A Potential Strategic Plan and Research Agenda for the National Cooperative Rail Research Program

DETAILS

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NATIONAL COOPERATIVE RAIL RESEARCH PROGRAM

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Research Results Digest 1

A POTENTIAL STRATEGIC PLAN AND RESEARCH AGENDA FOR THE NATIONAL COOPERATIVE RAIL RESEARCH PROGRAM

The content of this digest is extracted from the final report of NCRRP Project 12-02, which was undertaken to help define a strategic plan and research agenda for the program should additional funding be provided. The objective of this research was to prepare a document for review and discussion by the Rail Oversight Committee (ROC), the oversight committee for the NCRRP, as a guide for future research problem review and selection. The report identified a range of projects and ideas suitable for consideration by the NCRRP in the context of ongoing research throughout the industry. The original study was prepared by the Transportation Center at Northwestern University: Joseph L. Schofer, Breton L. Johnson, Norman Carlson, and Derek Kit Ho Cheah.

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SUMMARY

This report presents a potential strategic plan and research agenda for the National Cooperative Rail Research Program (NCRRP) should the program continue beyond currently available funding. NCRRP is one of a number of active rail research programs, including work of the Federal Railroad Administration (FRA), the Association of American Railroads (AAR), individual railroads, their suppliers, and research institutions.

While other rail research programs have been addressing technology, materials, and safety issues, NCRRP has focused on matters of policy, economics, and institutions. This report assumes that the focus going forward would continue to be primarily in these areas. That focus should not be interpreted to diminish the value of other rail research.

The potential plan and agenda provided here are based on a review of recent rail research and primarily on the results of interviews with more than 60 railroad stakeholders who were asked to identify key opportunities and problems facing the industry. The plan identifies eight areas where rail research is both needed and expected to produce cost-effective results. These are:

1. Assuring safe and efficient management of railroad capacity, particularly in the case of shared rights-of-way;
2. Facilitating and accelerating railroad project delivery;
3. Developing the railroad workforce;
4. Promoting innovation in funding and financing rail projects and operations;
5. Growing ridership on regional and commuter passenger services;
6. Promoting and facilitating freight rail services to reduce highway congestion, save energy, and reduce environmental impacts;

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7. Developing and deploying strategies and technologies for enhancing safety; and
8. Developing and deploying advanced methods and materials for railroad design, rehabilitation, and maintenance: faster, cheaper, and better methods.

This potential strategic plan describes each of these areas and presents several specific research topics under each. These topics reflect problems and opportunities raised by stakeholders, and they build on work that is currently underway. These broad topics are narrowed to a five-point potential research agenda based on the scale and scope of NCRRP and the work underway in other programs:

- *Assuring safe and sufficient railroad capacity*. The focus is on making safe and efficient use of limited physical infrastructure. Work in this area includes development of models and tools to guide the safe, shared use of rights-of-way by freight, passenger, high speed rail (HSR), and maintenance operations; institutional arrangements and valuations for right-of-way sharing; and strategies and methods for managing unexpected rail service disruptions such as severe weather events.
- *Defining the rail value proposition*. This area aims to facilitate rail project implementation by helping communities understand the value of existing and proposed rail facilities and services. The work covers methods to build community support for passenger and freight facilities and services based on the value of community outcomes; demonstrating the value of maintaining rail systems and facilities in a state of good repair (SGR); and conceptual and case-based studies of the public benefits and costs of investing in freight rail connectivity to support public investment decisions.
- *Developing the future rail workforce*. Research and development in this category is targeted to assuring sufficient and well-prepared personnel for passenger and freight rail services. Work in this area includes market studies and programs to attract workers to rail employment, ranging from operating and maintenance personnel to technical, engineering, and management professionals.
- *Sustaining funding for rail facilities and services*. Here the tasks are to show the value of rail services, particularly those requiring some level of public investment; to educate policy makers dealing with rail services about passenger rail economics and finance; and to explore innovative and effective financial strategies, including public-private partnerships.
- *Expanding the markets for passenger and freight rail services.* This research area looks for ways to attract demand for both passenger and freight services, and therefore to produce efficiency, environmental, and safety benefits for society. Specific actions would include market tracking studies using current and emerging, *big data*, sources; assessing promising strategies and best practices for growing markets; and identifying cost-effective approaches to delivering seamless services.

INTRODUCTION AND OBJECTIVES OF THE RESEARCH

This report outlines a potential strategic plan and agenda for NCRRP (http://www.trb.org/AboutTRB/Public/AboutCooperativeResearchPrograms.aspx). The purpose of the plan is to guide the program should the opportunity materializes to continue beyond currently available funding.

NCRRP is a part of the family of cooperative transportation research programs managed by the Transportation Research Board (TRB). Authorized in the Passenger Rail Investment and Improvement Act of 2008 (PRIIA), NCRRP began in 2012 to support applied research of importance to freight and passenger rail, including commuter, intercity, and HSR passenger service. The program is sponsored by the FRA and program oversight is the responsibility of an independent governing board—the NCRRP ROC—that is appointed by the U.S. Secretary of Transportation. The ROC selects projects for funding from ideas submitted by the railroad community, including members of the industry (public and private), standing committees of TRB that address railroad issues, members of the ROC themselves, and others. Solicitation of research ideas is an ongoing process.

The strategic plan for research is important not only because railroads are important to the nation, but also because NCRRP has limited resources to support research: PRIIA authorized $5 million per year for fiscal years 2009 through 2013 (http://www.

Table 1 Current NCRRP projects.

