and capacity
- impacts of litigation, liability, and regulation on technological change
- human resources
- environmental stewardship
- security and borders

All participants were provided with a guide document (Appendix C) in advance of the event explaining the objectives, the roles of various participants, and the conduct of the sessions for preparation purposes.

Two keynote speakers provided a 10-year look ahead at research and technology issues and a global perspective on manufacturing and intermodal logistics opportunities. This was followed by a session addressing each of the six themes.

Each session started with an environmental scan to provide an overview of current issues. This was followed by a discussion in which all symposium participants were encouraged to provide their point of view and recommend specific priority issues and topics for research. The discussion was professionally moderated, and issues and comments were hand-recorded and summarized at the conclusion of each session. Participants were also given a presentation of the results of a similar event, the Workshop on Research to Enhance Rail Network Performance, held in Washington, D.C., in April 2006. The symposium discussions concluded with stakeholder feedback on the results achieved and their particular perspectives on priority research

^{*} RRAB is made up of representatives from: Canadian National Railway; Canadian Pacific Railway; Railway Association of Canada, representing the collective interests of Canadian railways; VIA Rail Canada Inc.; Association of Regional Railways of Canada; Association of American Railroads/Transportation Technology Center, Inc.; Canadian Association of Railway Suppliers; the university research community; National Research Council Canada; Transport Canada, Rail Safety Directorate; Transport Canada, Transportation Development Centre; and Industry Canada, Automotive and Transportation Industries Branch.

issues. The event was not electronically recorded to allow participants to conduct a free and open discussion.

At the end of the symposium's technical program, an evaluation form (Appendix D) was distributed on site for feedback on the conduct and results of the symposium.

Report Preparation

Following the symposium, the recorded discussions and priorities were compiled into a draft "as-it-was-heard" synopsis. The RRAB Working Group review and assessment of the results led to the development of a draft list of the top 10 priority areas that were then integrated into a draft report. The draft report was issued to all symposium participants along with a survey questionnaire (Appendix E). This provided an opportunity for participants to indicate whether they were satisfied with the content of the draft report and the identified priorities, to provide additional information and/or request that information be removed, and to indicate specific projects in which their organizations could take a pro-active/funding role. The feedback submitted by participants was reviewed and integrated into the draft report. The resulting document was then submitted to the RRAB for review and comment, after which it was lightly edited and finalized. These Proceedings of the Canadian Railway Research Symposium constitute the final document produced and released.

Report Organization

The following sections provide the "as-it-was-heard" synopsis of the two-day symposium. These highlight the participants' presentations, discussions and recommendations for research that provide the basis for the top 10 priority areas for research. Presentations and discussions are summarized and outlined according to the symposium program. Also provided are the results of the symposium evaluation conducted on-site and the participant survey issued with the draft report. Finally, the identified top 10 research issues are presented, followed by the anticipated next steps.

KEYNOTE ADDRESSES

Keynote Address #1

Futuring and Visioning - Preparing for the Future

Stephen Millett, Founder, Futuring Associates LLC

- The future can be contemplated in a structured way. It's a mix of continuity and change.
- Futuring is not the same thing as visioning. Futuring is the identification of external opportunities and threats beyond our control. It starts from outside the organization. Visioning is the setting of desired goals and developing of desired strategies. It starts from inside an organization. That is important but it's not enough. Visioning without futuring is just wishful thinking.
- External changes occur faster than internal ones. Why? Because corporate culture and corporate assets do not change as quickly as the extra-corporate environment does. So adapting to the future all depends on preparation. You need to have, and to prepare for, alternative futures.
- A future forecast is not about data, because there is no data from the future—it is a story. What matters is the planning, not the plan itself.
- Even so, corporate culture needs to change more quickly. To do that, leaders should:
 - Develop a point of view about the future and incorporate it into operational plans.
 - Set periodic futuring/visioning workshops or retreats—ideally once a year.
 - Regularly scan and monitor with continual distribution of information.
 - Revise and update forecasts as soon as new information and conditions warrant.

Six external threats and opportunities will most likely drive the future of the rail industry:

1. Energy. This includes sources, prices, and efficiencies of production and use. We need to focus on what type of fuel will be used and how it will be generated. Organizations and industries should never be caught out by a sudden spike in energy prices.
2. CO₂ management and climate change.
3. Systems management. This depends on having real-time, accurate, transparent information. Systems management is enabled by—and driven by—"ICTs" (information and communications technologies).
4. Consumer spending and economic growth. Transportation follows trade.
5. Light rail. This includes human and freight movements. We must consider labour systems' costs (militancy of labour and interest groups) in our environmental move towards public transit. There will be more reliance on fewer people with greater responsibility—how will we train them?
6. Safety and security. Likely to be a fact of life for the foreseeable future.

There are also systemic issues:

- Public/private partnerships are a big opportunity.
- New business models—we need them for the entire surface transportation sector.

Keynote Address #2

Global Manufacturing and Inter-modal Logistics Opportunities

Dr. David Fung, CEO, ACDEG Group

- As a shipper, I need to know how innovations that originate with you—railways, governments, and researchers—will help my company and me.
- I am moving into the global supply chain with rapidly innovating business models. My company depends on fast, flexible, timely, high-quality shipping services. I need a first-class ticket and am willing to pay for it. But railroads have a “can’t do” attitude and they offer me only standby service.
- We have to think in terms of adding value. The old concept of earning revenue by manufacturing isn’t enough for Canada any more. It has given way to a new kind of thinking—creating and delivering value.
- We need to take action to improve Canadian productivity and competitiveness. The whole country needs to capture global supply chains and global markets in order to sustain our prosperity and security.
- The growth of Asian markets is seriously affecting North America. Asian companies have surpassed us in auto manufacturing—and they are closing in on U.S. purchasing power.
- How will Canadian railroads capture this market and opportunity? Rail is a key connector. We have one of the most efficient railway systems in the world—but one of the worst inland port systems.
- We can’t consider railroads alone—it’s a whole transportation system. Regulations for marine transportation should allow short-distance ship travel (short-sea shipping). If they did, many new container ports could be developed on the Great Lakes and on the West Coast of Canada and the U.S. Then we’d have opportunities for transportation plays that could power new business models.
- The Canadian government has committed \$5.8 billion for expansion of Gateways and Corridors. But China alone:
 - has committed \$220 billion for the same sort of thing
 - is building 18 new inland terminals
 - produces 60 percent of its exports for foreign multinationals
 - has inserted itself into the middle of our—Canada’s—business economy!
 - graduates 40 engineers for every one Canada does
- How will Canada maintain its position as the No. 1 exporter to the U.S.? Ships and rail will be the backbone, with trucks for short distance only.
- Freight costs to China are lower than they are to the U.S.! So we must pursue regulatory harmonization under NAFTA, and augment this North-America-only agreement with a global vision.
- There is another problem. We do not have enough inland (internal) container port capacity. We urgently need infrastructure to support container movements on land—before and after they pass through seaports.

- We must stop wasting rail capacity with empty movements. We fill grain cars and intermodal containers for one direction only. There are far too many empty backhauls. We are shipping air!
- We need railway freight cars that meet my needs—two double-stacked, 40-foot containers.
- My business cannot survive and prosper if I face the time and cost penalties when shipments are inspected crossing the border. We need to increase the security of trans-border shipments with innovative radio frequency identification (RFID) black boxes in every single container.
- Does Canada have institutions to address these issues and move things forward?
- Can major railroads like CN and CP become multimodal in order to gain a competitive advantage for themselves and for me?
- Can governments overcome the skepticism of importers and exporters, many of whom have been banding together to form their own logistics policies?
- Can provincial governments overcome trade barriers within Canada? We have even bigger barriers between provinces than we do with China!

THEMATIC SESSIONS

Theme #1

Services and Demand: Outlook and Implications for R&D

1. Environmental Scan

Dr. Malcolm Cairns, Director, Business Research, Canadian Pacific Railway

- There is a close correlation between GDP growth and Rail Ton Mileage growth. Annual growth is expected to be 2–4 percent per year.
- Demand: Rail labour productivity and system capacity is unlikely to keep pace with the growth in traffic (especially on the operations side).
- Supply: Shippers will be increasingly concerned with reliability, time-sensitivity, real-time shipment tracing, and security.
- The public will expect to mitigate the railways' footprint on communities, and to increase their emphasis on safety. This may mean building new terminals outside of urban areas.
- Passenger rail: Should current infrastructure be used, or should new rights of way be developed, incorporating North American technology? Probably the latter. Why? Because the future is likely to see a growing conflict between freight and passenger rail if the same infrastructure is used:
 - Light rail service in particular is likely to need dedicated infrastructure.
 - Freight railways need the full capacity of their lines.
 - Clash of funding mechanisms: freight pays its own way, but no intercity passenger service in the world is fully funded from the fare box.

