



**Long Range Strategic Issues Facing the
Transportation Industry**
Final Research Plan Framework

Prepared for:

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Prepared by:

ICF International
9300 Lee Highway
Fairfax, VA 22031

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ABSTRACT

The transportation industry will face new and emerging challenges in the future, which may dramatically reshape transportation priorities and needs. During a three-month, intensive process, ICF conducted a literature scan and workshop with transportation experts to examine the major trends shaping the future and their interrelationships with transportation. These activities resulted in a framework for a new research program that will address long-range strategic issues facing the transportation industry. The goal of the framework is to anticipate the future issues that may be approaching so that transportation agencies are better prepared to *respond to new and emerging challenges*; and to explore visions of what the future should look like, so that transportation agencies can help *shape the future* through their decision-making. The report first identifies future issues and trends, based on a literature scan of work conducted by “futurists,” demographers, economists, and other experts. The report then outlines a set of research focus areas, problem statements, and possible projects or tasks, building off the future issues and trends and a discussion by a distinguished panel of transportation experts who were convened to address these issues. The five research areas are: 1) travel demand behavior, 2) advanced transportation system operation and performance, 3) sustainable transportation, 4) transportation finance, and 5) delivery of transportation services.

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1. INTRODUCTION

The transportation industry will face new and emerging challenges in the future, which may dramatically reshape transportation priorities and needs. The American Association of State Highway and Transportation Officials (AASHTO) Standing Committee on Research (SCOR) recognizes that research can help ensure that transportation practitioners are equipped to deal with future challenges facing the industry over the next 30 to 40 years. These challenges may derive from the impacts of major global trends, such as climate change, changes in the cost of fuels, and new technology, and from domestic trends, such as changing demographics and lifestyle expectations, changes in land use patterns, and limitations in current transportation finance methods. To support this effort, SCOR intends to allocate research funding to examine longer-term strategic issues, both global and domestic, that will likely affect Departments of Transportation (DOTs).

This document presents a framework for a new research program that will address long-range strategic issues facing the transportation industry. It first identifies *future issues and trends*, which may create new challenges for the transportation industry, based on a literature scan of work conducted by “futurists,” demographers, economists, and other experts. The report identifies a set of *research focus areas, problem statements, and possible projects or tasks*, building off the future issues and trends and a discussion by a distinguished panel of transportation experts who were convened to address these issues.

Process for Developing Draft Research Framework

This document was developed in a three-month, intensive process, in which ICF conducted a literature scan and conducted a workshop on August 19-20, 2008, with transportation experts to examine the major trends shaping our future and their interrelationships with transportation. Specific steps in this process are noted below:

1. *Research Scan* – ICF conducted a literature scan to identify major trends that may affect surface transportation in the future. The resulting “briefing” identified major thematic areas of inquiry and a structure for considering research needs, and served as a “read ahead” for discussions that took place at the workshop.¹
2. *On-line Survey* – ICF created an on-line survey of the invited workshop participants to gather preliminary thoughts on the major trends and issues of importance to transportation in the future.
3. *Workshop* – NCHRP hosted and ICF facilitated a workshop with transportation experts in Arlington, Virginia on August 19-20, 2008 to serve as a primary basis for developing the draft research framework, gain agreement on major thematic areas of inquiry; and develop initial draft problem statements and possible projects (See Appendix for a list of participants). ICF devoted substantial time to

¹ Available upon request

facilitated discussion sessions addressing the key themes identified from the literature review and draft research framework.

4. *Refining Research Framework* – Following the workshop, ICF developed workshop proceedings, and used the results to refine the research framework. This effort involved an analysis of crosscutting research issues that span the trend areas discussed at the workshop.

Goals for the National Cooperative Highway Research Program (NCHRP) “Future-Oriented” Research Program

The research framework presented in this document will serve as a basis for soliciting, identifying, and selecting research projects for funding by SCOR each year. Fundamentally, the research program will fund projects focused on a longer timeframe (30 to 40 years) than are typically examined in more traditional research programs. Although some of the future challenges facing the transportation industry are emerging today, the goal of this research program is to think outside of the current mind-set and look beyond the issues currently facing the transportation industry.

If you cannot accurately predict the future then you must flexibly be prepared to deal with various possible futures.

--Edward de Bono,
Serious Creativity

In developing the framework for the research program, it is therefore useful to consider the following two goals:

- 1) To anticipate the future issues that may be approaching so that transportation agencies are better prepared to *respond to new and emerging challenges*; and
- 2) To explore visions of what the future should look like, so that transportation agencies can help *shape the future* through their decision-making.

2. ANTICIPATED TRENDS AND FORCES AFFECTING TRANSPORTATION

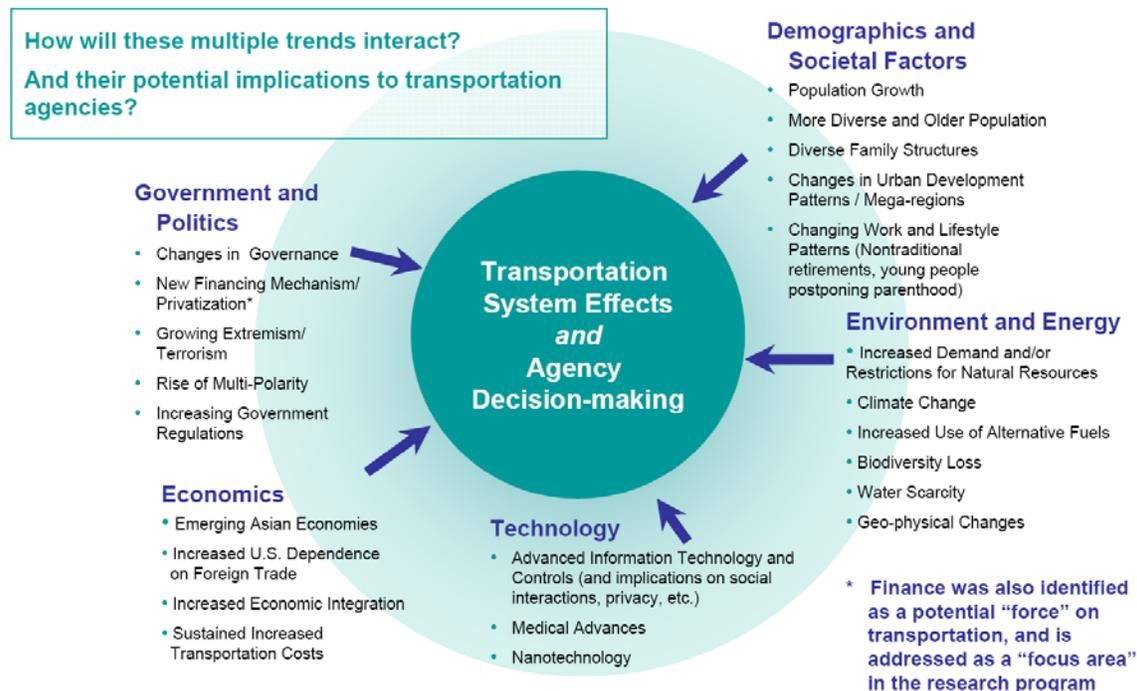
The future is difficult, if not impossible, to predict. The level of uncertainty about the future also increases with a longer timeframe; what may be more likely in a year may change dramatically within 10 years, much less 40 years. Although this research program does not set out to predict the future, it is important in developing a framework for future-oriented research to assess potential changes that could have significant effects on society, and transportation issues in particular. This section identifies several of the key domestic and global trends (external forces) that experts believe are likely to shape the future.

Anticipated Future Trends and Issues

Based on a scan of relevant literature on emerging domestic and global trends, and input from the expert panel, a wide range of factors and trends were identified that may have important implications on transportation in the future. The major trends are organized into five categories of “forces,” as shown in Figure 1. Each of these forces is described briefly below.

If one goes back 40 years and looked at the world of 1968, one would find large differences in the issues facing society and the focus of transportation policy. Could we have anticipated the vast changes in demographics, development patterns, technology, the economy, and world stability over this period? Moreover, would we have made different choices concerning transportation?

FIGURE 1: Key Forces and Trends Influencing Transportation²



Demographics and Societal Factors – The profile of America is expected to change substantially over the coming 40 years. According to the Census Bureau, the U.S. population is projected to increase to 438 million by 2050, more than a 40% increase from the 2008 population of 304 million. This population will be more ethnically diverse; over 80% of the projected population increase is attributed to immigrants and their descendents. The population will also be substantially older; it is estimated that more than 20% of the U.S. population will be 65 years or older by 2050, compared to 12.6% currently.³ The sizeable increase in population will create the need for more housing, employment, and services, which may lead to substantial impacts on travel patterns and demands. It is estimated that majority of the U.S. population will live in mega-regions, with more than 80% of the population in urban/metro areas, including suburbs.⁴ Baby boomers are expected to choose a ‘soft retirement’ and continue to work part-time beyond retirement age.⁵ Young people coming out of full-time education may increasingly choose to enter what they consider temporary, short-term jobs, which they use to finance international travel, volunteering in non-profit or arts-related careers, and/or continued education. These non-traditional workers are sometimes referred to as

² Initially, demographics and societal factors were included as two separate topics in the ICF literature review, but the experts at the workshop suggested combining these.