Project Number	Project Title	Stage
02-01	Comparison of Passenger Rail Energy Consumption with Competing Modes	Active
03-01	Intercity Passenger Rail Service and Development Guide	Active
03-02	Intercity Passenger Rail in the Context of Dynamic Travel Markets	Active
06-01	Building and Retaining Workforce Capacity for the Railroad Industry	Active
07-01	Alternative Financing Approaches for Passenger and Freight Rail Projects	Active
07-02	Developing Multi-State Institutions to Implement Intercity Passenger Rail Programs	Active
07-03	Inventory of State Passenger and Freight Rail Programs	Active
12-01	Legal Aspects of Rail Programs	Active
12-02	Potential NCRRP Strategic Plan/Research Agenda	Completed

govtrack.us/congress/bills/110/hr6003); however, only one year was appropriated. Recognizing a need for a longer-term guide to future research, this strategic plan is intended to provide a basis for informing research decisions should additional funding be provided for the NCRRP.

NCRRP currently supports the nine projects listed in Table 1. The topics under study span both passenger and freight issues.

RESEARCH APPROACH

To develop a potential strategic plan, the research team reviewed railroad research, underway or recently completed, sponsored by a variety of institutions. Information came from published literature, as well as TRB's web-based listing of Research in Progress (http://rip.trb.org/). The research team also reviewed the substantial FRA research program that is focused primarily on safety, railroad infrastructure, and rolling stock and control systems, as well as work support by the AAR. AAR also focuses largely on the hardware side of the industry, at least in the portion of its research that is not proprietary. AAR's subsidiary, TTC, Inc., operates the U.S. Department of Transportation-owned Transportation Technology Center in Pueblo, Colorado, which engages in research, consulting, and large-scale testing of railroad equipment, materials, and methods.

Additional research is conducted by railroad companies as well as original equipment manufacturers (OEMs). Most of this work is proprietary and therefore neither visible to the research team nor particularly salient for a publicly supported program like NCRRP.

A review of research completed and in progress was conducted to identify areas of importance that are not being addressed by current research or where there appears to be under-investment, as well as to avoid duplication of research efforts.

The most productive part of the effort to develop the potential strategic plan for research was the outreach program whereby views on railroad problems of today and tomorrow were discussed with more than 35 rail industry stakeholders. These discussions were a mixture of one-on-one interviews conducted by members of the research team and some small-group meetings with stakeholders (focus groups). Included in these interviews was an extended teleconference with members of the Project Review Panel, which was followed up by individual discussions with members who could not participate or in cases where more in-depth information was offered by particular members.

In all of these interviews, stakeholders were asked to identify problems and opportunities facing the industry rather than research needs. It was expected that this approach would be more fruitful than asking for specific recommendations for research activities, since almost none of the stakeholders involved were in the business of formulating research projects. They were, however, senior experts in some aspect of the rail industry and they were able to offer a broad and deep sense of problems, challenges, and opportunities facing both passenger and rail services. Table 2 provides a summary of the areas of expertise of our stakeholders.

The research team also conducted a web-based survey of members of TRB standing committees focused on railroad topics, facilitated with the support of TRB staff members. This approach allowed contact with many rail stakeholders easily, yielding nearly 30 more responses.

The research team used the results of these outreach activities to define a broad list of areas where

Table 2 Stakeholders interviewed and surveyed for this study.

Category	Number
Association of American Railroads	1
Construction, railroads and transit	2
Consultants, railroad logistics	4
Developers, development authorities (Intermodal facilities)	4
Federal Railroad Administration	1
Logistics companies – 3 PLs	3
Major shippers	3
Manufacturers (RR OEMs)	2
Commuter railroads	6
Railroads, national	4
Railroads, regional	4
Researchers	1
Subtotal - interviews	35
TRB Railroad Committees & friends	29
Total responses	64

there are important problems and opportunities, as indicated by the stakeholders. From this list, the research team was able to identify some examples of specific research topics. Using this list coupled with other considerations, the research team was able to identify examples of specific topics with potential as promising research ideas.

In this report all of the primary research thrusts identified are listed, but not all of these should be considered for the NCRRP program. Priorities for NCRRP should be on work that (1) is important as determined by the process followed in this research and by the judgment of the oversight panel; (2) has a sufficient *public* interest to justify investment of public funds, in contrast to work that would primarily benefit a part of the industry or a single firm; and (3) is not already supported by other sources. The next section of this digest highlights areas of primary interest to NCRRP followed by areas of less relevance.

It was observed that, for some of the research areas, relevant work is or has been underway under NCRRP or parallel cooperative research programs, including the Transit Cooperative Research Program (TCRP), the National Cooperative Highway Research Program (NCHRP), the Airport Cooperative Research Program (ACRP), the National Cooperative Freight Research Program (NCFRP), and the Hazardous Materials Cooperative Research Program (HMCRP). The overlap is largest with the TCRP program as many of the projects are closely related to the needs of the commuter rail industry. Some useful examples of relevant work in these programs are listed here, but this document does not provide a comprehensive summary of all relevant work under the TRB Cooperative Research Programs. However, in formulating and updating the NCRRP research program, overlaps and synergies with the other cooperative research programs should be carefully considered.

POTENTIAL KEY AREAS FOR RAILROAD RESEARCH

AREA 1: Assuring Safe and Efficient Management of Railroad Capacity, Particularly in the Case of Shared Rights-of-Way

This area of research includes managing and reducing conflicts between freight and passenger services, and between these services and HSR, through operations management, technologies, modeling, and institutional arrangements at both regional and corridor scales.