2. Discussion

Forecasts

- Future shipment estimates mentioned by Dr. Cairns may be low.
- How will climate change affect economic demands?
- Is there a need to research Canada's rate of economic growth in order to have an accurate view? This will help forecasting.
- Rail transportation into and out of the oil sands will be of national and global importance.

Business Initiatives and Constraints

- Should the Canadian rail industry concentrate on expanding to meet needs of the Canadian economy, or should it think in terms of expanding to meet the needs of the global economy?
- The trucking industry currently does not seem to have a direction in terms of environmental and energy price issues—and the same can be said about the rail industry. Trucking may be a less favorable option for long-distance freight transportation in the future than it is today.

Ports and terminals

- Eastern and northern ports should not be neglected because they have capacity available to take more traffic—and because current west coast facilities are not meeting demand.

Business initiative and constraints

- It seems that Canadian railways have a wait-and-see approach to research and development, despite the reality that rapid growth is occurring in Asia and that Canada lacks port and land transportation capacity.
- It is difficult for the railway industry to change quickly because of the amount of fixed capital in the industry, but the prevailing sentiment in the industry is the need for change to stay competitive.
- CPR does have plans in place for capacity expansion and it is one of the firms in the industry that makes the most capital investments.

Realpolitik

- When consumers, shippers, and the public make recommendations to government, government usually listens because there are significant economic issues at stake. This is not the case when railways make such recommendations.
- It is difficult to develop port and rail expansion because communities are often opposed to it. What we need is a strategy to obtain public support.

Passenger rail investment

- Demand for passenger travel by rail will increase in the future, but the freight industry is reluctant to give up capacity for passenger transportation. It will fall to government to invest in developing infrastructure for passenger transportation.
- Increased urban sprawl and continuing incentives to reduce automobile use may be an incentive to foster research and development in passenger rail transportation.

3. Research Issues

The business and market environment

- Emphasize customer service. As David Fung said, railways are key enablers of new business ventures in Canada, provided they can deliver high-grade service—or whatever service shippers really need.
- Improve infrastructure to increase capacity.
- Find ways to finance infrastructure improvements. Note that due to public investment, infrastructure for the trucking industry is growing faster than it is for rail.

Develop the market for research, and research talent

- The rail industry should support and encourage university programs related to railways (China and India already do this). Where else will railways get the technical talent they need?

- Railways need to create more job opportunities for graduating engineers. Currently they don't hire many. So what will they do after their existing technical talent retires—the kind of talent they stopped recruiting two decades ago?

Priority areas for research

- **Vibration and noise impact on communities.** Use this knowledge to develop guidelines for proximity to communities. Having the support of communities will help permit growth.
- **Transportation into and out of oil sands.** Provincial and national rail research is needed to support the special needs for ensuring efficient and reliable oil fields rail transportation.

Modal and regulatory environment

- Governments should not re-regulate freight railways as a way of increasing passenger traffic. Instead they should:
 - develop investment plans for new infrastructure for passenger rail;
 - particularly consider electrification of passenger lines;
 - where passenger and freight must share the same track, encourage the use of positive train control (PTC) if it can contribute to efficient sharing of mixed traffic.

(Business) models for funding and exploitation

- Emphasize public/private partnerships. Develop creative new business models and competitive strategies across all modes—we need more cooperation among railways, and between railways and other modes.
- Government should provide funding incentives for independent R&D. Canadian railways are no longer much involved in R&D.

Theme #2

Network Connections and Capacity: Growth Through Innovation

1. Discussion

General

- At present the railway industry is not optimized to manage unexpected events.
- Short line railroads in Canada can provide a valuable contribution to transportation, as well as local economic development. In the U.S. approximately 25 percent of car loads to Class 1 railroads originate from short lines. They need to be maintained to the standard 286,000 lb. car, so they can handle interchange with Class 1 railroad loadings.

The effect of information management on flow

- Can information be organized to increase capacity? Every delay in the trip chain becomes a capacity issue.
- Railways are really combinations of two networks: track and telecommunications. The latter involves many systems such as PTC, RFID, and GPS tracking.

- The reliable and effective flow of information to the right person at the right time is just as important as the reliability of systems. Customers find it useful and sometimes critical to have accurate information on the status of their shipments.
- PTC alone may not be the key to significantly increasing capacity; improved communications and coordination may also contribute to increasing capacity. Electronic braking systems used with PTC can reduce headway needed for safe stopping.
- Due to some of its technical limitations, GPS cannot be used as the basis for determining train location for safety and train control information, perhaps only for additional non-essential information for car set-offs and car/container location and other business purposes.
- Modern train location systems will be required to support “Moving Block” systems for capacity increase, PTC for safety. It will also be desirable to eliminate trackside wiring and trackside signals for maintenance cost efficiency. Certain of these train control systems already exist in the USA, Europe, and Canada.

Bottlenecks

- Larger ships that carry more containers are contributing to bottlenecks.
- The cause of rail bottlenecks should be evaluated, because reducing bottlenecks has a significant impact on increasing capacity.
- One cause of bottlenecks is the reduction of train speeds in urban areas. Furthermore, low train speeds can have a perverse negative impact on communities—for example, when a slow-moving train blocks a crossing and an ambulance needs to get through. So it may be beneficial to move terminals away from urban areas.

Economics, operational effectiveness, and cost-benefit analysis

- Do studies exist that demonstrate the reality of capacity problems? This may help in swaying political opinion, showing the true cost of reduced capacity.
- The true cost of capacity shortfalls and bottlenecks should be articulated to influence the political sphere.

Natural conditions

- The climate and geography of Canada cause particular problems for railway transportation. Resulting delays can increase costs, which will be transferred to the shipper and then the consumer. So it is important to keep the system fluid in spite of Canadian conditions.
- Ground hazards are a particular impediment to increasing rail capacity. Canada’s geology is relatively young and in constant development, which can affect infrastructure with slides and washouts or even the threat of them. Climate change may also cause unpredictable hazards from weather events. It is important to find ways to mitigate these issues.
- The implementation of Intelligent Weather Systems and the development and deployment of track sensors would help railroads address these weather-related issues.
- The development of transportation to serve the Far North may be impeded by global warming, especially with tracks built on melting/softening permafrost.

Search for new technologies

- Are new technologies available for laying track in ways that reduce downtime—and so increase capacity?
- Increased rail traffic could result in less time available for regular maintenance, which could compromise safety. Must consider how heavier vehicles, increased traffic and increased capacity could increase stress on infrastructure (i.e., bridge fatigue).

2. Recommendations

System design and optimization

- Before building new infrastructure to increase capacity, it may be important to optimize current systems first.
- Research is needed to identify “corridors for the future” (for both freight and passenger) and their corresponding infrastructure requirements. Allowance for preservation and possible build-out of these corridors for the future needs to be of provincial and national interest.
- The theory of network-centric warfare applied to railways would increase operational flexibility, improve decision making, raise safety and security, save money, improve customer allocation, and reduce energy consumption.
- Increase the harmonization of equipment (matching tracks, power sources) operations (speeds) and regulations—which will raise capacity. Remove incompatibility in current systems.
- Research is needed to assess the infrastructure needs of smaller (short line) railroads (in the areas of track, bridges, signals, and facilities) to provide for safe and efficient rail movements, and to maintain their short- and long-term viability.

More creative business models and equipment

- Avoid empty haulbacks—conduct research into the economic and technical feasibility of having trains with empty containers available for re-use.

Ocean ports and inland terminals

- Consider a super port that could unload 15K-capacity container ships and transfer containers to 4K-capacity container ships for redistribution to smaller ports where they would be transferred to rail.
- Look seriously at short-sea shipping as a (partial) solution to bottlenecks at borders.
- Consideration should be given to building terminals away from urban areas to avoid level crossings.
- Design modal interfaces with minimum multiple handling. Conduct research on intermodal container transfer between trucks, trains, and ships or barges.

Information and communications technologies (ICTs)

- Identify the impediments to implementing PTC—it can raise capacity. A common protocol could be developed to organize multiple networks.

- Higher capacity lies in electronic communications systems and GPS. Note that the U.S. Department of Defense and the President both have publicly declared (1) that GPS signals will not be degraded at any time, and (2) that the new generation of GPS satellites will not have the capability to transmit degraded signals.
- Consider having a third party to handle information and data exchange between modes—this would facilitate transfer of containers.