³ U.S. Census Bureau Forecasts released August 4, 2008, <http://www.censU.S..gov/population/www/projections/2008projections.html>

⁴ Deakin, Elizabeth. 2001. “Thinking about the Future: Sustainable Transport.” University of California-Davis Transportation Center. <http://www.uctc.net/trends>

⁵ Training Journal. 2008. “Learning & Development 2020: February 2008 Interim Findings.”

“Moofers” (Mobile Out of Office Workers). Potential changes in family structure, incomes, lifestyles, and social expectations may also occur.

Environment & Energy Issues – Environmental and energy issues may play an increasingly important role in society, due to increased competition for natural resources (as economic inputs and environmental goods), the impacts of climate change, and a potential shift from traditional fossil fuels to alternative sources of power. The increased cost of traditional materials as inputs for projects could also affect transportation agencies’ ability to provide services affordably; these can be related to supply issues, regulatory burdens, or increased demand. For example, energy consumption is expected to continue to increase, especially within the transportation sector and largely outside the developed world. The Energy Information Administration forecasts that world energy consumption will grow by 50% over the 2005 to 2030 period; only 15% of this growth will be within the developed world.⁶ Consequently, world carbon dioxide (CO₂) emissions are projected to increase from 28.1 billion metric tons in 2005 to 34.3 billion metric tons in 2015 and 42.3 billion metric tons in 2030.⁷ In the U.S., energy-related CO₂ emissions are projected to grow by about 16% to 6,851 million metric tons in 2030.⁸ Changes in the supply and price of fossil fuels and emerging policy related to climate change, however, could dramatically alter this scenario. Impacts of climate change and other environmental challenges could also have significant impacts on settlement patterns. In particular, water scarcity and biodiversity issues are anticipated to grow in importance. It is estimated that by 2025, nearly 2 billion people will be living in countries or regions with absolute water shortage, where water resources per person fall below the recommended level of 500 cubic meters per year.⁹

Technology – Technology has rapidly advanced over the past several decades, and the future promises even more and potentially greater changes in technology, which offer the potential to enhance communications, health, safety, and quality of life. Increased capability and access to information and communications technology (ICT) will offer unprecedented amounts and variety of data, and even greater interaction among people independent of geographic location, with implications on public expectations for information. Public knowledge is continuing to invade the once tightly regulated world of journalism, and as a result, citizen reporting is emerging as a linkage between the daily news and public opinion.¹⁰ Widespread surveillance of private individuals is more commonplace; active video surveillance systems are in Chicago, IL; New York City, NY; Washington, DC; Tampa, FL; and other cities around the U.S. Use of the internet as a

⁶ U.S. Energy Information Administration. International Energy Outlook. 2008.

<http://www.eia.doe.gov/oiaf/ieo/highlights.html>

⁷ International Energy Agency. 2005. “30 Key Energy Trends in the IEA & Worldwide.” p.16.

https://www.iea.org/textbase/nppdf/free/2005/energy_trends.pdf

⁸ US Energy Information Administration. Annual Energy Outlook 2008: With Projections to 2030.”

<http://www.eia.doe.gov/oiaf/aeo/overview.html>

⁹ World Health Organization. Water Fact File.

http://www.who.int/features/factfiles/water/water_facts/en/index2.html

¹⁰ Cetron, Marvin J. and Owen Davies. 2008. “55 Trends Shaping Tomorrow’s World Forecasts and Implications for Business, Government, and Consumers.” The World Future Society.

primary social and communication tool has become a basic part of life for many people. Dubbed “Social Networks 2.0,” the trend began in the early 2000s when a business-like approach to allowing users to organize recreational and business networks began to dominate the internet. Medical advances, especially in genetics, are revolutionizing prevention and treatment from the species level to individual level.¹¹ Nanotechnology maximizes other research gains through its small size characteristic. How these advances function on a small scale may affect the elemental properties of color, conductivity, or magnetic qualities, allowing for new applications, as well as data collection. Technology will affect how agencies design, construct, and maintain their transportation facilities. Materials with data receptors could inform transportation planners of travel demand at all times, combining ICT and nanotechnology technologies seamlessly. Technology may also enable improved environmental performance (e.g., zero emissions vehicles), safety, and accessibility.

Economics - Just as an efficient domestic transportation system is critical to the health of the U.S. economy, the strength and structure of the domestic economy, and its relation to world markets, is a critical factor in the organization of the transportation system.¹² The U.S. economy is more linked than ever before to an international marketplace that is constantly seeking the most cost-effective manner for transporting goods and services on a global scale. As America’s increasingly services-based economy adapts to an evolving international landscape in which Asia’s emerging economies are showing tremendous growth in exports and domestic demand, so, too, will transportation routes, volume, and costs adjust in accordance to changing economic conditions. Goldman Sachs estimates that China could surpass the U.S. as the world’s largest economy in less than 30 years.¹³ China’s economic growth was recorded at 11.4% in 2007 while India’s was 8.5%.¹⁴ These economies are already increasing the competition for resources, and may create new challenges and opportunities for the American economy. The continued flow of international goods and services, however, is increasingly dependent on complicated supply chains that are only viable given certain transportation price points. The relative price of transportation in terms of total production cost will affect the exchange of goods and services; likewise, economic comparative advantages will determine the nature of future transportation needs.

Government & Politics - The forces of globalization, government regulation, and idealistic extremism of nationalist and religious natures (e.g. terrorism) are expected to be key political trends that will shape the future. The rise of multi-polarity driven by the emergence of Russia, China, India, Iran and the independence of the European Union

¹¹Gottlieb, Scott. 2003. “The Future of Medical Technology.” The New Atlantic. Spring 2003.

<http://www.thenewatlantis.com/publications/the-future-of-medical-technology>.

¹² Lockwood, Steve. 2007. “Factors Affecting the State of Our Transportation Infrastructure.” 2007 James L. Oberstar Forum. <http://www.cts.umn.edu/Events/OberstarForum/2007/documents/lockwoodpaper.pdf>

¹³ Goldman Sachs. 2003. “The BRIC’s Path to 2050: A Dramatically Different Global Economy.”

http://coursenligne.sciences-po.fr/2005_2006/gouvernance/braga/cours_1_brics.pdf

¹⁴ Economic Commission for Africa. 2008. “Recent Economic Trends and Prospects for 2008.”

<http://www.uneca.org/era2008/>

likely will transform the geopolitical landscape.¹⁵ As society becomes more complex and globally integrated, the political process for many countries may be unable to produce good decisions in a timely fashion.¹⁶ The number of free countries grew from 46 to 90 over the past 30 years, of which those countries' populations account for 46% of the world's population. For the past several years, 64% of countries have been electoral democracies.¹⁷ In the U.S., a growing amount of debt is coinciding with massive government expenditure requirements on entitlement programs for the aging population.¹⁸ In addition, public expectations about the role of government and the ability of government to finance public services may change. Specific to transportation, the gas tax as the traditional transportation finance mechanism is failing to keep up with rising demands, and this is likely to be exacerbated in the future. Society is becoming increasingly more regulated, and the proliferation of safety, security, environmental, work force, and other regulations will likely continue. In 1996, the U.S. Congress passed regulatory reform laws intended to slow the proliferation of government regulations. Nonetheless, by 2001 more than 14,000 new regulations were enacted.¹⁹ A study by the Congressional Office of Management and Budget estimated that the annual cost of major federal regulations enacted from 1992-2002 amounted to between \$38 billion and \$44 billion per year. However, the estimated benefits of those regulations added up to between \$135 billion and \$218 billion annually.²⁰

Independently, and in combination, these trends may have significant implications on the transportation system. It is important to note that many of the trends and forces affecting the future are interrelated. For instance, societal and political factors may be in response to underlying changes in technology and economic structure. Indeed, the impacts of some trends in combination could have synergistic effects and increase the timing or magnitude of effect; others could have antagonistic or offsetting effects.

Determining What Issues Are Important

In developing a framework for the future-oriented research program, several dimensions are important to explore.

Magnitude / Importance of Potential Impacts - External forces and trends will have important implications on the transportation system, including the level and distribution

¹⁵ Strategic Foresight Group. "Global Security and Economy: Emerging Issues Report." January 2008. http://www.strategicforesight.com/Global%20Security_Economy%5B1%5D.pdf

¹⁶ Cetron, Marvin J. and Owen Davies. 2008. "55 Trends Shaping Tomorrow's World Forecasts and Implications for Business, Government, and Consumers." The World Future Society.