This research would address the balance between the need for capacity; the costs and difficulty of expanding infrastructure; and the imperative for safety, exploring creative and technology-supported ways to manage operations under conditions of congested, and shared right-of-way use. It should consider the possibility that fulfillment of the Positive Train Control (PTC) requirement may lead to safer right-of-way sharing opportunities, and thus increased capacity.

The public interest in right-of-way access questions arises mainly where there is an effort to provide or expand passenger services on freight railroad infrastructure, but in some cases the potential for freight use of passenger routes offers added value. A primary question is how to come to an agreement on right-of-way access that works for all parties. Reaching such agreements can, at times, be difficult, raising the possibility that a reasonable basis for agreement has not yet emerged, i.e., an exchange that satisfies both infrastructure owners and users. There also may be operational and technology strategies

that can safely squeeze added capacity out of existing infrastructure.

Here are some examples of specific research topics:

- Identify and evaluate *equitable and cost-effective strategies for sharing capacity safely for freight and passenger services.* The public interest lies in assuring sufficient and safe capacity for both passenger and freight rail services. Railroad rights-of-way are scarce and costly resources. While most of these are in private hands, there can be needs and values associated with providing public access. This work would identify successful experiences in right-of-way sharing, the types of exchanges and access priorities that can work for both parties, the opportunities to develop consistent and accepted methods for value analysis and cost allocation, as well as standardized forms of access agreements.
- Identify *technologies that will support safe and efficient right-of-way sharing*. This area of research includes control systems (e.g., PTC), as well as rail cars, such as diesel multiple unit (DMU) trains, that are suitable for safe mixed operations. Much technology-oriented research and development is sponsored by OEMs and public sources, but additional value may come from extracting and focusing on work that specifically addresses the conditions and policies under which freight-passenger right-of-way sharing may be facilitated.

  (See *TCRP Report 130: Shared Use of Railroad Infrastructure with Noncompliant Public Transit Rail Vehicles: A Practitioner's Guide* and *NCHRP Report 657: Guidebook for Implementing Passenger Rail Service on Shared Passenger and Freight Corridors.*)
- *Develop advanced operations management and planning models and methods to support long- and short-term decision making for passenger rail and urban and regional freight operations, facilities, and services.* While there has been considerable work in this area, there are likely to be opportunities to develop and deploy advanced models that address contemporary needs and resources, and that take advantage of new data sources and control options. Expanded interest in passenger rail at regional and national scales, including HSR, and engagement of state and regional public agencies in planning and investing in freight facilities, puts added value on research in this area. Important and promising applications of operations research (OR) methods are likely to be in modeling, analyzing, and optimizing railroad operations to extract additional capacity in congested and shared-use corridors safely and with minimum investment in new fixed infrastructure, resource scheduling and deployment, and disruption management.

  Some specific project areas include:

  a. Operations research models to identify and evaluate options for increasing capacity and safety in shared corridors—passenger and freight, freight and HSR, commuter rail and HSR.
  b. Routing models that address current and evolving policies on exposure of communities to hazardous materials (hazmat) shipments, including risks associated with lateral conflicts on closely spaced tracks in sensitive corridors.
  c. OR studies of strategies for increasing the efficiency of utilization of railroad power, rolling stock, and personnel.
  d. Optimization of maintenance scheduling under continuing railroad operations, contributing to the dual and sometimes competing goals of assuring a SGR and maintaining essential rail services.
  e. Models to support service disruption management, both for advanced planning and quick-response tools to support rapid assessment and selection of management and recovery strategies.

  There is an active community of OR researchers working on rail problems in the Railway Applications Section of The Institute for Operations Research and the Management Sciences (RAS-INFORMS). This is both a resource for ideas and a source of problem-solving skills.
- *Develop freight railroad planning tools for use by metropolitan planning organizations* (MPOs) to support investments in new or rehabilitated facilities, provide new rail access, or eliminate bottlenecks. These tools would include models for forecasting project outcomes and frameworks for evaluating alternatives.

- *Develop improved forecasting tools for freight planning* to predict demand, costs, and performance. (See, e.g., the Strategic Highway Research Program 2 (SHRP2) freight modeling initiative (SHRP2 Report S2-C20-RR-1, "Freight Demand Modeling and Data Improvement").
- *Develop practical rail project evaluation methods, addressing benefits and costs, economic development impacts, and return on investment* (ROI), to support (and promote consistency of) public and public-private investment decisions. Preparation of these evaluation methods relates closely to research to define the value proposition for public investments in both passenger and freight rail facilities. Here it will be important to distinguish between outputs—measures of service quantity and quality—and outcomes, such as economic development, jobs, and incomes. This work should offer recommendations for criteria for merit-based project selection. (See *NCFRP Report 12: Framework and Tools for Estimating Benefits of Specific Freight Network Investments.*)
- *Define enhanced performance measures and supporting data sources for management and oversight of intercity passenger services.* This area of concern is of interest where there are intergovernmental funding arrangements for passenger rail services, e.g., state subsidies for Amtrak or for regional transit facilities and services.
- *Identify improved ways to manage impacts of and response to external disruptions,* particularly natural disasters such as floods, hurricanes, snowstorms, landslides, forest fires, and earthquakes, as well as derailments, collisions, and toxic spills. This is an issue facing both private railroads and public agencies. The public interest arises when there are serious externalities, or when essential transportation services are compromised, e.g., a freight incident that disrupts local productivity or passenger services. This would include risk assessment of extreme natural and accidental events to identify threats and set priorities for protecting against them; best practices in operational responses to major service disruptions and hazards; and identification of cost-effective long-term responses to natural disruptions—hardening, redundancy, and elasticity.
- *Develop advanced intercity passenger demand-forecasting models* to support planning for conventional and HSR services. There is a need for effective and credible models for forecasting the demand for HSR services. Much work has been done, and is underway, in conjunction with the specific HSR rail initiatives around the country. In addition, the FHWA has been leading an effort to synthesize a database on intercity passenger travel to support model development and planning. Decisions about investments in passenger travel demand models under NCRRP should await results of efforts now in progress.