Manage risk of service disruptions to improve reliability of flow

- Develop contingency plans, such as a second route to Western Canada, in times of unpredictable weather.
- Improve risk management techniques (inspection and maintenance) and proactive hazard mitigation (e.g., seismic sensors).

Economics and cost-benefit analysis

- Conduct research in little-understood economic drivers, such as the number and cost of lost customers.
- Conduct research to forecast potential disruptions at border crossings and to predict demand. Perform cost-benefit studies and determine financing methods for greater integration and optimization of current systems.

Engineering improvements

- Minimize build-time and outages for repair—conduct research on better methods of laying new track.

Supporting issues

- Resolving traffic conflicts between freight and passenger rail is a complex issue that needs more attention in future than it has had in the past.
- PTC could play a key role in resolving freight and passenger traffic conflicts.
- Railways need to have their customers advocate on their behalf.
- Canada needs a global vision for marketing and manufacturing in order to stay competitive.
- Railways need to restore the value they once placed on in-house technical knowledge and expertise.

Theme #3

Litigation, Liability, and Regulation: Driving Technological Change

1. Discussion

The vision and the need

- It is not clear whether regulation or legal issues impede the development and implementation of technologies by railways. Research may not be needed on this topic.

- What are the liabilities if research on safety topics is not conducted? What if safety issues are identified and action is not taken in time to mitigate risks? Liability could risk stifling the availability of information and taking of action.
- It can take a long time for regulations to catch up with technological developments.
- The *Railway Safety Act* is a good framework for ensuring the safe operation of railways, but there needs to be more collaboration from all stakeholders.
- There is a provision in the *Railway Safety Act* to use regulations to drive innovation, and standards could be developed from this provision.
- Environmental assessment may hinder the development of research projects because special interest groups sometimes hijack the process.
- The best trespasser casualty mitigation strategies are to build fences. The main issue is who should pay for and maintain the fences.

The situation in other countries

- In Europe, criminal charges can be laid against employees of companies who cause accidents or endanger people out of neglect.
- Are railways looking into procedures that would minimize damage caused by derailment? (Research in the U.S. is under way on this topic.)

Hazmat

- Legislation is being developed now in the U.S. to handle hazmat liability and to push the shipment of hazmat out of, and away from, cities.
- It may be a problem to make shippers share liability for unforeseen accidents, because they often cannot afford the liability, and accidents may not be their fault. Many shippers are self-insured, especially for the shipment of innocuous goods.
- The ability to monitor hazmat cargo could be a beneficial security issue (using RFID or black-box-equipped containers).

2. Recommendations

Research management and priority setting

- Research should be conducted to evaluate the effectiveness of grade crossing safety education campaigns.
- Regulations could be used to create efficiency by equipping all containers with RFID tags. This would facilitate border crossing. These regulations would have to be enforced by governments; there is an ISO standard for having RFID tags on containers but their use is voluntary.

Improving the practices and processes for risk management

- Further research should be conducted on safety management systems and human factors.
- Transport Canada should develop an improved/acceptable system of risk management: for example, using Canadian Standards Association (CSA) guidelines.

Related non-research issues

- We should not wait for technologies to be perfect before implementing them—we should implement, monitor, and perfect them over time. Lengthy testing by railways tends to inhibit innovation.
- A compilation of best practices should be developed for environmental assessment processes.
- Government and regulatory authorities need to take a lead in determining fair and mandatory allocation of costs for building and maintaining fences to prevent trespassing.

Theme #4

Human Resources: Challenges and Opportunities

1. Environmental scan

Dr. Christopher Barkan, Associate Professor and Director of Railroad Engineering Program, University of Illinois at Urbana-Champaign

The current state of industry-academia relations in research

- Over recent decades the railroad industry has alienated many or most universities, which responded by turning their backs on rail as a subject of study and research. The same is not true of highway transport research, which remains better supported at universities in general because of government funding for the work. The funding disparity may not be fair, but it is a fact of life.
- There is a divergence of needs. Railroads need applied research (and therefore relatively focused funding), but university research tends to need funding that supports longer-term activities.
- The divergence is a pity. University research produces two deliverables—the research results per se, and graduate students with knowledge and experience in the subject at hand.

Supply vs. demand for new engineers in railroading

- The demand for rail freight is increasing rapidly. Railroads need skilled and knowledgeable people to ensure safe and efficient operations. The projected demand for engineers is high.
- There is a long latency period to develop those people. But the average age of the rail industry workforce is high and railroads will soon need a large influx of replacements.
- Do railroads make their work desirable and attractive? Not from the viewpoint of most engineering students. Railroads are a stealth industry—the public only ever hears bad things about them. And there is a modern imperative of getting continuously higher productivity from fewer people. So the prevailing view at universities is that railroads are not much of a career draw.

Bridging the gap

- Start with better mutual understanding. Railroads and universities need to understand each other's needs and their respective roles/purposes in order to foster strong, productive partnerships.
- Railroads should focus their interactions on a few universities.

2. Discussion

Trends

- General agreement with Chris Barkan's summary of key trends regarding human resources (HR) in the railway industry:
 - Rail freight demand is increasing rapidly, but human resources are declining.
 - The workforce is aging.
 - There is an inexorable trend to higher productivity and automation.
- Also concur with Dr. Barkan's point that connections have been eroding between railways and universities.
- The decline in relations was accompanied by an apparent decline in interest by railways about research and technology as subjects of importance and value to their operations and culture.
- Railway operating staff often work in crisis mode because there are not enough human resources to do everything required. Staff these days work longer hours—to the point that fatigue management is necessary. There has been a reduction in training times in order to bring in more staff rapidly, which has a potential impact on safety.
- Then, too, railways have been developing and cultivating a vision of a high-tech growth industry.
- If a large influx of inexperienced staff arrives to replace upcoming retirees, managing safety will become more of a challenge.
- The HR needs of railways in the next 5 to 10 years will be mainly in operations. That is because railways have divested many of their engineering functions to consultants. So the demand for new railway engineers may come largely from the consulting industry.

Needs

- Despite a trend toward greater automation, on-board crews will still be needed to ensure safety and reliability.
- There is a need for greater mentoring of the new workforce members because education programs can only go so far. Hands-on mentoring within the industry would be beneficial for new workers.
- Four key HR needs:
 - fatigue management
 - multitasking competence—the HR shortage requires employees to do many tasks
 - skills training and ongoing education
 - optimizing work vs. life balance

Opportunities

- The rail industry has a lot of potential to improve its image to attract new people to the labour pool. The railway sector can be perceived as an enabler of wealth, a growth industry, and an environmentally sound means of transportation. The environmental benefits in particular can be levered to attract young people.
- Universities can always find opportunities to lever industry sponsorship with funding from a variety of other sources. The rail industry can multiply its resources if it works with universities to that end.
- In the past few years, human error has been a primary contributor to many accidents. So there is a possibility that enhanced training programs would help prevent them.
- Long-term (sustained) R&D commitments increase the value of research because it promotes continuity between projects. Research has to trigger innovation, which has been lacking in the railway field. University projects can be good for long-term visionary research with non-stringent deadlines.

3. Recommendations

Narrowing the industry/university gap

- Re-establish a creative research focus in the railway industry.
- Create “Centres of Expertise” for railways within universities to attract professors and students.
- Develop outreach programs for young people to create interest in the industry, including as a career opportunity.

Modal equality

- From the government perspective, Centres of Expertise would benefit from a multimodal approach because that will make them easier to sell from a modal-equality standpoint.
- Governments need to increase spending on railway-related education programs—this should be to the same extent as highway-related education programs are funded now.

Areas of probable value

- R&D programs looking at human factors, fatigue, and system reliability, particularly fatigue and working time conditions for on-board train crews and reasonable crew scheduling practices.
- Conduct research into safety management systems and how to best use them for audit purposes.

Background studies

- Conduct research into work processes and how human resources are being used in the industry.
- Conduct research on hiring practices in the rail industry, and what its (the industry’s) future HR needs will be.

Non-research issues

- Develop a program to mentor new railway employees, and transfer skills and knowledge. Extend this to consultants who are doing much of the engineering work.
- Make an inventory of current systems of record-keeping and how they can be improved. Evaluate electronic record-keeping as a means of keeping information up to date and relevant.

Theme #5

Environmental Stewardship: Powering the Business Model

1. Environmental scan

Peter Eggleton, Consultant, Telligence Group

Regulatory guidelines and policies aimed at improving energy efficiency

- Emissions penalties for railways where existing structure is dominated by single track railway lines and exclusive use of a petro-diesel energy source.
- Guidelines on Greenhouse Gas (GHG)-intensity targets are included in the Memorandum of Understanding (MOU) between Transport Canada, Environment Canada, and RAC covering the period 2006–2010. The MOU also cites Environment Canada standards for diesel fuel sulphur content and the U.S. EPA emissions standards that set limits on the Criteria Air Contaminants (i.e., NO_x, HC, CO and PM).
- There is a need to develop policies to encourage R&D and technology uptake to improve fuel economy and meet more stringent emissions targets.