¹⁷ Puddington, Arch. 2008. "Findings of Freedom in the World 2008 -- Freedom in Retreat: Is the Tide Turning?" Freedom in the World. Published by Freedom House. <http://www.freedomhouse.org/uploads/fiw08launch/FIW08Overview.pdf>

¹⁸ Kelderman, Eric. 2007. "Report: Tolls Can't Meet Future Highway Needs." Stateline. 8 March <http://www.roadsbridges.com/Tolls-can-039-t-meet-needs-of-future-highway-funding--NewsPiece13180>

¹⁹ National Intelligence Council. 2004. "Mapping the Global Future: A Report of the National Intelligence Council's 2020 Project." http://www.dni.gov/nic/NIC_globaltrend2020.html

²⁰ National Intelligence Council. 2004. "Mapping the Global Future: A Report of the National Intelligence Council's 2020 Project." http://www.dni.gov/nic/NIC_globaltrend2020.html

of passenger and freight travel demand, traveler safety and security, vehicle operations and highway capacity, among others. These transportation system effects in turn will have a variety of implications for transportation agencies' activities and decisions, including how transportation agencies plan for infrastructure, develop projects, maintain, and operate the transportation system, finance projects and programs, and the organization and operation of transportation agencies. Having a sense of the potential scale of changes that may occur, and their potential effect on transportation, is important to determine the focus of the research program. For instance, some emerging issues and trends may have somewhat limited effects on transportation (e.g., medical advances may have an indirect effect on transportation safety, fatalities, etc.) while others may have direct and important implications (e.g., potential dramatic increases in fuel prices). The magnitude and importance of potential transportation impacts, therefore, should influence what research is funded.

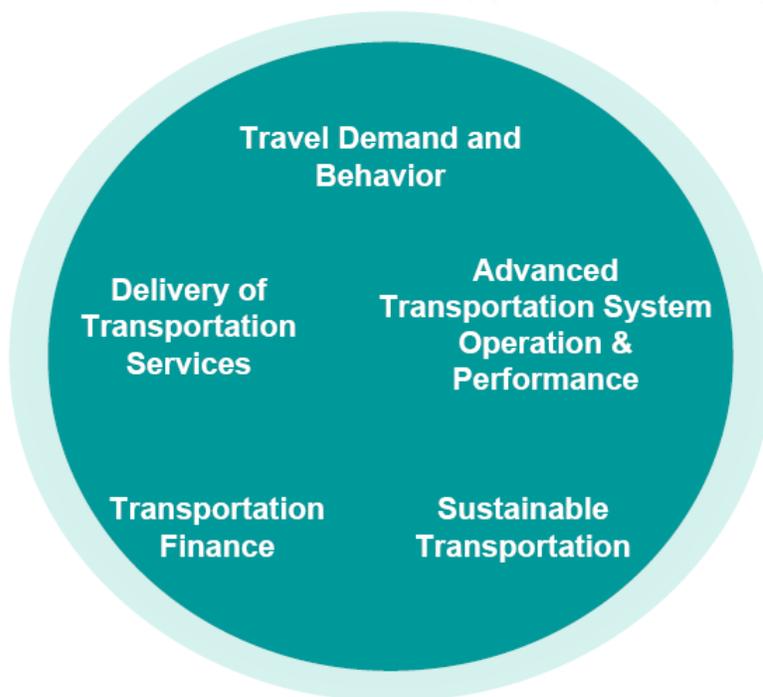
Uncertainty / Likelihood of Impacts - In combination with magnitude, the certainty of impacts is an important consideration. Some trends are highly uncertain (particularly political, technological, and social changes), while others have greater likelihood of taking shape (e.g., population growth, demographic changes, climate change). As noted above, many forces are contingent on, or changed and accelerated by, other forces. Assigning a degree of uncertainty is relevant particularly once the potential impact has been considered and weighed. For instance, a high level of uncertainty regarding a factor that can have a major impact is associated with more risk than a factor where there is a lower level of uncertainty and smaller impact.

3. RESEARCH FRAMEWORK

While the five categories of trends/issues identified in the previous section could serve as a framework for the research program, the experts participating in the workshop and ICF recognized that it is important to examine the crosscutting linkages between trends and forces that will affect transportation in the future. For instance, changes in population, the economy, and technologies will likely have implications on where Americans live, how much they travel, and their expectations regarding travel choices. Focusing the research program around each type of change independently might not address the broader and important crosscutting and cumulative issues.

As a result, the ICF research team examined the various categories of trends, scenarios, and issues associated with these changes, based on the literature review and workshop discussion, to develop a research framework organized around broad issues that are likely to face the transportation system and transportation agency decision-making in the future. This framework has five research *focus areas*, as identified in Figure 2 and described below:

FIGURE 2: Five Research Focus Areas



Travel Demand and Travel Behaviors – Changes in demographics, economic structure, and technology, as well as the cost of fossil fuels, may have important implications on both passenger and freight travel demand. This research will focus on understanding the fundamental changes that might occur in travel demand, developing tools or methods to better assess long-range future demands, and understanding how changes in travel

behaviors and expectations (passenger and freight) may affect transportation planning and program delivery in the future.

Advanced Transportation System Operations and Performance – New vehicle technologies, materials, and communications, as well as social and political forces, may affect the way in which highways, transit, freight rail, and other modes of transportation are designed, operated and interact. This research will focus on understanding how technological, social, and economic changes may affect system operations – in terms of mobility, safety, and reliability – and on developing methods to foster adoption of technologies and institutional approaches to optimize transportation system performance. This research also addresses the changes in hardware materials (design, construction, and maintenance of transportation facilities) and systems as well as the software areas of analysis and optimization.

Sustainable Transportation – Issues associated with energy, natural resource depletion, climate change, and other environmental issues are likely to grow in importance and create motivation for changes in transportation activities and agency decision-making. Sustainability is a term that focuses on the balance amongst economic, environmental, and social concerns, and developing and providing a system that can be sustained over the long-term. This research will focus on understanding the impacts of environmental change (e.g., climate change, reduced biodiversity, major geological events, etc.) on the transportation system, and fostering decision-making approaches to address these issues, integrating economic, environmental, and equity concerns.

Transportation Finance – No matter how impressive the best transportation plans are, it can be impossible to realize them without sufficient/appropriate funding. The ability to pay for transportation facilities and services remain a top concern of decision-makers. Furthermore, alternative funding mechanisms, such as user fees, congestion pricing, tolling, and sales taxes have become more prevalent as a funding solution. This research will focus on issues such as the federal level budget competition, the decline in traditional mechanisms for funding, and the public’s willingness to pay for public goods.

Delivery of Transportation Services – Transportation agencies deliver transportation services and related information in a variety of ways. However, some of the traditional methods may be less effective over the coming decades. ICT developments may dramatically affect public involvement and transportation agencies abilities to intersect with the public. With the growth of mega-regions and an increasingly interconnected economy, solutions are not confined to just one jurisdiction. This research will focus on how best transportation agencies can capitalize on new public involvement strategies, leverage multi-jurisdictional decision-making, and other related internal decision-making options (e.g. agency workforce and operations).

Figure 3 illustrates some examples of how the major trends from the literature review are linked to the research framework’s focus areas. Please note that even though each square (linkage) is filled, it does not identify the importance of such a linkage. For example, sustainable transportation, historically, has focused on the environmental aspect, and may have a more indirect connection to other trends and issues. These linkages are not exhaustive, but a sampling.

FIGURE 3: Anticipated Trends and Research Focus Areas Connections

		<i>EXTERNAL TRENDS AND FORCES</i>				
		<i>Demographics & Societal Factors</i>	<i>Environment & Energy</i>	<i>Technology</i>	<i>Economics</i>	<i>Government & Politics</i>
RESEARCH FOCUS AREAS	<i>Travel Demand & Behaviors</i>	<ul style="list-style-type: none"> - Population growth - Aging and more diverse population - Impaired and distracted driving - New retirement and recreational patterns 	<ul style="list-style-type: none"> - Changes in settlement patterns due to environmental issues (water, climate, geological changes) - Changing energy prices and supply 	<ul style="list-style-type: none"> - Ability to substitute trips with technology - Use of GPS and other technologies that affect travel behavior 	<ul style="list-style-type: none"> - Changing structure in the nature of economic activity - Changing income 	<ul style="list-style-type: none"> - Increasing level of government regulations regarding safety, the environment, etc.
	<i>Advanced Transportation System Operations and Performance</i>	<ul style="list-style-type: none"> - Increasing mega-regions - Changing social values about security and safety issues 	<ul style="list-style-type: none"> - Increased competition for natural resources - Increasing focus on climate change and its impacts - Changing energy sources and supply 	<ul style="list-style-type: none"> - Increased capability and access, including improved real-time information - New technologies to enhance safety, reliability, etc. 	<ul style="list-style-type: none"> - Changing structure in the nature of economic activity - Changing economic value of transportation 	<ul style="list-style-type: none"> - Increasing level of government regulations - Government finance/privatization
	<i>Sustainable Transportation</i>	<ul style="list-style-type: none"> - Population growth - Increasing mega-regions 	<ul style="list-style-type: none"> - Climate change - Changing energy sources and supply - Water and ecosystem diversity issues - Interest in recycling, minimizing footprint 	<ul style="list-style-type: none"> - Increased capability and access 	<ul style="list-style-type: none"> - Increased U.S. dependence on foreign trade - Sustained increased transportation costs 	<ul style="list-style-type: none"> - Government finance/privatization - Democracy and governance
	<i>Transportation Finance</i>	<ul style="list-style-type: none"> - Population growth - Public willingness to pay 	<ul style="list-style-type: none"> - Changing energy sources and supply affecting traditional finance mechanisms 	<ul style="list-style-type: none"> - Technological advances allowing new pricing mechanisms - Increased capability and access 	<ul style="list-style-type: none"> - Increased economic integration - Sustained increased transportation costs 	<ul style="list-style-type: none"> - Privatization - Public-private partnerships
	<i>Delivery of Transportation Services</i>	<ul style="list-style-type: none"> - Workforce and educational issues - Mega-regions 	<ul style="list-style-type: none"> - Changing energy sources and supply 	<ul style="list-style-type: none"> - Rapid pace of technological advances - Increased capability and access 	<ul style="list-style-type: none"> - Changing structure in the nature of economic activity 	<ul style="list-style-type: none"> - Increasing level of government regulations

Identification of Research Needs and Project Ideas

For each research focus area, the sections below identify trends motivating the research focus, problem statements, and possible research projects. Informed by the workshop participants, the problem statements identify research needs for further inquiry, and possible project or task ideas are identified under each problem statement.