As research in this area moves forward, it will be important to compare ideas for study with the state of the art and practice, and with work completed and underway in the National Cooperative Highway Research Program as well as the National Cooperative Freight Research Program (e.g., *NCFRP Synthesis 23: Synthesis of Freight Research in Urban Transportation Planning*). It will also be important to cross reference research ideas with modeling and operations research work sponsored by the FRA, the railroad industry, university research centers, RAS-TIMS, and other more analytical sources and publication streams.

AREA 2: Facilitating and Accelerating Railroad Project Delivery

Stakeholders expressed frustration with the public opposition or apathy associated with attempts to implement railroad investment projects, e.g., line extensions, new or rehabilitated terminals. This has long been a common issue facing transportation projects; freight projects may face more opposition than passenger facilities because it can be more difficult for affected communities to see the benefits of freight service. Several specific areas for research on this topic were highlighted by stakeholders.

- Identify and evaluate strategies and methods to address community opposition and to *build support for sustaining railroad operations and advancing expansion and extension projects.* A key focus here would be development and articulation of the *railroad value proposition*, answering questions such as, "What's in it for

me?" and "Why should we accept the negative impacts of a new rail facility or service? What are the tradeoffs?"

There is a particular need to articulate the value of freight services to the community, the region, and the nation. It is usually more difficult to make the case for freight projects because the benefits of more efficient logistics are not salient to most people. Freight movements and their values are invisible, distant, and disconnected from the certainty of having products on the supermarket shelves or online purchases deliver to the doorstep in two days. There is an educational product, general and project-specific, that needs to be constructed and delivered. The need for this product is underscored by the public reaction to recent rail accidents, derailments, and spills of hazardous materials.

More broadly, this project would develop strategies for making the case for operation and expansion of railroad facilities and services. The focus would be on describing and quantifying community, regional and national benefits of rail improvements, in conceptual terms (outlining the generally expected benefits and costs), in the form of case studies of successful implementations, as well as tools to predict these outcomes for railroad project planning.

This work should address the not-in-my-back-yard (NIMBY) position. For example, the SHRP2 capacity track has invested in development of SHRP2 C01, "A Framework for Collaborative Decision Making on Additions to Highway Capacity," designed specifically to advance project delivery by making the planning and decision processes more open and accessible and by engaging key stakeholders (in favor and opposed) early in the process. This is intended to bring critical issues to the earliest stages of project development as well as to bring stakeholders themselves into the process of developing the projects, to shift them from opponents to collaborators.

- Develop *cost-effective and credible strategies for mitigating and managing environmental impacts and hazard risks* of railroad projects and operations. Resistance to rail projects is sometimes grounded in realistic concerns about environmental impacts—noise, air pollution, water runoff—and the associated health and safety risks of those projects. This work focuses on developing ways to address the environmental costs and the benefit-cost tradeoff. While there has been much work on transportation impact mitigation, opportunities remain to conduct specialized studies aimed at specific kinds of railroad expansion projects. This work may use case studies to explore the effectiveness of promising designs, operations, and mitigation ideas and to identify good practices.
- Develop effective and credible *strategies for preventing catastrophic railroad accidents and spills.* Reactions to the dread risk associated with accidents and toxic inhalation hazard (TIH) releases are real and have been exacerbated by recent events. As railroads are increasingly tasked with moving petroleum products and other toxics, these reactions can be expected to grow in intensity and, along with them, the resistance to new rail projects.

  While hardware and operating strategies to address both environmental impacts and accident/spill hazards are the subject of research elsewhere (e.g., FRA, AAR), there may be opportunities for the NCRRP to invest in the development of more effective risk reduction strategies as well as more successful ways to communicate with stakeholders about risks and risk mitigation. For example, NCRRP research might focus on integrating such hardware and operating protections into the evolving value proposition that builds the case for railroad investment.

AREA 3: Developing the Railroad Workforce

A majority of the stakeholders expressed the need to cultivate a sufficient and well-prepared workforce to secure the future of the railroad industry, both passenger and freight, and at regional and national scales. This effort will require marketing, training, and in some cases adapting job characteristics to fit the preferences of today's worker. This topic is under study as NCRRP Project 06-01, "Building and Retaining Workforce Capacity for the Railroad Industry." The importance of assuring the railroad workforce of the future may warrant additional study that continues and extends the activities of Project 06-01.