Technology and system improvements to reduce GHG emissions

- Improvements are ongoing in fuel efficiency and reductions to Criteria Air Contaminants emissions from diesel engines, and in development of hybrid locomotives.
- Need to identify opportunities and sites to deploy alternative energy sources (natural gas, electrification, biodiesel, hydrogen, etc.)
- Need to improve rolling stock technology using higher capacity, lighter-weight materials, steerable-axle trucks, reduced aerodynamic resistance, increased use of sensor and specialty designs and recoupment of braking energy.
- Technology improvements specifically for passenger trains could include low-energy lighting, increased insulation, recoupment of braking energy, etc.
- Infrastructure improvements that could aid in reducing GHG emissions include overcoming track alignment irregularities (sharp curves, grades, uneven roadbeds, etc.) and reducing wheel/rail friction.

Measures to reduce the environmental footprint of the rail industry

- Reducing noise and vibration, which impact communities, infrastructure and equipment.

- Reducing the possibility of HAZMAT incidents using specially designed railcars, automated tracking and monitoring, training for operating crews, and awareness generation of best practices for spill avoidance and spill clean up.
- Raising awareness for energy conservation and reduction in all operations and introduction of hybrid technology for related non-rail vehicles such as cranes, shuttle vehicles and automotive fleets.

Operating and management practices

- Need to enhance inspection technologies/techniques.
- Regular and accurate data gathering and emissions testing will be necessary for emissions credits trading.
- Environmentally friendly methods, equipment, and practices to facilitate adequate grooming of right-of-way.
- Training/increasing awareness, conservation, and sustainability require a “top-down” commitment.
- Monitoring and participation in international R&D and innovation, because 93 percent of new technology and innovation comes from outside Canada.

2. Discussion

Tradeoffs and alternatives

- The electrification of railways may simply move emissions from one place to another—from the vehicle to the power plant. But this may not be such a problem for Canada because of an abundance of clean hydroelectric power.
- There are concerns that electrification may not go forward because of high capital investment costs, and return on investment could take a long time. PTC and new braking technologies are relevant research topics, and more likely to be implemented than electrification.

Incentives and constraints

- Railways that carry coal are not responsible or taxed for the GHG emissions produced from burning the coal.
- Consideration should be given to setting mile-per-gallon targets for vehicles.
- The shorter lifespan and lower efficiency of truck engines (5 to 7 year life for truck engines, as opposed to 20 to 30 year life for locomotive engines) provides a (perverse) incentive to conduct more research to reduce trucking emissions.

(Bold) visions for the future

- Railway routes through the Rockies are limited in number and capacity, but trade will ultimately increase with India and China, so alternative routes need to be found. This could even include drilling long distances through mountains, which has been done in Europe. Public/private partnerships should be explored to make this a reality. This is a long-term objective.

- Carbon emission-trading will encourage a shift to electrification of railways. European railways with electrification already use regenerative braking from trains to return power to the grid, thus gaining carbon credits.

3. Recommendations

Visions

- Electrification of passenger railways in Canada should be seriously considered, especially as Canada has abundant low-cost energy sources. We should take inspiration from European railways—virtually all of them have abandoned fossil fuel. A method of financing this conversion should be explored. Electrification should be seen as a long-term goal, one that will need significant political will to achieve.
- Electrification of freight on railways should not be abandoned. This will require a long-term R&D strategy and collaboration between stakeholders.

Economics and cost-benefit analyses

- Explore the cost-benefit of reducing GHG emissions.
- Establish performance goals for each research issue.
- Develop capital investment and funding strategies to update current equipment and to fund R&D.

Funding and leverage

- As part of the growing international interest in electrification of railways, funding agreements between countries could be established for relevant research.
- Canada should become more involved with the International Union of Railways.

Areas of promise

- Explore, as a research topic, the recouping of energy through regenerative braking made possible by electrification. Benefits include reduced emissions, better acceleration, and better braking with less wear and tear on brake parts.
- Conduct an inventory of candidate rail lines and energy sources for electrification—this would be the first step in initiating electrification projects.
- Conduct research into improvements to dynamic braking systems.
- Explore alternative fuels and novel approaches to fuel efficiency because electrification of freight trains is not likely to occur soon. Canada's contribution to this research on a global scale could be an evaluation of extreme weather on alternative fuels.
- Explore the impact of a growing rail industry (passenger and freight) on communities. This growth will result in more noise, emissions, and safety concerns for communities.
- Conduct research into data integrity, system vulnerability, and security issues. These issues will be important because of the growth of intermodal containerization.

Theme #6

Security and Borders: Risk Management and Competitive Advantage

1. Environmental scan

Jason Proceviat, Manager, Commercial Vision, Canada Border Services Agency

About CBSA

- CBSA's new mandate includes a commercial vision for 2017. The Agency seeks a strategic consultation with clients and stakeholders. Some of the key factors are the U.S. political climate and post-9/11 protectionism, trade and transportation trends, and the growth and development of e-commerce.

Needs and opportunities

- Canadian ports can expect to see traffic overflow from congested U.S. ports, particularly on the West Coast.
- Technology is vital for getting the balance right between heightened security and trade facilitation.

2. Discussion

Cost considerations

- Can a Canadian perspective be emphasized for tracking and tracing of freight shipments? Determining a cost-effective way to assemble autos and auto parts and ship to the U.S. is important because it adds \$800 to the cost of every automobile.

Strategies

- We should study risk-based management. The objective of terrorist threats is to achieve maximum disruption and damage, grab attention, and identify symbolic targets. We need to find methods of identifying high-risk elements.
- The World Customs Organization is now looking at a system of authorized economic operators. This is a method of pre-screening freight to facilitate trade. It will probably include biometric indicators. Another pre-screening activity could be the pre-screening of transportation and security personnel (confidentiality and human rights issues must be considered).

Practical foci

- The U.S. plan to verify 100 percent of containers may not be an effective use of resources. [But what if the U.S. does it anyway?]
- CBSA's security focus is on high-risk elements. Freight transported by CPR and CN is not necessarily considered high-risk because fewer people are likely to be affected directly by a security breach than other transportation situations.
- These issues are business and government security issues and therefore need special and classified research, development, and handling. These are not part of basic railway technical, management, or operations research but they will need the cooperation and participation of the railroads.

- Passenger rail transport represents a higher perceived risk than freight shipment, especially in light of recent incidents in Spain and the UK.
- When discussing security issues, we usually mean terrorist threats and not trespassing or conventional criminal activities.
- A properly designed PTC system could aid in preventing hijacking of trains.
- Because a train does not need to be hijacked to cause damage – it simply needs to be derailed – surveillance systems and track sensors need to be deployed.

Opportunities

- On-board commodity sensor packages in containers could be a solution for pre-screening freight. These technologies can already detect whether containers are compromised by monitoring changes in temperature, oxygen levels, light levels, and so on. If they are combined with a certification plan involving international partners, this would be a powerful pre-screening tool. The U.S. government is sponsoring a program to develop such “on-board commodity sensors”.¹
- Canada has more manufacturing plants than any other country in the world that are certified by U.S. authorities. This presents opportunities for leverage to alleviate stress on borders. However, regulations for U.S. and Canada must be harmonized.

3. Recommendations

Background studies

- Because the approach to security in Canada and the U.S. for all modes of transport is based on level of risk, an evaluation of potential risks and threats would be beneficial.
- Transport Canada should explore the possibility of encouraging or regulating short-sea shipping as a means of taking trucks off the road and thus alleviating stress on borders.

Promotion

- Canada should really “work” a strategy of persuading the U.S. that goods coming from Canada are safer than those coming directly from other countries. This should take advantage of opportunities mentioned immediately above.