In developing problem statements, it is useful to consider the types of research that will be needed within this program:

- *Fundamental Knowledge* - Basic research will be needed to understand the fundamental relationships between transportation systems, infrastructure, human behavior, the environment, the economy, land use, and communities. In the context of a future-oriented research program, fundamental knowledge involves more than understanding existing relationships. It involves exploring how relationships may change, and may involve conducting scenario analysis, or “what if” analysis, to assess the potential range of possible future scenarios.
- *Analytical Tools and Methods* - Research on tools and methods involves exploring effective techniques for data collection, modeling, and other technologies to help transportation agencies better assess future needs or adapt to potential alternative futures. It also involves exploring potential new methods for constructing, maintaining, and operating the transportation system in the context of future trends. This type of research focuses on ensuring access to appropriate data to support analysis; integration of analysis tools, including new forecasting tools; and methods to better communicate the results of analyses to the public and to decision-makers. The research will also include performance-based standards to stimulate innovation and test methods required for their use.

Role of Forecasting and Scenario Analysis

Research addressing current transportation challenges often begins with a literature review to identify existing knowledge or a scan of existing practices, which serve as the building blocks for developing new approaches, tools, or best practices.

While the future-oriented research program may also rely on and build on these techniques, it will also need to rely more heavily on scenario analysis and risk assessments to ask:

- What do we anticipate may occur in the future?
- How important might these effects be? In addition, how certain are these effects?

This leads to questions such as:

- How can transportation agencies be better prepared to address anticipated and unanticipated future challenges?
- How can transportation agencies be innovative in embracing advancements? Moreover, how can transportation agencies develop a vision of the future so that institutions and decision-making structures support the achievement of this vision?

- *Institutional and Implementation-oriented Research* - This research is designed to explore new ways for institutions like transportation agencies to improve decision-making, building on fundamental knowledge and tools and methods. This type of research focuses on organizational structures and approaches, and may involve developing strategies or visions for how transportation agencies can help to shape the future.

For each research focus area below, in addition to problem statements and examples of possible projects, the sections below identify how the work under this program would differ from research under existing programs.

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Travel Demand and Behaviors

Future Challenges Motivating this Focus Area:

Transportation demand is a function of the number and types of people in an area, their lifestyles, and economic structure and activity. Many issues over the next 30 to 40 years will change the population's transportation needs, travel patterns, and expectations regarding mobility. These include changes in demographics (e.g. population size, affluence, ethnicity, age, etc.) and technologies that substitute or alter travel behaviors (e.g. telecommuting opportunities or mode shifts). In addition to passenger travel, changes in global and national economic activity, fuel prices, and policy will influence freight travel demand. The interplay between these issues is important as well. The effects of some trends, such as population growth, may mitigate or amplify the effects of others, such as the aging population or migration.

In 2050, the U.S. population will be significantly larger, older, and more ethnically diverse than today. Clearly, these trends may dramatically influence transportation demands and patterns. Some of these trends suggest a dramatic increase in mobility needs – the addition of over 130 million more Americans in the next 40 years, medical advances that enable older Americans to have increasingly active lifestyles, and shifts in the growth areas within the U.S. suggest surging travel demands. At the same time, it is plausible that travel demands will not increase substantially, due to enhancements in information and communication technologies, changes in land use patterns (e.g., movement to urban, pedestrian-oriented areas that minimize vehicle travel demands), increases in fuel prices, and changes in attitudes toward transit and alternatives to driving. Furthermore, if a majority of the population increase is from immigrants, then their transportation habits may differ. The patterns of travel could also change substantially, with travel increasing for different types of trips, in different locations, and at different times than currently.

Similarly, freight demand could increase dramatically due to rising wealth and continued increasing global trade. On the highway system, there is an average of 10,000 trucks per day per mile currently. By 2035, it is projected that there will be an average 22,700 trucks per day per mile and the most concentrated areas will see close to an average 50,000 trucks per day per mile.²¹ Alternatively, freight patterns could shift considerably if there are dramatically higher fuel prices, global protectionism, or other changes.

How this Differs from Other Research Programs:

This research area seeks to look beyond current travel behaviors to understand fundamental ways in which travel behaviors and patterns may change in the future, and what these changes may mean in terms of transportation system needs. It will also help to address technological advances and their social/institutional adoption. It will build on

²¹ Lockwood, Steve. "Factors Affecting the State of Our Transportation Infrastructure." 2007 James L. Oberstar Forum. <http://www.cts.umn.edu/Events/OberstarForum/2007/documents/lockwoodpaper.pdf>

research in the Travel Model Improvement Program (TMIP), the Freight Analysis Framework, other Federal Highway Administration (FHWA) research programs, the NCHRP and NCFRP programs, and other programs addressing demographic changes and travel behavior.

Problem Statements:

The following problem statements aim to investigate the impacts of these trends on travel demand and behaviors.

Examine the long-term interplay between changing demographics, lifestyle choices, affluence/wealth, and settlement patterns on personal transportation demand. Develop improved tools for scenario analysis and forecasting that account for these considerations.

Long-range transportation planning being conducted by States and Metropolitan Planning Organizations takes an outlook of 20+ years into the future, but is largely based on the current relationships between demographics, land use patterns, and travel activities. A wide range of demographic, social, technological, and economic changes are likely to affect travel demands and patterns in the future. These changes, and their fundamental relationships to travel demand, are currently not well understood.

This research would focus on understanding the fundamental relationships between social, demographic, and economic factors and travel demands. These include effects such as increasing diversity, aging and retirement patterns, personal wealth, increasing immigration and its impact, increasing mega-regions, changing regional migration patterns, and the decreasing size of households and changing family structures. It would also help to develop more accurate tools and approaches for forecasting travel demand and behavior.

Possible Projects or Tasks

- Conduct a detailed disaggregated comparative analysis of elderly citizens' travel patterns in several settings (rural, urban, and suburban) with attention to demographic and cultural characteristics. Also, include retirement lifestyle trends, such as partial retirement, etc.
- Investigate the predicted effects of immigrants and immigration patterns on travel demand, travel patterns, and needs of the transportation system. In particular, identify if immigrant settlement trends will overlap with those of the younger generations and influence transportation demand.
- Analyze shifting patterns of population growth and personal income and its effect on transportation demand/needs. Include the relationship of demographic change to economic change and the distribution of economic opportunity, such as housing affordability.

- Analyze potential scenarios of changing demographics, energy prices, and technologies, and potential implications of major environmental forces, such as the impacts of climate change, including sea level rise, increased hurricanes, and water scarcity, on settlement patterns. Research trends for movement to mega-urban areas and trends for movement to rural (remote) areas for jobs, recreation, and/or retirement. Use information on anticipated regional population growth to determine the areas that will likely experience increased travel demand and to what degree.
- Examine a sample of existing long-range transportation and land use plans from metropolitan areas to assess to what extent they account for potential changes in development patterns and travel demands in response to changing demographics, technology, climate change, and other factors.
- Develop improved travel demand forecasting models or approaches to modeling, which account for the potential influence of long-range changes in factors affecting travel demand; this may include a structure for developing regional scenarios, accounting for risks and uncertainties regarding technologies and other factors.
- Assess long-term risk from political and social extremism on transportation demand and habits (for example, foreign nationalization of oil reserves or other limited resources or domestic protests around VMT reduction).

Examine the potential influence of technologies, including those that rapidly affect human interactions and social considerations, on travel behavior.

This research concerns technologies and social considerations that will affect travel demand and behaviors. It would explore technologies that may affect travel demand, such as advanced communications technologies, which offer greater potential for telecommuting, and substitution of other types of trips, including those for educational, medical, and social activities. It would also address social factors, such as the values of younger generations and immigrants, factors affecting distracted or impaired driving (either due to age, substance abuse, or the proliferation of communications technologies), and shifts in preferences toward different forms of mobility.

