

Cross-Cutting Environmental Research Needs Workshop

Conducted in Conjunction with the

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'Better Delivery of Better Transportation Solutions'

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1 INTRODUCTION

In 2002, an Environmental Research Needs Conference was hosted by the Transportation Research Board in Washington, DC. That conference was designed to select and draft top-priority statements of environmental research needs. The two and one-half day conference convened over 200 invited experts who identified research needs in 15 topic areas.¹ As research needs and priorities continue to evolve and respond to changing conditions in the transportation sector, the natural environment and in society, the Federal Highway Administration (FHWA) recognized the need for an updated look at environmental research topics. The TRB Environment and Energy Research Conference, held June 6-9, 2010, in Raleigh, North Carolina, and attended by some 500 transportation and environmental professionals from across the country, offered an excellent and timely opportunity to collect research ideas, communicate the status of research underway, and provide outreach on existing findings.

During the 2010 conference, the FHWA partnered with the Center for Transportation and the Environment (CTE) in a two-pronged approach to maximize the collection of ideas:

- A one-half day, facilitated workshop prior to the formal opening of the conference, focused on cross-cutting environmental topics
- On-going collection and prioritization of ideas during the conference week

The result was a high level of participation before and during the conference. A substantial number of The ideas and priorities that emerged will contribute to the development of a comprehensive agenda for environmental, social, and economic research needs.

The ideas gathered at the June, 2010, event do not, of course, represent the concerns of the entire transportation research community. As the research programs for the coming years are developed, additional input on ideas and priorities will be incorporated. Those seeking to contribute additional research topics for consideration may do so by working directly with the relevant TRB Committee(s). Each Committee submits research problem statements to the Research Needs Database, available at: <http://rns.trb.org>. AASHTO's Standing Committee on the Environment's (SCOE) Center for Environmental Excellence also collects research ideas and compiles them in the Transportation Environmental Research Ideas (TERI) database. As a resource to those interested in submitting new ideas, TRB maintains searchable databases of existing and ongoing research: TRISOnline is available at: <http://tris.trb.org/> and the Research in Progress database is available at <http://rip.trb.org>.

The purpose of this report is to compile the research ideas collected from the attendees at the conference and highlight existing and ongoing research related to those topics. The report will provide a timely resource for those developing targeted research problem statements, advocating for investment

¹*Environmental Research Needs in Transportation. Report of a Conference.* Transportation Research Board, Washington DC, 2002. Available on line at: http://onlinepubs.trb.org/onlinepubs/conf/reports/cp_28.pdf.

in particular lines of research, or looking for current research related to the cross-cutting topics discussed at the workshop.

The report is organized as follows. Section 2 describes how the pre-conference workshop was organized and facilitated. It also describes how conference attendees contributed to the ideas and other inputs on research needs and priorities throughout the conference. Section 3 offers a summary and synthesis of the research ideas generated as well as a summary of input collected about how to improve the conduct of transportation research. Section 4 describes the next steps to be taken to develop the research ideas into formal research problem statements which can become funded research projects. The section closes with some concluding remarks. Full compilation of research ideas and workshop materials are provided in the Appendices.

2 WORKSHOP AND CONFERENCE ACTIVITIES

Pre-Conference Workshop

Approximately 150 conference registrants indicated that they would attend the workshop. The actual number of participants was approximately 120 and represented a broad range of interests, represented by the 12 TRB Committees attending the conference:

- ADA60 Public Involvement in Transportation
- ADC10 Environmental Analysis in Transportation
- ADC20 Historic and Archeological Preservation in Transportation
- ADC30 Transportation and Ecology
- ADC60 Waste Management and Resource Efficiency in Transportation
- ADC70 Transportation Energy
- ADC80 Alternative Fuels and Technologies
- ADD20 Social and Economic Factors of Transportation
- ADD30 Transportation and Land Development
- ADD40 Transportation and Sustainability
- ADD50 Environmental Justice in Transportation
- AVO30 Environmental Impacts of Aviation

These TRB Committees were joined by the AASHTO Standing Committee on the Environment (SCOE), which is organized into four subcommittees:

- Air Quality Subcommittee
- Natural Systems and Ecological Communities Subcommittee
- Communities and Cultural Resources Subcommittee
- Environmental Process and Analysis Subcommittee

Prior to the workshop FHWA's Office of Planning, Environment and Realty's Surface Transportation Environment and Planning Cooperative Research Program (STEP) Program commissioned a series of four white papers from the U.S. Department of Transportation's John A. Volpe National Transportation Systems Center (Volpe Center). Based on input from the TRB Committees slated to attend the conference, the white papers outlined future research needs organized by four cross-cutting topic areas: **Climate Change, Energy, Livability, and Sustainability**. Each white paper offered a synthesis of ongoing and completed research related to the conference theme. The white papers are available at:

<http://www.cte.ncsu.edu/cte/EEConference/workshop/VolpeWhitePapers.pdf>. An extensive table listing over 120 relevant recent and ongoing research activities was also developed and is available on line at: <http://www.cte.ncsu.edu/cte/EEConference/workshop/VolpeMatricesofResearch.pdf>.