Priority areas for research

- Expand current research on perimeter security and geo-fencing.
- Conduct research in rapid recovery methods to deter potential terrorists from their objectives. Transport Canada suggests a “four-pillar” approach based on prevention, mitigation, response, and recovery.
- Increase research and/or applications development for:
 - integrity testing (RFID tag- and sensor-equipped containers)
 - ID certification for shipping employees
 - pre-inspection to push inspection away from borders
 - train security using on-board surveillance

1. See <http://www.nta.org/cbr.htm>

STAKEHOLDER PERSPECTIVES

Environmental Scan: U.S. TRB Workshop on Priority Rail Research Issues

Robert Dorer, Federal Railroad Administration, U.S. DOT

- The Transportation Research Board (TRB) hosted a similar two-day event, the Workshop on Research to Enhance Rail Network Performance, held in Washington, D.C., in April 2006, to focus on issues of capacity, safety, and efficiency.
- The main recommendations of this work fell into three categories:
 1. Continue ongoing research tasks
 2. Invest in “high risk” research unlikely to be funded by private sector
 3. Avoid R&D fragmentation
- New directions and reinforced existing directions that were identified for research included:
 - PTC and related technologies
 - Performance-based regulations
 - safety and trespasser casualty mitigation
 - HR management
 - network capacity analysis
 - energy efficiency and environmental issues
- The railway R&D strategic plan that emerged from the workshop stressed the need to:
 - incorporate current knowledge and complement other R&D strategic plans in the U.S.;
 - align the railway R&D strategic plan with U.S. DOT goals.

Railway Industry

Mike Lowenger, Vice-President Regulatory Affairs, RAC

The Railway Association of Canada (RAC), on behalf of the Canadian railway industry, recognizes the importance of the following research issues and opportunities that were identified during the symposium. We must consider avoiding duplication by taking the best work already done and building on it.

- Service and demand
 - port operations efficiency
 - optimizing passenger vs. freight operations
 - any service, security, and safety R&D that provides cost-effective measures and new technology
 - surveys and measures to assess the effectiveness of education and awareness of crossing safety campaigns
 - understanding and managing the impact of development and expansion on communities in close proximity to railways (i.e., noise, vibration, and safety)
 - infrastructure R&D with full-cost accounting

- Network capacity
 - engineering preparedness
 - PTC and related systems—especially cost and benefits of implementing them
 - R&D on braking technology
 - developing a North American strategy to implement GPS and tracking technologies
 - R&D for winter operations and operations in mountainous terrain
- Litigation and liability
 - expand research to improve track safety rules and improve inspection technologies (note that regulations can facilitate or impede the implementation of research results, so the regulators must be at the table)
 - hazmat issues and liability concerns as they affect carriers
 - standardization of risk assessment techniques
 - trespassing, suicide, and grade crossing elimination
 - protection of information
- Human resources
 - relationships between academic institutions and industry
 - evaluation of coordinated research analysis for e-learning and e-record keeping
 - work practices, ergonomics and human factors, and in-cab safety
 - creation of multimodal Centres of Expertise
 - training
 - evaluation of work practices to ensure safety and efficiency
- Environmental stewardship
 - there are many good research proposals related to environmental stewardship, but effective funding methods are still needed
 - intermodality—finding best ways to move products [by different modes] while minimizing impacts on the environment
 - continued research into alternative fuels and electrification
- Security and borders
 - [technologies for fail-safe] identification of employees, freight, and cars
 - process improvements to enhance flow and minimize obstacles

Government

Nada Vransy*, A/DG TTI, Policy Group, Transport Canada

Transport Canada's mission and priorities

Susan Spencer, speaking on behalf of the Transportation Technology and Innovation (TTI) Directorate made the point that the Government of Canada's main role should be to help foster partnerships and identify important Canadian issues for R&D. Competitive issues related to a specific industry should be addressed by the industry itself—for example, improving its image.

- Transport Canada will place renewed importance on R&D, technology, and innovation.
- Transport Canada's mission is to enhance the transportation system as a whole, and thus it cannot focus exclusively on rail.
- This means Transport Canada's focus is on integrating technologies, and integrating all modes of freight shipment to reduce the environmental footprint and raise safety, security, and economic viability of the nation.
- The government sees its role as:
 - encouraging and fostering the formation of strategic partnerships
 - helping identify Canadian issues for R&D
 - helping remove institutional barriers to R&D
 - helping foster skills development
 - helping foster the creation of Centres of Expertise
- Agree with Chris Barkan that there will be two outputs from Centres of Expertise: research results per se, and human resources with competence in research and technology.

Research Community

John Coleman, General Manager, CSTT, National Research Council Canada

John Coleman of the Centre for Surface Transportation Technology (CSTT) made the following points about the results of the symposium and R&D in general.

The discussions at this symposium can be grouped into three layers that encompass different elements of the research problem:

1. Top layer — change is driving action
2. Middle layer — economics will require adaptation
3. Foundation layer — the focus for research that needs to be done, especially in Canada

Foundation layer—research content

- A partial list of areas identified at this symposium:
 - increasing flow—by improving intermodal transfer, reducing outages, reducing service failures, and so on

* Represented by Susan Spencer

- adding capacity—by higher traffic densities, technologies for laying track, reducing the need for maintenance, etc.
- improving the management of information—in order to inform customers and manage operations
- reducing the intrusiveness of railways—noise, vibration, and physical presence at grade crossings
- improving emission and energy performance—there is a long list provided by Peter Eggleton
- managing ground hazards through geotechnical research—along the lines of the program currently being chaired by Mario Ruel of CN
- improving surveillance and response to safety and security needs—by identification, inspection, and other technologies

Top layer—change

- Change will drive the need for research. Participants of this symposium have told us where, and to what extent, the change is expected to come.
- Unless we do new things, we can expect to lose whole industries in Canada.
- Other countries are “moving our cheese”, and if Canadian institutions and their leaders fail to adapt quickly enough, there will be unimaginable economic pain—the kind about which David Fung now warns.

Middle layer—economics

- Challenges for the railways:
 - to support and enable their customers’ changing business models
 - to offer first-class tickets to their demanding customers, like David Fung (who are prepared to pay for it)
- That brings us back to economics:
 - Do railways know the cost of losing individual customers?
 - Do railways know the cost of losing whole industries?
 - The loss of industry sectors happens very slowly. Do net-present-value (NPV) calculations and discounted cash flows capture the real cost of that pain? Those calculations make far-off events appear inconsequential today—even serious events.
 - The demographics of baby boomers are driving a need for retirement income, and thus a corporate focus on next-quarter earnings, so it is very unlikely that the rail (or any other) industry will stop using NPV calculations any time soon.
 - So who will justify 25-year and 100-year investments—like tunnels through the Rockies and electrification of freight lines? Who will speak for Canada? Who will invest for Canada?
- At the micro level we need, especially in research:
 - new understanding of where the funding will come from.
 - new research investment vehicles, like Networks of Centres of Expertise

- new understanding of the basis on which those investments will be made, both on a sustaining and transactional basis
- On a sustaining basis: Chris Barkan and others made the case for this, especially the benefits of developing technological competence in human resources.
- On a transactional basis: we confront two economic challenges:
 - Proponents of research are expected to quantify the monetary value of benefits they are proposing to create; however, proponents of research generally do not know the financial impact on a railway of the operating changes it (the railway) will make with the results of a successful piece of research. Therefore, a proponent of research must try to convince the railway manager:
 1. to invest speculatively in an economic study to determine whether the anticipated benefits of a proposed piece of research are worth buying, or
 2. to invest speculatively in the research itself, given the possibility of inconclusive results or even technical failure
- To encourage research on a transactional basis, we need at least one of two things:
 - a source of funding from which to invest \$15K for an economic study of every project before it is approved.
 - a new ethos about research—in which we agree to alter the premise of the bargain between managers and researchers so that:
 1. proponents of research are not expected to prove in advance something that cannot be proven (e.g., that reducing wheel/rail friction will save 0.5% on fuel, when the cause-and-effect changes in fuel consumption cannot possibly be measured with such precision)
 2. railway managers engage in a new willingness to accept certain things on the basis of reasonable scientific and engineering evidence—credible models, sound calculations, well-thought-out pilot projects, etc.

If we can deal with research on the basis of, first, knowing what Canada needs; second, understanding how railways intend to serve rapidly changing customer needs; and third, bridging the railway/government/researcher gaps in perception, understanding, and confidence, we will have the makings of a technologically and financially sustainable national economy and railway industry for decades to come.

PARTICIPANT FEEDBACK

Symposium Evaluation Form: Conduct of Symposium and Results

An evaluation form (Appendix C) was designed and distributed on site to participants concerning the conduct of the symposium and the results achieved. Out of a total of 55 participants, 34 (62%) questionnaires were returned. Survey respondents by industry sector are as follows:

18%	Railways
20%	Rail industry stakeholders and constituents (including shippers)
0%	Academia
20%	Research & development community
20%	Consulting industry
22%	Government

The results of the questionnaire and the respondents' comments are tabulated below, by order of question number.

- 1) Was the format of this symposium effective in provoking a dynamic and interactive discussion from all participants on issues affecting the railway sector?