The current project is assessing workforce needs now and in the future and examining current practices for recruiting, training, and retaining

workers. It includes identification of best practices in and beyond the railroad industry. Design of the most efficacious next steps in addressing workforce development should await completion of Project 06-01. Topics that might be considered for further study include:

- *Conduct market research to measure how members of the current cohort of potential workers (e.g., men and women between 18 and 35) perceive railroad careers.* This information should lead to a better understanding of the aspects of current job descriptions that new workers find particularly appealing or unattractive, and where awareness gaps prevent job seekers from considering the railroad industry. This could become the basis for developing and testing revised and updated job specifications to better match the preferences and capabilities of the evolving workforce, along with recruiting schemes to communicate these opportunities to potential workers. Particular targets may be jobs that now require extended time away from home bases, difficult living conditions, high risks, or simply poor public image, as well as the impression that the rail industry is outdated and not high tech. The results may lead to different ways to organize work and attract and reward employees.
- *Identify best practices for collaborations with training organizations* (e.g., vocational schools, community and junior colleges, and 4-year colleges) to develop the rail transportation and transit work force, including work study and mentored internship opportunities. Observations and experimentation may be used to define effective practices for workforce attraction, training, and retention.
- *Identify and report best practices to bring military veterans into the railroad workforce.* Review programs already in place in some railroads, and define strategies for extending these to other parts of the industry. This should include a special effort to match disabled veterans with appropriate railroad jobs.
- Develop and test *strategies for taking advantage of railroad adoption of advanced technologies to attract young, technology-savvy workers* to railroad careers.
- *Develop IT-based workforce training technologies for the new railroad work force.*
- *Address the need to attract technical and managerial professionals into the rail industry* by reviewing the skill sets taught in colleges and universities; developing learning modules (e.g., case studies, analytic problems, writing assignments) for use in undergraduate and graduate programs in engineering, economics, and management; exploring professional employment trends and preferences among college graduates; and developing outreach, information, and internship programs to draw future leaders into railroading. Support for graduate study and research in rail-related topics may also draw more technically trained people into the industry.

  The RAS-INFORMS hosts a problems solving competition that promotes interest in rail research among operations researchers. Its student paper competition attracts younger researchers to railroad problems, a contribution to workforce development. This offers an additional channel through which to promote career interests in the rail industry.
- Develop *strategies to capture the knowledge and experience of senior employees*, harvesting and moving knowledge from generation to generation. These may include organized mentoring programs, development of training videos and simulations, and job shadowing to document activities and methods.

AREA 4: Promoting Innovation in Funding and Financing Rail Projects and Operations

The need for more, and more consistent, funding for railroad investments and operating support was frequently expressed by stakeholders contacted for this study. This issue is aimed at publicly supported passenger services and those cases where public investments are targeted to freight facilities. This area is closely related to topics under Area 2: Facilitating and Accelerating Railroad Project Delivery that addresses the value proposition of rail investments: logically, funding should follow value (benefits received). Research on this topic is underway in NCRRP Project 07-01, "Alternative Financing Approaches for Passenger and Freight Rail Projects," and it is also addressed in Project 07-03, "Inventory of State Passenger and Freight Rail Programs." There has also been

considerable research conducted under the TCRP that addresses funding and financing, pricing, fare collection, and non-fare revenue sources.

Pending the results of this work in progress and assessment of other studies now underway and/or completed under ACRP and TCRP, there are a number of additional research and development investments that might inform funding decisions, some of which are identified here.

- *Develop an educational program, "Commuter Rail Finance 101," to inform local leadership about the contemporary economics of commuter rail services* (e.g., the interrelationships between ridership, costs, pricing, price elasticity, and subsidies), funding sources, and financing options for the purpose of supporting informed fiscal management. This would be a finance and economics primer that would guide appointed and elected local and regional rail agency leadership, political leaders, the press and the public in discussions about funding and financing options, opportunities, and revenue sources. The differences between the economics of private freight railroads, and public passenger services in the United States, particularly expectations about profitability and subsidies, should be addressed, as should realistic comparisons between U.S. and international experience with the economics of rail passenger services. (See *TCRP Report 89: Financing Capital Investment: A Primer for the Transit Practitioner*, and *TCRP Report 129: Local and Regional Funding Mechanisms for Public Transportation.*)
- *Estimate and develop strategies to communicate the benefits of maintaining passenger rail systems in a state of good repair* (SGR) *to decision makers and the public.* This would address the operator and customer costs of deferred maintenance. It should provide a quantitative basis for comparing critical rehabilitation projects with line extensions, which are often more politically attractive.
- *Describe and analyze strategies for using public-private partnerships (PPPs) to finance rail rehabilitation projects.* While PPPs are not new, and applications of the concept are growing, there would still be value in an informational product aimed at local and regional rail leadership that covers general concepts of PPPs applied to rehabilitation projects, characteristics of feasible agreements, experiences of various agencies, pitfalls and limitations, and best practices. The value of this work would grow if it were to include case studies of public-private partnership arrangements for regional passenger services (e.g., Denver Eagle P3) and identify best practices.
- *Develop improved cost models for rail service, particularly regional and corridor passenger services* that reflect the true, fully loaded cost. These would define more realistic baselines for defining funding needs and setting prices. There has been much work on railroad costing over many decades, focused largely on freight services, but there is reason to suggest that objective and comprehensive cost estimates are sometimes disconnected from passenger rail pricing and management.
- *Develop pricing strategies and guidelines for applying yield management principles to rail passenger and commuter services*, e.g., pricing by market segments such as peak, off-peak, nights, weekend, and reverse commute markets. Yield management objectives would include both revenue and ridership maximization and points in between. Research sponsored by the TCRP has done some work in this area, e.g., *TCRP Report 94: Fare Policies, Structures and Technologies.*
- *Identify approaches to getting the most from non-fare revenue sources*. (See NCRRP Project 07-01, *TCRP Synthesis 32: Transit Advertising Revenue: Traditional and New Sources, TCRP Report 133: Practical Measures to Increase Transit Advertising Revenues*, and ACRP Project 01-15, "Assessing and Implementing Innovative Revenue Strategies—A Guide for Airports.")
- Identify and assess applications of *progressive fare collection strategies and technologies* that are market responsive, efficient, and effective.
- Develop case studies of the establishment and operation of *dedicated funding sources* for (passenger) rail infrastructure and services.