Possible Projects or Tasks

- Conduct a scan to identify current, emerging, and under-development technologies that offer the potential to reduce or shift travel demand significantly. Examine the direct and indirect impact of mechanisms that trade travel to work, retail, etc. for something else (e.g., home-shopping, working in cafes, webinars, on-line courses). Identify what types of trips are likely to be affected, by what groups of people (e.g., by age cohort, other demographics), and whether unintended effects are possible (e.g., increases in trip making due to increased social connections). Examine the extent to which existing communications

- technologies, such as computers, cell phones, etc. have or have not affected travel demand, and how these interplay with economic and other trends.
- Explore the values of Generation X, and Generation Y, and its effects on travel trends (e.g., work and recreational travel).
 - Using information of past societal trends, develop a model to predict how different age groups and/or income brackets will respond to potential changes for regional or statewide transportation systems.

Examine the role of freight, and potential changes in goods movement in light of changing economic systems and demand. Develop improved tools for scenario analysis and forecasting that account for these considerations.

The U.S. transportation system has long served as a catalyst for American economic activity; likewise, the growth of the American economy has stimulated expansion of the domestic transportation system.²² With the growth of just-in-time freight delivery and the shifting of shipping routes to more concentrated freight corridors, however, the needs of the economy are exerting pressure on a congested transportation system. Changes in trade dynamics, including a growing demand for imports in developing economies, will affect not only how many goods need transporting, but also where those goods will need to go. If multinational companies continue to use increasingly complicated supply chains to assemble goods from disparate locations, higher shipping costs and declining freight capacity could affect the origin, destination, and mode of freight traffic.²³

Possible Projects or Tasks

- Examine broad global changes and economic shifts, and their effects on freight imports/exports, including entry/exit, destination, and cargo/truckload information. Examine how the range of potential structural changes in the economy brought on by changes in energy prices, global economic changes around the world, and advances in technology, could affect the transportation sector. In particular, explore the demands of emerging Asian economies, and foreign trade. Pay attention to proposed governmental regulations and shifting public opinion regarding free trade, globalization, and international relations. Conduct scenario analysis to assess potential changes in freight movement.
- Explore changing economic structure within the U.S., and its effects on economic activity across different regions and industries. Conduct a meta-analysis of demand forecasts for a 30 to 40 year period, and analyses of freight infrastructure and operational needs.

²² Lockwood, Steve. "Factors Affecting the State of Our Transportation Infrastructure." 2007 James L. Oberstar Forum. <http://www.cts.umn.edu/Events/OberstarForum/2007/documents/lockwoodpaper.pdf>

²³ "Summary Report: 8th Annual Freight and Logistics Symposium." 2004. <http://www.cts.umn.edu/Publications/pdf/Proceedings/logistics/2004-FLOGSymposium.pdf>

- Explore the implications of changes in energy prices on efficient freight movement, in particular, exploring shifts among modes and different ways of structuring the economy.
- Explore the implications of and the public attitudes towards a long-term shift of locally grown food on the freight system (i.e. growing food close to home as a way of improving global sustainability).

Develop “model” multi-modal transportation planning and policy approaches to address coming changes in travel demand, and to shape future passenger and freight travel in ways that improve access, mobility, and economic productivity.

In addition to understanding what changes may occur in the future in regard to travel demand, it will be valuable for transportation agencies to consider how their investment decisions, policies, and programs can help shape long-term travel demands and mobility needs, in light of increasing population, environmental pressures, and other considerations. This research would set out to develop a visioning approach that states and regions could use to foster desired outcomes.

Possible Projects or Tasks

- Consider actions transportation agencies can take to manage travel demand more effectively, including pricing mechanisms, incentives, use of technology, and effective integration of transportation and land use.
- Research the ability of leveraging social networking mechanisms to better organize/rationalize trip making.
- Develop approaches to partner with land use planning, economic development, and other agencies to help foster improved access and economic vitality while minimizing negative externalities.

Advanced Transportation System Operations and Performance

Future Challenges Motivating this Focus Area:

Changing development and travel patterns, as well as increasing population, will put stresses on the existing transportation system, but new technologies also offer potential new ways to meet traveler needs and expectations more efficiently and effectively. New vehicle technologies, materials, and communications offer the potential to advance the operation and performance of transportation systems and support renewal and preservation of existing transportation infrastructure. The prevalence of communications technologies offers the potential for real-time traveler information for not only traffic information, but also transit services, and connections between individual travelers to optimize system capacity. Advancements in materials science can help to make transportation facilities perform better and over longer periods. GPS systems, automated vehicles, and other advanced technologies also offer the potential to reroute travelers to avoid delay, reduce crashes and improve overall safety, and increase reliability. The advances in intelligent transportation systems (ITS) are enormous through the combinations of these technologies. New materials and construction and maintenance approaches also offer the potential to preserve transportation infrastructure effectively.

How this Differs from Other Research Programs:

This research area seeks to look beyond current approaches for preserving, managing, and operating the transportation system, and address the potential of new technologies and approaches to create a more efficient and effectively performing transportation system. This work will build upon current research by the Strategic Highway Research Program II focus areas of Reliability, Safety, and Renewal, as well as the FHWA's efforts to advance operations.

Problem Statements:

The following problem statements aim to investigate the impacts of these trends.

Study the range of multi/inter-modal connectivity options, focusing on how to optimize different forms of system capacity, improve reliability, and create a seamless transportation system.

After the interstate highway system was completed, federal transportation policies began working toward a new goal—part of which was an intermodal system. This policy change has been furthered by an increased focus on transportation network connectivity and corridor plans to integrate these modes. Unfortunately, the goal of a complete multi- and intermodal system has not yet been realized. As recently as 2007, the Government Accountability Office identified many barriers, one of which is agencies' need for further

guidance on creating it.²⁴ Some possible topics could include an integrated funding source, greater coordination with local transportation planning activities, and evaluation tools for multimodal and intermodal projects.

Possible Projects or Tasks

- Define the likely technological characteristics of desired future multi-modal transportation systems in order to provide a framework for areas where technological improvements could be developed by a non-transportation entity.
- Assess the flexibility within current federal regulations (e.g. regulations on spending federal funds) to address the transportation needs of the future. Develop possible organizational structures that may best support multi-modal travel and goods movement and what actions would lead to such organizations. This may include assessing the potential for interagency cooperation and analyzing societal trends toward a preference for more sustainable and environmentally friendly development practices.
- Study how the domestic transportation system and the global transportation system interact to create (or dissipate) value from the public perspective. Note the state of current and anticipated international affairs in order to determine the potential for transportation connectivity on a global scale. Create an adaptive modeling system involving all players in transportation (pedestrians, business, shippers, system operations, police, etc.) in order to facilitate intelligent and adequate designs for future systems. This may include attention to changing social values regarding security and safety issues as well as issues with government finance and the potential for privatization in the transportation sector.

Develop a framework for transportation agencies to advance adoption of new technologies to improve system infrastructure, operations, and performance.

This research problem explores the variety of options that transportation agencies may use to capitalize on technology to preserve the transportation system and improve transportation system performance. For instance, there is potential for creation of better and longer-lasting materials for transportation facilities. The advent of greater capacity and access through information and communication technology allows for enhanced traveler information, instant re-routing, and establishing practical user fees. Future technologies offer even greater potential to improve safety, reliability, and mobility, and create a “truly” intelligent system that dynamically responds and adjusts to system demands (e.g., advanced traffic control systems, traveler information, and vehicle communications). Furthermore, this area involves not only adoption of technologies by transportation agencies, but ways in which transportation agencies can anticipate and help shape research and development of vehicle technologies, communications technologies,

²⁴ U.S. Governmental Accountability Office. 2007. “Intermodal Transportation: State DOTs Could Take Further Actions to Address Intermodal Barriers.” GAO Report 07-718
<http://www.gao.gov/new.items/d07718.pdf>

and other products that are not implemented by transportation agencies but affect transportation system performance. There are many questions to determine how best to integrate the future of transportation services with the future of technology: How to spread the technology use throughout an agency or through the public? What can reduce barriers to the implementation of certain technologies?

Possible Projects and Tasks

- Conduct an in-depth, ongoing scan to evaluate emerging technologies in non-transportation scientific areas applied to transportation needs. Assess these trends in the context of the evolutionary trajectory of vehicle technology. Investigate dual-mode guideways (i.e. cars that can be driven on ordinary roads but that can also become part of a system-controlled guideway) with particular attention to safety and mobility issues. Note the rapid pace of technological advances as well as rising energy prices and increasingly more attention to and support for environmentally friendly options.
- Characterize citizens' views about legal dimensions of privacy in the data obtained in the management, operation, and charging for transportation system use. Note the changing social values regarding security and safety issues. This may include reviewing the role of technology in terms of the pace at which it facilitates transfer of information between consumers and transportation agencies.
- Examine the societal resistance to vehicle technology application (e.g., black boxed, DUI, navigation, ITS, pricing mechanisms, etc.) and mechanisms for lessening resistance. Note the trends in demographics, including the level of technological sophistication, and increasing immigrant population, which may present language communication barriers.