88% Yes 3% No 9% No Answer

Summary of comments:

Overall, respondents were satisfied with the format of this symposium. It was noted that the size of the group and the one-room setup of the meeting might have hindered an in-depth exploration of each topic. Evaluation from respondents suggested holding this type of session with a breakout/workshop group format for each theme followed by a presentation of recommendation by each group to all participants.

- 2) Did the six symposium themes sufficiently reflect the key issues facing the railway sector today?

85% Yes 12% No 3% No Answer

Summary of comments:

Overall, respondents believed that the symposium themes reflected key issues facing the railway sector. It was noted that each of the six themes provided a good starting point to stimulate broad discussion; however, focus on specific topics and ideas could have been improved.

- 3) Did the keynote addresses, and the environmental scan for each theme provide an adequate overview of the current situation?

84% Yes 0% No 16% No Answer

Summary of comments:

Overall, respondents were very satisfied with the two keynote presentations and the environmental scans provided for certain themes. The keynote presentations and environmental scans presented valuable background information before theme discussions.

But respondents indicated that theme discussions not preceded by an environmental scan lacked focus.

- 4) Did the meeting facilitator effectively summarize and capture the key points of each theme?

76% Yes 6% No 18% No Answer

Summary of comments:

Overall, respondents were satisfied with the services of the meeting facilitator. It was noted that the discussion summaries for each theme provided on the second day were very useful and the discussions of the first day would have benefited from this.

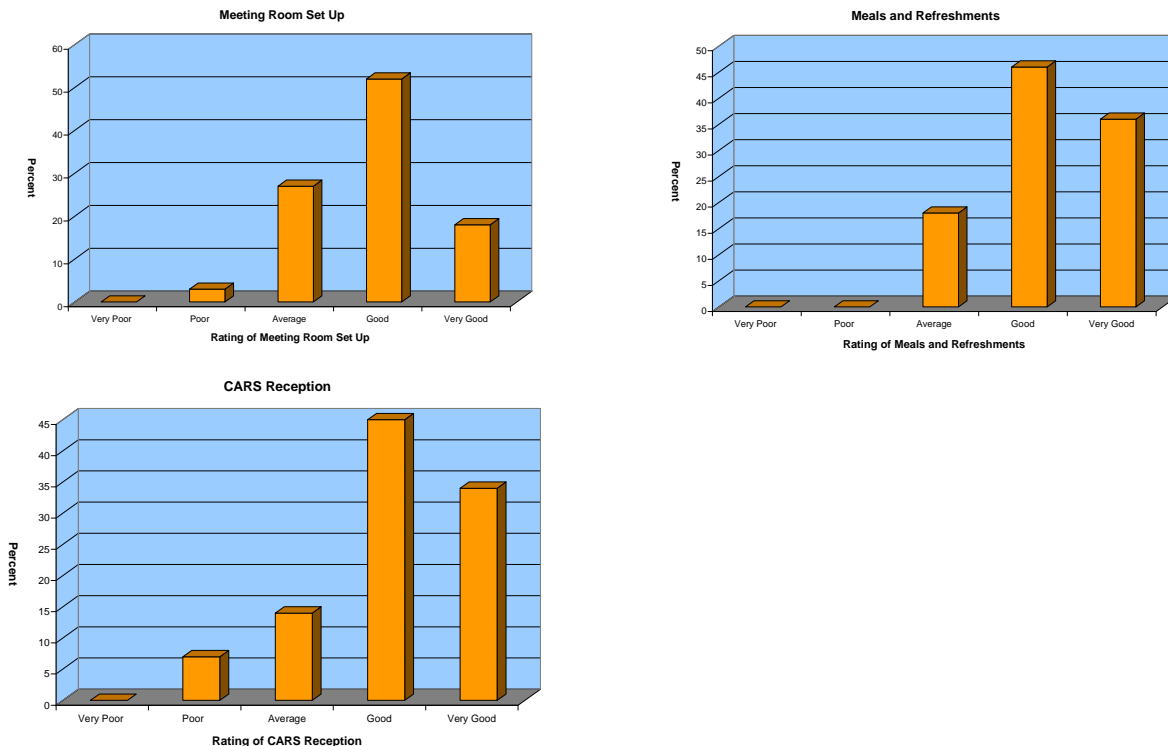
- 5) Did this symposium reach its goal of identifying industry priority areas for railway research and development for the next 5 to 15 years?*

41% Yes 12% No 47% No Answer

Summary of comments:

Overall, respondents believed that this activity was a good first step in identifying broad research areas, but that much work would have to be done to specify and prioritize issues for Canada. Respondents said that they appreciated this exercise and looked forward to obtaining the post-symposium report.

6) Meeting Facilities



* It should be mentioned that, due to time constraints, the Top 10 Research Issues could not be formulated and discussed during the symposium.

Participant Survey Form: Draft Final Report and Results

Following the Canadian Railway Research Symposium, a draft version of the report and a participant survey sheet (Appendix D) were circulated to all participants. This was done to ensure that comments and views recorded at the event were accurately incorporated into the report. It also permitted participants to suggest further areas for research as well as specific issues of particular interest in which they would be prepared to collaborate. Feedback received has been incorporated into various sections of the report where appropriate. Other comments of a more general nature and not amenable to inclusion in other sections of the report were summarized and are listed below for information purposes.

- The challenge now is to determine issues that are uniquely Canadian and initiate projects and funding to pay for them.
- Some of the research issues identified are not those that should be supported by tax dollars. Only those issues (or elements of issues) where there is a social, public safety/security or public policy concern should receive federal government funding assistance. The railway sector should be financially responsible for its own R&D, especially for priorities #1 (Service Monitoring and Expediting), #2 (Modal Transfer Points) and #9 (Intercity Passenger Service). It is to the industry's benefit to invest in R&D.
- A topic not mentioned in the symposium was a suggested amount of annual federal funding for R&D for the railway sector. A target suggested by the OECD is that 3 percent of any activity budget should be invested in R&D and innovation so as to underpin a healthy future. This could also be a research issue.
- Rail safety was not considered in the top research issues. It remains an issue and although some of the top issues will address and improve rail safety, I am of the understanding that funding of research on safety issues will be dealt with through regular ongoing R&D programs funded through TDC (Transportation Development Centre).
- In line with items raised during Robert Dorer's presentation on a similar event, the Workshop on Research to Enhance Rail Network Performance, held in Washington, D.C., in April 2006, it is recommended that this RRAB exercise lead to ongoing research tasks, invest in "high risk" research unlikely to be funded by the private sector, and avoid R&D fragmentation.
- The points made by Susan Spencer, representing the government perspective (speaking on Nada Vraný's behalf), were all relevant and important to a new start for railway research in Canada. The policies proposed should perhaps be "chiseled in stone" and are well worth carrying on for the future 5 to 15 years.
- When management of information is discussed, it would be best to have a railway IT manager present to explain how railway information is exchanged. Railways have a strong tradition of embracing information technology. The issues of information exchange are business and legal issues, not issues for research in the IT or R&D sense.

RESULTS: TOP 10 RESEARCH ISSUES

The following 10 priority areas, listed in no particular order of importance, were identified for R&D aimed at technological innovation and development of the Canadian railway industry over the 5 to 15 year horizon:

- ***Service monitoring and expediting:*** automated tracking of movement, condition, and safety of goods and their clearance at border crossings and gateways
- ***Modal transfer points:*** automated and efficient interchange of goods, people, and data to support innovative business models
- ***Harsh and changing environments:*** cold weather, mountain operations, and ground hazards
- ***Human resources:*** performance in the workplace; safety management; education and training tools/models
- ***Energy efficiency and emissions (CO₂) reduction:*** fuel consumption and efficiency; energy alternatives
- ***Urban footprint:*** mitigating community impacts
- ***Crossings and rights-of-way:*** risk management and operating efficiency
- ***Infrastructure:*** monitoring and management of risk; deterioration of track and bridges; and renewal practices
- ***Rail capacity in urban regions:*** alleviating constraints of mixed traffic, and maximizing scheduled services and train speeds
- ***Intercity passenger service:*** transit time, service frequency, and reliability

NEXT STEPS

In its role as an advisory body, the RRAB will submit this report to Transport Canada and the industry for consideration. We anticipate that this will help mobilize the principal stakeholders to develop and implement specific R&D programs in a collaborative effort aimed at enhancing the performance of the railway sector and better serving the needs of Canadians.