AREA 5: Growing Ridership on Regional and Commuter Passenger Services

All but the most crowded passenger rail services are interested in attracting more riders. The

possibilities here are very broad, ranging from pricing to new service modalities to enhanced service quality to planning efficient land use and transit oriented development (TOD). Because research has been done on this topic under the TCRP, specific ideas should be vetted against TCRP work completed and in progress. A few examples are listed here.

- *Document changing market demographics in current and potential commuter rail corridors* and assess the implications for radial, reverse commute, and suburb-to-city rail services. Changing market characteristics are the subject of NCRRP Project 03-02, "Intercity Passenger Rail in the Context of Dynamic Travel Markets," and this is also a subject of study at the regional level through MPOs as well as commuter rail agencies. Integration of these results may add value and clarify both trends and effective responses to them.
- *Explore the potential of using of emerging big data sources and analysis methods* to gain insights into the behavior of current and potential rail passenger customers for service development and marketing. Data sources include electronic fare media, smart phone tracking, and social media dialogs. These data sources may also be useful for managing short-term service disruptions.
- *Identify new market opportunities for regional passenger rail services*, including airport links and intermodal connections in general (bus, car, bike, and walk). Airports may offer an attractive option for commuter rail services, especially where the fixed infrastructure is already present and is able to support fast travel to central cities. (See *TCRP Report 83: Strategies for Improving Public Transportation Access to Large Airports.*) More generally, identify cost-effective design and operating strategies to provide seamless intermodal travel options that extend the market reach of commuter rail services spatially and to night, weekend, and special events markets. Case studies coming from regional (MPO-level) planning efforts may illustrate promising ideas.
- Identify and evaluate opportunities *to apply advanced business practices for growing ridership:* marketing, applications of social media, service enhancements, and value-added services. This would include synthesis of experience with programs to boost ridership and revenue on existing infrastructure, pursuing market segmentation and yield management along with case studies of market response to new and improved services. (See *TCRP Report 95: Traveler Response to Transportation System Changes* series; *TCRP Report 111: Elements Needed to Create High Ridership Transit Systems*; and many others.)
- *Identify and evaluate innovations for seamless service concepts in last-mile commuter rail markets:* employer shuttles, van pools, car and bike sharing, and call 'n' ride bus services. (See *TCRP Report 153: Guidelines for Providing Access to Public Transportation Stations.*)
- *Identify opportunities and best practices for using regional-scale TOD policies* to grow commuter rail ridership and promote sustainability.
- *Synthesize experience and best practices for communicating real-time information to travelers*, including delivering real-time service information, responding to service disruptions, and applications of social media for traveler information and marketing.

AREA 6: Promoting and Facilitating Freight Rail Services to Reduce Highway Congestion, Save Energy, and Reduce Environmental Impacts

While private railroad companies have clear proprietary interests in growing and maintaining their market share, there is also a broad public interest in the rail freight industry because of the role it might play in reducing externalities associated with moving freight on highways. The public interest in passenger rail service is more evident, focusing on accessibility and mobility as well as energy and environmental goals. The public interest in rail freight also extends to assuring freight services deemed important for economic development. However, whether public funds should go toward rail advocacy efforts remains an open question.

Some project ideas coming from the outreach effort for this study include the following:

- *Conduct conceptual and case-based analyses of public benefits and costs of improved*

freight rail connectivity. This project idea relates directly to the development of the value proposition for rail investments as described earlier. (See *NCFRP Report 1: Public and Private Sector Interdependence in Freight Transportation Markets*, and *NCHRP Report 586: Rail Freight Solutions to Roadway Congestion—Final Report and Guidebook*.) The energy tradeoff is being addressed in NCRRP Project 02-01, "Comparison of Passenger Rail Energy Consumption with Competing Modes."

- *Document the value of and explore responsibility for last-mile connections to freight customers:* rail spurs and sidings. To achieve the value potential in freight rail expansion and extension projects, there is a need to connect directly to industrial sites. These connections can be critical for local economic development, but mainline railroads often will not make the investment, viewing this as a local responsibility. The public interest lies in this gap.

  Since the deregulation of the U.S. railroads under the Staggers Act (1980), the largest (Class I) railroads have sold off or abandoned many miles of track, concentrating on those carrying the most dense traffic and thus the most profitable lines. Many small towns lost service; but regional and local railroads gradually moved into some of these markets, acquired rights-of-way shed by the larger carriers, and evolved different cost models that allowed them to make short and low-volume routes profitable, thus restoring service to some smaller customers. As a part of many local economic development projects, and in response to a rebirth of short-haul and connecting rail services, there is renewed interest in, and opportunities for, connecting more places to railroad mainlines with last-mile service.