Sustainable Transportation

Future Challenges Motivating this Focus Area:

New environmental challenges, including the impacts of global climate change, water scarcity, and loss of biodiversity are putting new pressures on transportation agencies, and society as a whole, to develop new, and more sustainable ways of operating. Businesses in other sectors are moving towards to sustainable actions because they have a solid business case and competitive advantage for doing so; the same business case can be made for transportation agencies. In its most basic sense, sustainability means meeting the needs of the present without compromising the ability of future generations to meet their own needs.²⁵ Sustainability activities require balancing environmental, economic, and social equity.

A number of future trends will likely affect sustainable transportation. As the American population is expected to grow substantially, the demand on the national transportation system will increase greatly, potentially increasing the environmental impacts of the system. An additional concern is how energy prices may escalate into the future. Many economists offer substitution as a solution, but with fuel infrastructure, this may be a more difficult process for the transportation industry. Furthermore, it seems likely that as environmental concerns increase with such issues as climate change, that regulations to address these issues will proliferate as well. Environmental regulations can dramatically affect the availability of the most basic construction materials, further constraining transportation improvements. Most recently, the U.S. Supreme Court ruled that EPA had the authority to regulate greenhouse gases under the Clean Air Act. These developments could dramatically affect the way in which transportation agencies develop, maintain, and operate the transportation system.

How this Differs from Other Research Programs:

Although there is current research on environmental issues in transportation, including global climate change mitigation and adaptation, this research will build on work by the DOT Center for Climate Change and Environmental Forecasting, NCHRP, and other organizations, to create a longer-term and more holistic view on the demographic, energy, environmental, and social issues that affect sustainability.

Problem Statements:

The following problem statements aim to investigate the impacts of these trends, both individually and cumulatively, through the lens of sustainability, and focus on those aspects that directly influence transportation activities.

²⁵U.S. EPA.2008. "Sustainability" <http://www.epa.gov/Sustainability/>

Examine new approaches and technologies to enhance system preservation, maintenance, and renewal in light of expectations about decreasing supplies of natural resources, increased global competition for resources, and a focus on environmental sustainability.

Competition for natural resources, and resulting increases in transportation infrastructure costs, may have a direct effect on transportation agencies' ability to develop new transportation infrastructure, as well as maintain and preserve existing capacity, especially fundamental construction materials. At the same time, new technologies and approaches offer potential for developing transportation systems in ways that are more sustainable and require less raw resources (e.g., recycled pavement and concrete). The economic marketplace can create solutions to some of these problems, but it is not guaranteed. This research would explore the potential for new approaches to developing and preserving transportation infrastructure in light of potential changes in resource availability and cost.

Possible Projects or Tasks

- Examine the most likely scarce resources for transportation infrastructure, focusing on long-term depletion issues, absence of available substitutes, and alternatives feasibility. Note the likelihood and costs in the absence of these materials. This analysis may also focus on non-natural limits, such as environmental externalities or regulatory restrictions.
- Explore the potential for new materials and technologies, which could reduce the need for reconstruction and renewal of transportation infrastructure (e.g., long-lasting pavements, etc.), or require fewer raw resources (e.g., recycled pavements).
- Study the potential to improve mega-earthquake predictability in partnership with the U.S. Geological Survey.

Assess the effect of changing transportation energy supplies and alternative fuel sources on transportation, including changes in trade and shipment patterns, impacts on agriculture, and effects on other sectors of the economy.

Since the transportation sector accounted for two thirds of all liquid fuel consumption in 2006, it is clear that changing energy infrastructure and sources affect transportation activities. Hydrogen requires high efficiency fuel cells, which are not yet ready for large-scale market introduction. Hydrogen could capture 10-15% of the transportation fuel market by 2040-2050; however, this would necessitate a long transition period involving the diffusion of new vehicles, pipelines, and fueling stations.²⁶

²⁶ Gielen, Dolf and Fridtjof Unander. 2005. "Alternative Fuels: An Energy Technology Perspective." pg 26 www.iea.org/textbase/papers/2005/ETOAltFuels05.pdf

Possible Projects or Tasks

- Examine long-term impacts of energy price scenarios and environmental regulation on the U.S. economy, and, in turn, transportation. Identify the elasticity of demand in the face of long-term, high energy prices.
- Explore the potential consequences – intended and unintended – of developing new fuel/energy sources for transportation. This may include changes in international trade and fuel shipments (e.g., shipment of hydrogen), development of new U.S.-based or foreign technologies and associated impacts on the economy (e.g., new manufacturing, shipment, and energy distribution facilities), and impacts on agriculture (e.g. food production to fuel production) and other sectors of the economy.

Investigate the potential impacts of climate change on transportation infrastructure and operations, and adaptation approaches.

Climate change and its impacts will increasingly affect transportation activities over the next 30 to 40 years. Along with rising sea levels, higher greenhouse gas concentrations are likely to increase the Earth's average temperature, precipitation incidence, and storm pattern severity. The recent increase in coastal erosion and flooding are results of climate change and sea level rise.²⁷ Global mean sea level is projected to rise by 0.09 to 0.88 meters between 1990 and 2100. These environmental changes will have important implications on planning and renewal of infrastructure. Furthermore, there may be opportunities from these impacts, such as transportation agencies capitalizing on a national cap and trade system or green infrastructure initiatives.

Possible Projects or Tasks

- Examine in depth the potential implications of climate change on transportation infrastructure, and adaptation needs. Identify the range of responses to climate change to provide context for adaptation strategy and the best mechanisms/strategies to adapt existing infrastructure to climate change. Explore the need to revise wind loadings, flood mappings, landslide potentials, urban and wildfire potentials, water supplies, etc., as a result.
- Examine the linkages between climate change mitigation approaches (such as cap and trade) and transportation agency organizational structure.
- Develop a model to forecast carbon footprint and analyze potential benefits of alternative freight systems, considering modal alternative, freight bottlenecks, modal connectors, reduction in truck idling, truck-only lanes and fair pricing, rail, and water.
- In partnership with research agencies from other countries, develop a strategic approach to reduce transportation-related greenhouse gases globally.

²⁷ Intergovernmental Panel on Climate Change. 2007. "Climate Change 2007: Synthesis Report." pg 26

Define a sustainable transportation system and sustainability as an organizing principle for transportation agencies, projects, and systems.

Sustainability is likely to become a core focus for transportation agencies in the future. Many organizations advocate for sustainable transportation systems and agencies, but are challenged by what that means and how to achieve it. If it were simply an inclusion of environmental or social justice considerations, this would be relatively easy. However, these agencies want guidance on how to strive for a sustainable transportation system – economically feasible and sound, environmentally friendly/benign, and improved accessibility for all people. Furthermore, agencies desire the same for their internal operations and the ability to measure these changes, (e.g. performance measures/indicators).

Possible Projects or Tasks

- Understand the state DOT of the future working under a mandate of achieving sustainability goals. Examine what this means in terms of planning, project development, maintenance, and operations. Develop basic relationships between transportation, public health, environmental justice, and quality of life as defining principles of sustainability. Develop key elements of a long-term sustainable transportation system and strategy.
- Investigate the impact of continued and increasing societal environmental awareness on the provision of transportation services.
- Develop data and models for marginal environmental, societal, economic values of transportation system performance and compare with marginal costs. Study the costs versus benefits of federal regulations and if a restructuring could increase the return on the investment (reducing the narrow focus of individual agencies and facilitating interagency cooperation in order to include more participants in achieving common goals). Also include information on federal support for sustainable practices—both anticipated and realized.
- Identify different and more comprehensive approaches to environmental protection and enhancement, as opposed to project-by-project approaches, including benefits, cost savings, better outcomes, etc.
- Investigate and increase the understanding for the business case and market advantage for sustainability, in particular, looking at the commercial building industry.
- Determine the ability of future transportation systems to respond effectively to a national or international health epidemic. Consider issues with safety, capacity related to concentrated population growth in particular areas, and adaptability given the variety of potential scenarios.

Transportation Finance

The ability to finance transportation projects is fundamental to the delivery of transportation services including initiating new projects, preserving and maintaining existing infrastructure, and operating transportation services. To maintain the present state of this country's "pavements, bridges, and transit infrastructure, an expenditure by all levels of government of \$295 billion for capital investment and operations is needed by 2015." The current level of funding in transportation at the Federal, state, and local levels is insufficient to "maintain or improve the nation's highways and transit systems."²⁸ In fact, the Highway Trust Fund's revenue for maintaining the highway and transit systems will fall short by \$20 billion annually and \$43 billion short annually for improving these systems.²⁹

Certain trends will affect these funding challenges. The federal gas tax is one of the main funding sources of the Highway Trust Fund. However, it will not keep up with needs, given the expected shifts to alternative fuels and interest in more sustainable transportation options. In addition, there are general debt capacity issues. In the U.S., the increasing federal debt is coinciding with massive government expenditure requirements on entitlement programs.³⁰ The size of required infrastructure investments is limiting the government's ability to provide adequate funding. It seems plausible that not only will revenues fail to keep up with needs, but the ability to supplement those funds from other sources may decrease as well. Potential changes in public attitudes toward government and broad changes in the economy could also influence these trends. Financing transportation services is fundamental to any agency's activities, but there are competing demands for those financial resources. Leveraging present resources and identifying new strategies for funding is the basis for all transportation agencies' goals and ability to provide accessible, safe, and reliable transportation to the public.