APPENDIX A: LIST OF PARTICIPANTS

Name	Organization
Bob Ballentyne	Canadian Industrial Transportation Association
Chris Barkan	University of Illinois at Urbana Champaign
Bob Becker	VIA Rail Canada Inc.
Tony Benincasa	HBC Logistics
Daniel Blais	Transport Canada, Transportation Development Centre
Helena Borges	Transport Canada, Surface Transportation Policy
Frank Brady	Pandrol
Rob Bryson	Parrish & Heimbecker
Mike Byrne	Modern Track Machinery
Malcolm Cairns	Canadian Pacific Railway
Alan Clayton	University of Manitoba
John Coleman	National Research Council Canada, Centre for Surface Transportation Technology
Daniel Dagenais	Montréal Port Authority
Steve Ditmeyer	Transportation Technology and Economics
Bob Dorer	U.S. Department of Transportation, Research and Innovative Technology Administration, John A. Volpe National Transportation Systems Center
Said Easa	Ryerson University
Peter Eggleton	Telligence Group
Gord English	Transys Research Ltd.
Glen Fisher	CPCS Technologies Corporation
Nina Frid	Transport Canada, Rail and Urban Transit Security
David Fung	ACDEG Group
Denys Godbout	Bombardier Transportation
Jim Goss	Transportationcentre.com
Isaac Haboucha	CANAC Inc.
Tom Handkamer	Teamsters Canada Rail Conference
Cindy Hick	HPB Association Management
Mario Iacobacci	Conference Board of Canada
Jude Igwemezie	NorFast Inc.
François Kneppert	Bombardier Transportation
Jose Mathieu	Rail Power Technologies
Rob McKinstry	Railway Association of Canada
Peter Lloyd	Go Transit
Mike Lowenger	Railway Association of Canada
Eric Magel	National Research Council Canada, Centre for Surface Transportation Technology
Felix Meunier	Transport Canada, Innovation
Paul Miller	Canadian National Railway
Stephen Millet	Futuring Associates
Ian Naish	Transportation Safety Board
Jay Nordenstrom	Canadian Association of Railway Suppliers

Name	Organization
Kostas Papazoglou	Portec Rail Products
Malcolm Payne	Engine System Development Centre
Jason Proceviat	Canada Border Services Agency
Mike Roney	Canadian Pacific Railway
Fred Rose	Transport Canada, Rail Safety
Mario Ruel	Canadian National Railway
Tom Smithberger	HDR Engineering Inc.
Richard Soberman	Trimap Communications
Susan Spencer	Transport Canada, ITS Policy Branch
Allison Tait	Industry Canada
Sesto Vespa	Transport Canada, Transportation Development Centre
Nicholas Vincent	Consultant-Strategic
Kathie Wells	RRAB Member
Henry Wright	Transportation Safety Board

APPENDIX B: SYMPOSIUM PROGRAM

RAILWAY RESEARCH ADVISORY BOARD CANADIAN RAILWAY RESEARCH SYMPOSIUM

Radisson Admiral Hotel
Toronto, Ontario, November 28–29, 2007

Time	Wednesday, 28 November
08:15 – 09:00	Registration and Continental Breakfast (Ballroom Foyer—3rd Floor)
09:00 – 09:15	Welcome & Introduction (Salon A—3rd Floor)
	KEYNOTE ADDRESS
09:15 – 09:45	Steven Millett, Futuring Associates LLC
09:45 – 10:00	Q&A Period
	KEYNOTE ADDRESS
10:00 – 10:30	David Fung, ACDEG Group
10:30 – 10:45	Q&A Period
10:45 – 11:00	Health Break
	THEME 1 SERVICES & DEMAND OUTLOOK AND IMPLICATIONS FOR R&D
11:00 – 11:15	Environmental Scan: Dr. Malcolm Cairns (CP Rail)
11:15 – 12:15	Participant Discussion
12:15 – 13:15	Lunch (Ballroom Foyer—3rd Floor)
	THEME 2 NETWORK CONNECTIONS & CAPACITY GROWTH THROUGH INNOVATION
13:15 – 13:30	Environmental Scan: Not assigned
13:30 – 14:30	Participant Discussion
14:30 – 14:45	Health Break
	THEME 3 LITIGATION, LIABILITY & REGULATION DRIVING TECHNOLOGICAL CHANGE
14:45 – 15:00	Environmental Scan: Not assigned
15:00 – 16:00	Participant Discussion
16:00 – 16:30	SUMMARY & WRAP-UP: Dick Soberman
16:30 – 17:00	Health Break
17:00 – 18:00	Wine & Cheese Reception (Commodore's Restaurant—5th Floor)

Time	Thursday, 29 November
08:30 – 09:00	Continental Breakfast (Ballroom Foyer—3rd Floor)
09:00 – 09:15	Welcome & Introduction (Salon A—3rd Floor)
	THEME 4 HUMAN RESOURCES CHALLENGES & OPPORTUNITIES
09:15 – 09:30	Environmental Scan: Chris Barkan (University of Illinois)
09:30 – 10:30	Participant Discussion
10:30 – 10:45	Health Break
	THEME 5 ENVIRONMENTAL STEWARDSHIP POWERING THE BUSINESS MODEL
10:45 – 11:00	Environmental Scan: Peter Eggleton (Telligence Group)
11:00 – 12:00	Participant Discussion
12:00 – 13:00	Lunch (Ballroom Foyer—3rd Floor)
	THEME 6 SECURITY & BORDERS RISK MANAGEMENT & COMPETITIVE ADVANTAGE
13:00 – 13:15	Environmental Scan: Jason Proceviat (Canada Border Services Agency)
13:15 – 14:15	Participant Discussion
14:15 – 14:30	Health Break
	TOP 10 RESEARCH ISSUES FOR CANADA
14:30 – 15:45	Environmental Scan: Robert Dorer (USDOT/Research and Innovative Technology Administration) or M. El-Sabaie Summary of Theme Results: Lloyd Livingstone (Rana International Facilitator) Participant Discussion
15:45 – 16:30	STAKEHOLDER PERSPECTIVES: Mike Lowenger (Railway Association of Canada) Susan Spencer (Transport Canada) John Coleman (National Research Council Canada)
	WRAP-UP: Sesto Vespa (Transport Canada)

APPENDIX C: GUIDE DOCUMENT FOR PARTICIPANTS

Canadian Railway Research Symposium **Toronto, 28 – 29 November 2007**

Organized by the Railway Research Advisory Board

Guide Document

— to help speakers, moderator(s), provocateurs, and participants prepare by understanding what the symposium organizers are looking for

A. PURPOSE OF THE SYMPOSIUM

Railway progress is essential for Canada's economic competitiveness. And technology is critical to achieving that progress. Many vital qualities of Canadian railways—their service to customers, capacity, efficiency, safety, and sustainability—will change in ways we are only beginning to imagine. Because this kind of change can occur so rapidly, our current investment decisions must be directed at responding and adapting to these changing new conditions.

This symposium's goal is to identify industry priority areas, and in particular to create a Canadian strategic plan for innovation and technological development that will guide decisions over the next 5 to 15 years.

The insight and ideas that participants express during the symposium will form the basis of that plan. And because it will be a seminal plan, it needs to start with the most penetrating insight.

B. ROLES

All attendees are expected to participate in all themes in the symposium. But to stimulate people's thinking, and to organize the discussion, people will be asked to take on various roles. There are four different types of role.

Speakers

Most themes will begin with an environmental scan. This is to set the scene with a review of where things are going and why. Each one will be given by a "speaker" who should:

- prepare and deliver a presentation—*maximum 15 minutes*.
- include PowerPoint slides if desired.
- deliver it while seated if possible.
 - note: attendees will sit facing each other in a large "U" around the room.
- state or hypothesize where (and why) technological change in the railway industry is desired/essential/inescapable.
- aim to capture the attendees' imagination—and make all of them *want* to speak.

Moderator

There will be moderator for all the themes. This is to help keep the discussion going in the most productive direction. The moderator should:

- introduce speakers.
- encourage participation by everyone.
- stand and walk around.
- bring the discussion back onto the theme, if it digresses.
- say the minimum necessary to keep the discussion flowing.
 - note: this may include dropping short questions (but no soliloquies, please).
- diplomatically prevent any one participant from dominating the air time.
- stop the discussion five minutes before the end, and give the professional synthesizer the floor to summarize the key points.

Provocateurs

Each theme will be assigned a small number of provocateurs from among the attendees. This is to ensure there is vigorous discussion that does not stop at mere platitudes (an unlikely risk, no doubt!). Provocateurs should:

- do some background reading, if necessary, on the theme to which they are assigned.
- take a certain point of view and be prepared to champion it.
- come prepared with a few short (one- or two-minute) speeches, and be ready to deliver any of them at the drop of a hat.
- deliver any short speeches while seated.
 - note: attendees will sit facing each other in a large “U” around the room; only the moderator will be walking around.
- speak out if the discussion seems to be taking an illogical or unproductive direction.
- fill in any silent spots (an unlikely prospect, no doubt).
- aim to make everyone think—and think hard.