  Some local and regional governments have been willing to support or subsidize the connecting rail links to attract a new employer or secure another already in place, and there are some success stories to be told about these cases (e.g., car load freight facilities in Rochelle and Effingham, IL). In other cases there has been opposition or an unwillingness or inability to invest to secure new rail services. This presents another opportunity to examine the railroad value proposition and the distribution of benefits and costs of providing or supporting last-mile rail service. Analysis supported by case studies could help establish the benefits and costs associated with making these important, small-scale rail connections, *documenting the role of freight railroad services* in bringing economic development (jobs and income), energy conservation, and emissions reduction benefits to communities. Such information may help local and regional decision makers to make informed choices about support for local rail projects, and it might provide the basis for clarifying and enhancing the responsibilities of public and private agencies and entities for service integration.
- *Identify and develop actions to improve railroad services and marketing.* The benefits of this work would fall largely on the private freight railroads so this area of study is not primary for NCRRP. Still, work in this area has substantial value; it might include:
  a. *Develop strategies to integrate railroad service offerings into contemporary supply chain management processes.* Shippers plan and manage logistics from the perspective of supply chains, but contemporary transportation management system (TMS) software is not generally compatible with the way railroads present their service and pricing data. There is a need to adapt the ways in which freight railroads represent their services to the market place.
  b. *Design adjustments to railroad service offerings that better match customer needs* and expectations. The logic here is obvious, and presumably the freight railroads are working continuously to meet this need.
  c. *Define approaches to enhancing rail industry facilities and services to support intermodal and transload operations.* This may be a topic for public–private partnerships, such as joint efforts to provide intermodal facilities to support local industrial growth and employment.
  d. *Develop strategies to accommodate carload shipments profitably*, including reducing barriers to short-haul rail services, e.g., integrated trackage rights to reduce operating costs and improve service.

e. *Identify the implications of the PTC requirement for the costs of providing customer sidings.* Sidings are essential for providing rail access to some customers. Extension of PTC requirements to sidings boosts costs and discourages railroads from establishing or maintaining these last-mile connections. This work would explore options for safe operations of sidings.
f. *Identify opportunities for and value of applying advanced technologies for tracking railroad vehicles and shipments.* This work would explore cost-effective approaches for vehicle/shipment tracking as value-added service enhancements, and as tools for asset management.

AREA 7: Developing and Deploying Strategies and Technologies for Enhancing Safety

Safety has always been a primary issue in the rail industry, and it was frequently mentioned by stakeholders interviewed for this effort. The FRA and the rail industry support research in this area to understand accident causality and develop and test countermeasures. Concerns include collisions between trains and between trains and motor vehicles; pedestrian incidents (including suicides); derailments; severe weather events; and terrorist attacks. Safety and security are clearly elements of the value proposition for rail investments because they are often the motivation for community resistance to new rail projects (and ongoing operations). Some project ideas suggested by stakeholders contacted in this research are listed here.

- *Develop lower-cost warning and grade crossing protection systems, including "second train coming" warning devices for multiple track territories, especially for populated areas and stations.*
- *Identify cost-effective actions to prevent derailments*, addressing infrastructure, equipment, operations, and human factors. Even if and as PTC is broadly implemented, it will not address all causes of derailments and other accidents. In particular, failures in rail and roadbed infrastructure resulting from extreme temperatures, high stresses, and erosion will remain sources of risks. Research on sensors to detect and report existing and incipient failures could produce high value.
- *Develop strategies for preventing and moderating the effects of hazmat spills and TIH risks.* Research in this area is a target of both FRA and AAR, focused on rolling stock designs and materials, secure infrastructure, as well as operations.
- *Explore and articulate general risk management options* (e.g., accident avoidance *vs.* outcome mitigation) to inform the policy process and communicate with the public.

AREA 8: Developing and Deploying Advanced Methods and Materials for Railroad Design, Rehabilitation, and Maintenance: Faster, Cheaper, and Better Methods

While stakeholders expressed considerable interest in this area, much work, past and present, is and has been supported by the FRA, AAR, the freight railroads, and equipment manufacturers. Therefore, important as it is, this area is not a primary target for NCRRP. Specific research areas are listed below for completeness.

- *Develop robust and cost-effective designs for critical rail infrastructure components*, including roadbeds, track and special work, structures, tunnels, signals and control systems, terminals and intermodal facilities. This includes analysis and design for new, heavier loadings and for resilience under extreme conditions. It also covers efficient methods for rehabilitation and replacement of aging facilities.
- *Develop and test advanced materials and methods for rapid infrastructure repair and rehabilitation* (see projects under the SHRP2 Renewal program).
- *Develop and test new materials and designs for freight rolling stock* (liquid and bulk carriers) to prevent or limit spills of hazardous materials in the event of accidents or derailments.
- *Identify and develop applications of remote and real-time condition monitoring* for rail infrastructure and rolling stock, taking advantage of recent advances in wireless

sensors and communications technologies. This might include development of real-time detection of rail anomalies sufficiently in advance of moving trains to permit safe stopping.

INTEGRATION: A POTENTIAL STRATEGY FOR NCRRP

NCRRP potential research strategy should meet several requirements. First, the major components should reflect the guidance of the stakeholders who contributed to this research. Second, based on the judgment of the oversight panel (who are also key stakeholders), the program managers, and the research team, the priority areas should have broad value and impact. These requirements suggest the importance of a research program that connects to national interests and goals.

Problem Areas 1 through 8 represent appropriate and valuable research targets for NCRRP going forward (see page 1 for listing). The earlier text provides examples of more specific projects under each of these categories. With the guidance of the oversight committee, these can serve as seed ideas for defining a more detailed program of priority projects.