How this Differs from Other Research Programs:

Finance is currently an issue of increasing attention in the transportation community, given the growing crisis associated with funding shortfalls. This research would build on work to address immediate funding and financing issues to address broader, longer-term approaches, which may rely on new technologies and institutional approaches.

²⁸ Cambridge Systematics, Inc., Mercator Advisors, LLC., and Alan E. Pisarski. 2005. *Executive Summary of Future Highway and Public Transportation Finance, Phase 1: Current Outlook and Short-Term Solutions*.

<http://www.U.S.chamber.com/NR/rdonlyres/e3vdw7scn3revyembfeh4ojatupwfggal3zzqbksw7lylu6wvjymvig6mam6ww33bna3nrferh2od57mfbmy55fkdzf/TransExecSummaryWeb.pdf>

²⁹ Cambridge Systematics, Inc., Mercator Advisors, LLC., and Alan E. Pisarski. 2005. *Executive Summary of Future Highway and Public Transportation Finance, Phase 1: Current Outlook and Short-Term Solutions*.

<http://www.U.S.chamber.com/NR/rdonlyres/e3vdw7scn3revyembfeh4ojatupwfggal3zzqbksw7lylu6wvjymvig6mam6ww33bna3nrferh2od57mfbmy55fkdzf/TransExecSummaryWeb.pdf>

³⁰ Kelderman, Eric. 2007. "Report: Tolls Can't Meet Future Highway Needs." Stateline. 8 March
<http://www.roadsbridges.com/Tolls-can-039-t-meet-needs-of-future-highway-funding--NewsPiece13180>

Problem Statements:

The following problem statements aim to investigate the impacts of these trends on the funding prospects for transportation agencies.

Investigate how the decreasing power of traditional mechanisms affects agencies' ability to deliver transportation services. Explore potential new financing mechanisms and approaches, considering new technologies, privatization, and institutional approaches.

The Highway Trust Fund is moving toward a crisis. For transportation agencies, understanding the magnitude of these impacts is helpful, but that has been addressed in existing work. More importantly, the research should focus on transportation agency strategies to mitigate this impact, or identify other means for funding transportation services. The research should not be limited to strategies for increasing funding, but also the efficient use of funding or project prioritization, as well as changes to project design and fundamental transportation services that would achieve similar transportation service outcomes under reduced funding availability.

Possible Projects or Tasks

- Consider the future of government finance and the likelihood of privatization for parts of the transportation sector.
- Develop a system of fees and charges for a user-based financing transportation infrastructure that also encourages greater energy-efficiency and environmental sustainability. Analyze the effect of technological advances on efficiency. Identify the impact of the environmental movement on people's willingness to pay for more environmentally friendly options.
- Research legal and funding options to foster and allow for lower cost implementation of transportation projects while upholding environmental standards and requirements. Identify the potential for interagency cooperation to facilitate cost reduction. Note the potential role of technology in helping to reduce costs.
- Examine long-term impacts of parochialism in federal, state, and regional transportation policy decisions, specifically with funding scenarios. This may also include assessing the potential for interagency cooperation and resulting effects on policy decisions.
- Assess the ability of multi-/intermodal approaches ability to minimize the effects of reduced funding. This would look at how agencies can leverage/integrate multiple responsibilities at the highest organization level for transportation activities to reduce costs.

Examine changing public willingness to pay for public goods and perspectives on how user fees affect transportation funding.

One strategy for increasing transportation funding is by raising taxes; however, a high willingness to raise taxes connects to citizens' feelings about local government responsiveness. Citizens may be more willing to pay for improved governmental performance if they have a positive view of their community and if the government has clearly demonstrated that it is "willing to make unselfish investments" in the community.³¹ Thus, the more attention the government devotes to promoting a positive image in communities, the greater the likelihood for support for public projects such as necessary transportation improvements.

Possible Projects or Tasks

- Estimate the economic value (as in the "willingness to pay") to U.S. consumers of sustainable personal travel and goods movement. Evaluate linkages between people's willingness to pay and the perceived value of transportation infrastructure with and without sustainability elements.
- Assess the potential for adaptation and acceptance of the public to new pricing mechanisms. Note the pace of technological integration into an increasing number of aspects of daily life. Also, consider the familiarity of younger generations with technology and the effect on transportation systems' development.
- Develop long-term approaches to galvanize public support for transportation investment.
- Develop a model transportation agency structure or framework given public interest and scale of decision.

³¹ Glaser, Mark A. and W Bartley Hildreth. *Service Delivery Satisfaction and Willingness to Pay Taxes: Citizens Recognition of Local Government Performance*. Public Productivity & Management Review. 23:1, 48-67. <http://www.jstor.org/stable/3380792>.

Delivery of Transportation Services

Many transportation agencies increasingly need to make more complex and integrated decisions over larger geographic areas, which span jurisdictional boundaries, and affect social, economic, environmental, and other considerations. Many additional concerns are now included in the decision-making process, particularly in the areas of the environment, economics, land use, etc. Having the capability to deliver transportation projects, operate services, and preserve system infrastructure effectively is essential to agencies' success. Furthermore, technological changes are dramatically altering public interaction in general, with public agencies, and regarding transportation projects and other public goods.

The focus in this research area is institutional issues, including how agencies relate and interact with the public, other organizations, and internally, and how the transportation industry prepares its workforce to address these needs. Issues such as climate change do not respect jurisdictional boundaries or discrete subject matter, but require a wide range of professional skills and agency actions. Transportation agencies will need to adapt to these circumstances effectively to meet their missions. Conversely, increasing regulations may inhibit or promote cross-organizational collaboration, whereas more regionalism and improved communications and data may allow for greater collaboration. Collectively, these trends can influence the delivery of transportation services in multiple ways.

How this Differs from Other Research Programs:

This focus area will build on existing work being done under the Strategic Highway Research Program II focus area on Capacity, as well as work being undertaken by FHWA and others on planning and environmental linkages. It will go beyond existing models of decision-making and current laws and requirements to explore potential new ways to addressing emerging challenges.

Problem Statements:

The following problem statements aim to investigate the impacts of these trends on changing methods of public goods delivery for transportation agencies.

Investigate the methods of public involvement and communications through different social technologies. Explore how the Web 2.0 or future updated versions will affect transportation agencies' ability to communicate their mission, goals, activities, as well as receive guidance from the public and localized constituencies.

Public involvement and communication are integral to the successful completion of transportation projects. Traditional methods include open houses, mailings, and newspaper ads. However, the sheer level of access and capability means that reaching out to the public can take and may require an enhanced level of outreach. The public involvement demands of the future may involve technologically integrated web portals,

SMS services, and real-time interactions for community decision-making. Transportation agencies must be prepared to interact with the public of the future.

Possible Projects or Tasks

- Investigate the need for new public communication and involvement techniques, factoring in/capitalizing on current and anticipated social changes. Identify future increased expectations for greater transportation information from younger, more technologically sophisticated people. Analyze within the context of rapid technological changes. Note the anticipated population growth and potential effects on communication feasibility.
- Develop appropriate education materials for the public about transportation values and costs to make them informed voters and consumers. Consider the trajectory of technology in terms of advances in the speed, quality, and effectiveness of communication. Also, note the increasing aging population and immigrant population and the potential need to develop different education campaigns targeted to specific groups.

Investigate alternative models and strategies for multi-jurisdictional, -agency, and non-governmental decision-making and collaboration.

Increasingly, transportation agencies are responsible for a wide variety of issues, including not only mobility, but also environmental protection, economic development, safety, and security. The increasing level of economic integration and development of mega-regions suggests that the transportation agencies will need to develop effective institutional mechanisms for working across jurisdictional and functional boundaries. Not only is this collaboration in planning important, but also in operations, emergency management, etc. This research deals with the wide range of partnerships in which a transportation agency may engage— from localized community-based decision-making scenarios to larger interstate organizations, such as the I-95 Coalition. It may also include private entities, such as consultants and the vendor community, for service provision or the outright privatization of transportation facilities.

Possible Projects or Tasks

- Explore the causes for existing barriers to implementation of technology and solutions for overcoming them. Analyze the potential role of privatization in working with transportation agencies to accomplish common goals. Consider societal trends—both demographic and economic—as the overarching context within which technological improvements should be considered.
- Assess future organizational structures and capacities to manage the scale of impacts and benefits of transportation.
- Explore effective public-private government options for operating/managing U.S. transportation systems (multi-state regions, state, metropolitan areas) to achieve desired system performance and other objectives. Identify processes for

successful public-private collaboration by determining benefits compared with transactional costs to all parties. Conduct extensive evaluation of anticipated regulation reform to ensure the achievement of effective decisions and outcomes. Assess the potential technological developments that could result from a public-private partnership.