Participants

All attendees are expected to participate in all discussions. Every attendee has been selected for his or her knowledge, insight, and articulateness. No one should remain silent on any subject. Participants should:

- in preparation for the symposium brush up, if necessary, on background material (and their own thoughts) about each theme.
- at the symposium, listen to the speaker’s environmental scan for each theme and take a point of view about it.
- draw on their own knowledge, insight, and experience to envisage the business and societal conditions to which railway research and technology will need to respond.
- infer what kinds of research will be needed.

- speak frequently and with conviction about what they see being priorities for research—in temporal sequence if humanly possible.
 - note: it is perfectly permissible to disagree with speakers and other attendees.
- listen to the professional synthesizer’s wrap-up of each theme session, and help him or her re-cast the main points if necessary.

C. SUBJECT CONTENT

For all themes

The symposium is organized around six themes. Here is the material that the organizers are looking for in all of them.

All attendees should work to “tease out” trends occurring inside the railway sector, and outside it as well (for example global forces), that will propel change in this sector in North America over the next 5 to 15 years.

The trends can be economic, social, technological, financial, political, ecological, demographic, or anything else that is relevant.

It will be especially helpful if speakers and panelists can identify changes that are *discontinuities*—in other words, changes that will drive a *major* response, for example when:

- things reach a tipping point.
- breakdowns occur in “the way things have always been done”.
- systems and practices reach a limit beyond which incremental change is no longer sufficient or perhaps even possible.
- new approaches make otherwise-good past practices obsolete.
- new theories and opportunities shake up the way in which railroading has been done in the past.

All attendees should try to draw inferences from these causes. What will be the effect on railways and how they are led? Managed? Structured? Operated? Regulated?

And finally, all attendees should try to forecast the implications for (new) research —research needed to create, adapt, prototype, modify, implement, and manage technological change.

The symposium organizers — the Railway Research Advisory Board — are especially interested in research that could and should be done in Canada.

For individual themes

Here is the material we are looking for in each individual theme.

Theme 1: Services and demand—outlook and implications for R&D

How will changes in the nature and level of services expected from railways by society in general, and by major groups of customers in particular, drive the business and regulatory environment in which railways operate over the next 5 to 15 years?

In other words, what are the macro trends affecting the railways' level of business, and the nature of their business models? And what is this likely to do to the need for technology and the research on which that business will be based?

Theme 2: Network connections and capacity—growth through innovation

How could/should/must railways increase the capacity of their operations, and the capacity of the larger transportation system of which they are a part? For example, perhaps connections between one railway and another, and between railways and ships (at ports), and between railways and trucks (at intermodal facilities) could be promising areas at which to make gains in the overall throughput of the freight system. And at some point railways may have to deal with the possibility that the laws of physics will block further progress in areas where they (the railways) used to make gains in the past.

Some fertile areas for new or better knowledge might be:

- faster operations at intermodal ports and within intermodal facilities
- “direct-hit-at-the-port” operations—synchronized arrivals
- minimizing track outages and maintenance requirements
- controlling train position
- going beyond currently-understood limits (physical or economic) of car weight, axle loads, train length, train speed, train headway, and so on
- flat-lining of winter—making January look like June
- avoidance of congestion
- recovery from congestion

Theme 3: Litigation, liability, and regulation—driving technological change

How could/should/must railways, regulators, and policy-makers revise the way in which financial and legal responsibilities are assigned within the rail industry? There is probably a case to be made, that the current environment slows innovation by raising the risk to railways (and their suppliers) of deviating from past practice. This slows the acceptance of new technology. Regulation slows it too, if it does not keep up with changes in the science and technology that underpin the way in which railways operate.

Could we aspire to a climate that encourages, or even drives, responsible technological change? What kind of research is needed to enable a climate like that to emerge?

Some fertile areas for new or better knowledge might be:

- safety management systems
- transporting dangerous goods (hazmat)
- interoperability and interchange
- grade crossings and trespassing
- train inspection
- track inspection

Theme 4: Human resources—challenges and opportunities

How could/should/must railways adapt their working environment for their people—especially in light of changes likely to come in the *kind* of people that railways will have as employees in the future? You might call this simply “the challenge of human resources in the future”.

One of the most striking prospects is that some, or perhaps many, railway jobs in the future will not be the same as they are now. For example, the job of driving trains could involve doing very different things than what locomotive crews do today. This may propel the need for research in various areas, like man-machine interface, cognition, and so on.

Some fertile areas for new, or better, knowledge might be:

- the jobs, people, skills, and tools of the future in – train driving
 - train dispatching
 - train inspection
 - track inspection
 - track maintenance
- enhancing human performance with technology
- the aging workforce
- the business-savvy workforce
- the highly mobile workforce
- expectations held by people who make up the 21st century workforce

Theme 5: Environmental stewardship—powering the business model

How could/should/must railways respond to pressures to reduce their environmental footprint? The answer may depend on whether those pressures come directly from society, or indirectly from railway competitors responding to society.

Of special interest are technologies that will create *new business opportunities* for railways to make money and grow—for example by widening the environmental advantage they have over other modes of transport, or by overcoming any environmental *disadvantage* they have relative to some other modes of transport.

Some fertile areas for new or better knowledge might be:

- energy and emissions – the challenge of the eco-truck
 - the challenge of short-sea shipping (intercoastal barges)
- intrusiveness on communities—noise, vibration, visual pollution, blocked crossings
- dangerous goods (hazmat)—spills and leakage
- effective land use

Theme 6: Security and borders—risk management and competitive advantage

How could/should/must railways and governments respond to changes in the nature and level of security threats, and in the level of risk that society is prepared to accept, wherever passengers, and especially goods, cross national borders? These are points at which railways can gain or lose competitive advantage, and where their capacity and throughput can be impeded to a greater or lesser extent.

Some fertile areas for new or better knowledge might be:

- automated inspection
- fail-proof reporting
- tamper-proof containers
- origin-to-destination tracking of shipments

APPENDIX D: SYMPOSIUM EVALUATION FORM

RAILWAY RESEARCH ADVISORY BOARD CANADIAN RAILWAY RESEARCH SYMPOSIUM Participant Evaluation Form

Your evaluation of this event is important. Please take a moment to answer the following questions and return the completed form to the Symposium Working Group (hick@bellnet.ca).

Please indicate the sector that you represent (check all that apply)

- ☐ Railways
- ☐ Rail industry stakeholders and constituents (including shippers)
- ☐ Academia
- ☐ Research & development community
- ☐ Consulting industry
- ☐ Government

1) Was the format of this symposium effective in provoking a dynamic and interactive discussion from all participants on issues affecting the railway sector?

☐ Yes ☐ No

2) Did the six symposium themes sufficiently reflect the key issues facing the railway sector today?

☐ Yes ☐ No

3) Did the keynote addresses, and the environmental scan for each theme, provide an adequate overview of the current situation?

☐ Yes ☐ No

4) Did the meeting facilitator effectively summarize and capture the key points of each theme?

☐ Yes ☐ No

5) Did this symposium reach its goal of identifying industry priority areas for railway research and development for the next 5 to 15 years?

☐ Yes ☐ No

6) Please rate the meeting facilities:

	Very Poor	Poor	Average	Good	Very Good
Meeting room and setup					
Meals and refreshments					
CARS Reception					

Comments

APPENDIX E: PARTICIPANT SURVEY

RAILWAY RESEARCH ADVISORY BOARD CANADIAN RAILWAY RESEARCH SYMPOSIUM Evaluation of Post-Symposium Report

Your evaluation of this report will ensure that all comments and views were accurately recorded. Please take a moment to answer the following questions and return the completed form to the Symposium Working Group (hick@bellnet.ca).

- 1) Do the top 11 research issues identified reflect the discussions held during the symposium?

☐ Yes ☐ No

If you answered "No" please specify what needs to be changed

- 2) Are you satisfied with the overall ranking of the top 11 research issues identified?

☐ Yes ☐ No

If you answered "No" please specify how they should be ranked

- 3) Is there any information that you feel should be removed from this report?

☐ Yes ☐ No

4) Is there any information that you feel should be added to this report?

☐ Yes ☐ No

5) Based on the top 11 research issues identified, are there any specific projects in which your organization would be prepared to take a pro-active/funding role?

☐ Yes ☐ No

General Comments and suggestions