There are several significant cross-cutting themes within these broader categories that provide the basis for defining a more streamlined and strategic research plan for the rail program. These cross-cutting themes include the following:

Assuring Safe and Sufficient Railroad Capacity

Assuring capacity for safe management of rail operations in congested and shared rail corridors is important for the good of the economy, improvement of services, and the sustainability of the industry. Adding capacity, and particularly right-of-way, is difficult and expensive. A key challenge is getting the most use out of existing capacity as demand increases. More recently, it has become clear that there is a need for strategies to restore services when unexpected disruptions, such as extreme weather events or accidents, occur. This work could produce:

- Operations research models that identify efficient or optimal strategies for shared right-of-way operations, considering a range of equipment and control technologies, and reflecting operations with and without PTC.
- Tools that jointly optimize maintenance and operating schedules, and that support routing decisions to minimize hazmat risks.
- Institutional arrangements, capacity valuation, and best practices for right-of-way sharing.
- Analysis tools to support operations and restoration strategies in the face of major external disruptions, particularly severe weather events. This work could include case studies that identify the consequences of alternative response strategies and best practices.

Defining the Rail Value Proposition

Quantifying the benefits of rail investments, facilities, and services can define the value of rail projects. A clearer and well-documented value assessment of rail projects, general and specific, can provide a stronger foundation for planning, evaluation, and building stakeholder support for both passenger and freight rail projects. This work would begin with establishing a theoretical and conceptual framework for estimating the value of rail passenger and freight projects; move on to empirical analyses; develop a portfolio of case studies at the local, regional, and corridor levels; and eventually produce a toolkit for project and service value analysis. The results of this work could address such issues as:

- Building support for equitable and cost-effective strategies for sharing rail capacity, based on valuation of capacity used for freight and passenger services.
- Building community support for both passenger and freight facilities and services by showing the value of community outcomes.
- Estimating the value of maintaining rail systems and facilities in a SGR.
- Assessing new markets and rail service improvements based on incremental values produced.
- Preparing conceptual and case-based studies of the public benefits and costs of investments in freight rail connectivity.
- Generating enhanced, practical evaluation tools to support regional planning for freight and passenger services.

- Estimating the local and regional benefits of rail freight improvements, including last-mile connections, to support planning and public investment decisions.

Elucidating the value proposition for rail facilities and services is a research area that is distinct from the work supported by other programs and sources. It would be a foundational product for NCRRP, producing data, analyses, and methods that can help to address a variety of problems identified by rail stakeholders.

Developing the Future Rail Workforce

While this is the subject of NCRRP Project 06-01, it was consistently highlighted by stakeholders as a major area of concern; and the scale of the challenge is likely to warrant ongoing research. Project 06-01 should provide a strong basis for additional work, which may take the form of pilot studies and experiments to assess the effectiveness of different strategies for attracting and retaining qualified workers. While the nature of future work should rest on the results of Project 06-01, these projects may become part of the workforce research area:

- Market research studies to measure attitudes and perceptions about rail industry career opportunities.
- Pilot studies and field assessments of best practices for partnering with training organizations to produce candidates for rail employment.
- Development of marketing messages that capture the technology basis for the modern rail industry.
- Development of approaches to capture and transfer the retained knowledge of experienced rail personnel.
- Design of strategies to attract college graduates in engineering, sciences, and management to railroading. These might include not only career-oriented marketing, but also funding for graduate study and research.

Sustaining Funding for Rail Facilities and Services

This is another much-studied challenge that shows no sign of fading in importance. Work in this area is likely to benefit substantially from results of the rail value proposition studies. This is based on the notion that, at a minimum, funding decisions will be directly influenced by credible estimates of the economic value linked to rail investments. Component projects may include:

- *An educational program, "Commuter Rail Finance 101," to inform local leadership about funding needs and options*. Lack of understanding of rail project costs, current financing schemes, and alternative arrangements is an obstacle facing funding decisions by the public and their elected representatives.
- *Strategies for using PPPs to finance rail investment and rehabilitation projects.* This is another well-studied area, but there is value in developing information directly salient to rail projects in the form of case studies and best practices.
- *Improved cost models of rail service*, particularly regional and corridor passenger services that reflect the true, fully loaded cost.
- *Case studies of the establishment and operation of dedicated funding sources* for (passenger) rail infrastructure and services.

Expanding the Markets for Passenger and Freight Rail Services

This is also a well-studied research area, but opportunities are changing as demographics shift, energy prices climb, and the logistics world adopts new models. Tracking success and failures can produce lessons for the future. This research thrust is also tied to development of the value proposition for rail, as markets follow and contribute to service values. This, too, is an area that is closely related to issues addressed in several other research programs, i.e., transit, freight, and airports. Elements of this program area could include:

- *Documentation of changing market demographics in current and potential commuter rail corridors*, as well as market responses to innovative rail services.
- *Identification of new market opportunities for regional passenger rail services* and assessment of responses to new services for such markets, using current and emerging big data sources.
- *Identification and evaluation of opportunities to apply advanced business practices for growing rail ridership:* marketing, applications of

social media, service enhancements, and value-added services.
- *Assessment of innovations to achieve seamless service concepts* in last-mile commuter rail and freight markets, focusing on both market response and successful funding mechanisms.

These five cross-cutting themes, carved from the eight broader research areas, are important for the rail industry and the customers (freight and passenger) that it serves. Discussions with stakeholders that contributed to the preparation of this research plan indicated a strong and clear public interest in the results of research in each of these areas. There is an understanding that, despite the fact that foundational work and in some cases much prior work has been accomplished in each of these areas, important and evolving questions remain to be addressed. Research on these topics is generally feasible and likely to produce results in several time frames: immediately useful products and results that will take longer to develop and grown in value.

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