- Research policy architectures to enable effective decision-making at various levels of government and across a broad spectrum of functions (e.g., transportation, environment, land-use). Identify how regulations will be categorized: life cycle costing, performance-based, or outcome-based. Assess the potential for public-private partnerships in helping to facilitate interagency cooperation. Analyze the potential for governmental support for sustainable planning—specifically in light of changing societal trends and the growing consideration for environmental aspects.

Explore the direct impacts of a changing transportation workforce on agency operations and identify future workforce training needs.

Many of the issues that affect the greater American business community will also affect the transportation workforce. However, the question is how those impacts may differ for transportation agencies. How does an agency prepare and position itself for some of these trends? In light of multi-agency collaboration, what is necessary to keep in-house? These may influence transportation agencies differently in light of the necessary educational requirements, institutional knowledge, and technological understanding of the individual agency employees.

Possible Projects or Tasks

- Determine the best practices to encourage workforce development and education concerning opportunities in transportation fields. Identify opportunities for incorporating more aspects of the technological field into transportation systems. Analyze those groups experiencing the greatest population growth, as this may help provide structure for outreach and marketing campaigns.
- Identify the long-term transportation work-force composition, retention, and preparation. Consider changes in retirement patterns—specifically that people are choosing to work further into their life. Identify the role of private entities in terms of public-private partnerships, as this could comprise another group in the transportation work force.
- Conduct a synthesis of current and emerging technologies of direct consequence to transportation professionals. Assess the trajectory of technological advances of direct relevance to the transportation industry. Note those areas of research and development in which the government has invested as a way to adequately prepare for future developments.
- Analyze role of academia in providing for the transportation workforce's future needs, both with degree programs and continuing education.

4. NEXT STEPS

Using this framework, NCHRP will have a future research agenda to present to SCOR at their November 2008 meeting. From this, SCOR will allocate research funding to examine longer-term strategic issues, both global and domestic, that will likely affect DOTs. In order to sustain this program, NCHRP will need to develop a structure for on-going solicitation, selection, and development of research needs statements within this future-oriented research framework. By establishing a forward-thinking research framework, NCHRP can help facilitate greater preparedness for state DOTs and transportation decision-makers.

DRAFT

5. APPENDIX: PARTICIPANTS AT WORKSHOP HELD AUGUST 19-20, 2008

Participants	
<p>Dr. Gary R. Allen, PhD. (Chair) Chief of Information Technology, Research & Innovation Virginia DOT Virginia Transportation Research Council 530 Edgemont Road Charlottesville, VA 22903 Phone: 434/293-1938 Fax: 434/293-1990 Email: gary.allen@vdot.virginia.gov</p>	<p>Ms. Leni Oman Director, Office of Research and Library Services Washington State DOT 310 Maple Park Avenue SE PO Box 47372 Olympia, WA 98504-7872 Phone: 360/705-7974 Fax: 360/705-6911 Email: omanl@wsdot.wa.gov</p>
<p>Mr. John T. Gray Senior Vice President, Policy and Economics Association of American Railroads 50 F Street NW Washington, DC 20001 Phone: 202/639-2319 Fax: 202/639-2499 Email: jgray@aar.org</p>	<p>Mr. Neil J. Pedersen, P.E Administrator Maryland State Highway Administration 707 N. Calvert Street Baltimore, MD 21202 Phone: 410/545-0400 Fax: 410/209-5009 Email: npedersen@sha.state.md.us Alt. Phone: 443/829-1928</p>
<p>Dr. Jeffrey Keaton, P.E. Senior Principal Engineering Geologist MACTEC Engineering & Consulting, Inc. 5628 East Slauson Avenue Los Angeles, CA 90040 Phone: 323/889-5300 Fax: 323/889-5308 Email: jrkeaton@mactec.com</p>	<p>Mr. Gordon D. Proctor Gordon Proctor & Associates 7825 Wiltshire Drive Dublin, OH 43016 USA Phone: 614/313-6421 Email: goproctor@wowway.com</p>
<p>Ms. Sandra Q. Larson Director, Research and Technology Bureau Iowa DOT 800 Lincoln Way Ames, IA 50010 Phone: 515/239-1205 Fax: 515/239-1766 Email: sandra.larson@dot.iowa.gov</p>	<p>Dr. Sandra Rosenbloom University of Arizona 5540 E. Miles Circle Tucson, AZ 85712 Phone: 520/626-2821 Fax: 520/623-1705 Email: Rosenblo@U.Arizona.edu</p>
<p>Mr. Michael T. Long Project Delivery Manager Oregon DOT 455 Airport Rd SE Building A Salem, OR 97301-5397 Phone: 503/986-6935 Fax: 503/986-2839 Email: michael.t.long@odot.state.or.us</p>	<p>Dr. Joseph M Sussman Massachusetts Institute of Technology MS 1-163 77 Massachusetts Ave Cambridge, MA 02139 United States Phone: 617/253-4430 Email: sussman@mit.edu</p>
<p>Mr. Richard C. Long Director, Research Center Florida DOT 605 Suwannee Street Mail Stop 30 Tallahassee, FL 32399-0450 Phone: 850/414-4617</p>	<p>Dr. A. Keith Turner Emeritus Professor of Geological Engineering Colorado School of Mines Department of Geology and Geological Engineering Golden, CO 80401-1887</p>

<p>Fax: 850/414-4696 Email: richardc.long@dot.state.fl.us</p>	<p>Phone: 303/273-3802 Fax: 303/273-3859 Email: kturner@mines.edu</p>
<p>Ms. Susan Martinovich, P.E. Director Nevada DOT 1263 S. Stewart Street Carson City, NV 89712 Phone: 775/888-7440 Fax: 775/888-7201 Email: smartinovich@dot.state.nv.us</p>	<p>Dr. Martin Wachs Director, Transportation, Space, and Technology Program RAND Corporation 1776 Main Street P.O. Box 2138 Santa Monica, CA 90407-2138 Phone: 310/393-0411x7720 Fax: 310/393-4818 Email: martin_wachs@rand.org</p>
<p>Dr. Michael D. Meyer Professor Georgia Institute of Technology School of Civil & Environmental Engineering 790 Atlantic Drive Atlanta, GA 30332-0355 Phone: 404/385-2246 Fax: 404/894-2278 Email: mike.meyer@ce.gatech.edu</p>	<p>Dr. Richard Wright 20081 Doolittle Street Montgomery Village, MD 20886-1354 Phone: 301/977-9049 Fax: 301/977-9049 Email: richard.n.wright@verizon.net</p>
<p>Dr. Lance A. Neumann President Cambridge Systematics, Inc. Suite 400 100 Cambridge Park Drive Cambridge, MA 02140 Phone: 617/354-0167 Fax: 617/354-1542 Email: lneumann@camsys.com</p>	
<p>FHWA Liaisons</p>	
<p>Ms. Debra Elston Director, Office of Corporate Research Technology, and Innovation Management Federal Highway Administration Turner-Fairbank Highway Research Center, F214A 6300 Georgetown Pike McLean, VA 22101 Phone: 202/493-3181 Fax: 202/493-3475 Email: debra.elston@fhwa.dot.gov</p>	<p>Mr. David Kuehn Program Manager, FHWA Exploratory Advanced Research Program Federal Highway Administration Turner-Fairbank Highway Research Center, Room F-220 (HRTM-4) 6300 Georgetown Pike McLean, VA 22101 Phone: 202/493-3414 Fax: 202/493-3475 Email: david.kuehn@dot.gov</p>
<p>AASHTO Liaison</p>	
<p>Ms. Priscilla Benavides, PE Engineering Management Fellow AASHTO 444 N. Capitol Street NW, Suite 249 Washington, DC 20001 Phone: 202/624-5868 Fax: 202/624-5469 Email: pbenavides@aaashto.com</p>	<p>Mr. James T. McDonnell, P.E. Deputy Program Director for Engineering AASHTO 444 N. Capitol Street NW, Suite 249 Washington, DC 20001 Phone: 202/624-5448 Fax: 202/624-5469 Email: jimm@aaashto.org</p>
<p>Mr. Ken Kobetsky Program Director for Engineering</p>	

<p>AASHTO 444 N. Capitol Street NW, Suite 249 Washington, DC 20001 Phone: 202/624-5254 Fax: 202/624-5469 Email: kenk@ashto.org</p>	
<p>NCHRP Staff</p>	
<p>Mr. Crawford F. Jencks, P.E. Deputy Director, Cooperative Research Programs Transportation Research Board 500 Fifth Street NW, 4th Floor Washington, DC 20001-2721 Phone: 202/334-2379 Fax: 202/334-2006 Email: cjencks@nas.edu</p>	<p>Ms. Lori Sundstrom Senior Program Officer, NCHRP Transportation Research Board Cooperative Research Programs 500 Fifth Street NW, 4th Floor Washington, DC 20001-2721 Phone: 202/334-3034 Fax: 202/334-2006 Email: lsundstrom@nas.edu</p>
<p>Mr. Nanda Srinivasan Senior Program Officer, NCHRP Transportation Research Board Cooperative Research Programs 500 Fifth Street NW, 4th Floor Washington, DC 20001-2721 Phone: 202/334-1896 Fax: 202/334-2006 Email: nsrinivasan@nas.edu</p>	