Working definitions were developed for the four cross-cutting topic areas by FHWA for use by workshop participants. (See text box below for brief topic area definitions; full definitions provided to workshop participants and conference attendees are available in Appendix A.)

The white papers were distributed to conference registrants in advance of the research needs workshop to provide an opportunity for all potential workshop participants to digest the information prior to the workshop. The documents served to frame the workshop discussions of existing and on-going research and emerging research needs. The purpose of the workshop was described during a brief orientation session at the start of the workshop:

- Identify future research needs within the cross-cutting topic areas of Climate Change, Energy, Livability, and Sustainability
- Prioritize research needs based on participant feedback
- Collect input on how to improve the conduct of research and the administration of research programs
- Identify individuals that are willing to continue discussion of the prioritized research needs to develop research problem statements for future funding
- Kick start the conversation on research needs for the remainder of the conference

Additional introductory information presented by Ms Shari Schafflein, Acting Director, Office of Human Environment, FHWA, included: what will happen with the results of workshop, definitions of ‘research’ for the purposes of the workshop (basic research, policy analysis, best practices syntheses, etc). She also provided an overview of the FHWA’s Office of Planning, Environment and Realty’s Surface Transportation Environment and Planning Cooperative Research Program (STEP) Program, which supports applied research in environmental topics. Participants were randomly assigned to one of the four cross-cutting topic areas. Each topic area group was assigned to a breakout room, with two groups of 8 to 10 people. Facilitators introduced the topic area by offering the working definition. Facilitators asked the small groups to provide several research ideas in response to the focus question:

What are the critical research needs over the next 5 years that must be addressed in the topic area to better support planning and environmental processes and their associated program and project outcomes?

Further, each group was asked to note the following information for each research idea:

- Is this topic oriented toward informing National Policy (NP), or does it address Practitioner needs (P)?
- Will this research deliver outcomes targeted to the Near Future (NF) or for the Long Range (LR)?

- Is this research idea related to any on-going or recent research?
- What type of research is best suited to addressing this research idea? (Examples: synthesis, scan, peer exchange, etc.)
- If this research idea is more closely related to one of the other four cross-cutting topic areas, note which one.

Climate Change is any change in climate over time, whether due to natural variability or as a result of human activity. In the transportation context, two broad types of responses to climate change impacts have been identified: mitigation and adaptation. Mitigation refers to the implementation of any policy or strategy that will reduce greenhouse gas emissions and enhance carbon storage capacity. Examples of mitigation strategies include lowering emissions that fuel climate changes. Adaptation refers to changes in the way transportation infrastructure is planned, designed, constructed, operated, and maintained.

Energy is a broad concept, which touches on the efficiency, public health, environmental impacts of the substances used as fuels during the construction, maintenance, and use of the transportation system. Since our current transportation system relies heavily on the most energy-intensive means of transportation—highways and aviation—the transportation sector is a critical focus of national energy policy. Commonly cited energy goals specific to the transportation system include less reliance on petroleum, fewer negative impacts on the environment, reduced greenhouse gas emissions, and increased efficiency.

Livability in transportation is about tying the quality, location, and modal composition of transportation facilities to broader opportunities such as access to good jobs, affordable housing, quality schools, and safe streets. This includes addressing road safety and capacity issues through better planning and design, maximizing and expanding new technologies, and using Travel Demand Management approaches to system planning and operations. Livability also includes developing high quality public transportation to foster economic development, and community design that offers residents and workers the full range of transportation choices. And, it involves fully connecting the modal pieces – bikeways, pedestrian facilities, transit services, and roadways – into a truly intermodal, interconnected system.

Sustainability and Sustainable Development means finding a balance between the capacity of natural environmental systems with societal developmental needs, both in the present and for the future. Viewing transportation (or one part of the transportation system such as highways) in isolation is not ideal when addressing sustainability. Sustainability in transportation should be addressed with the mindset that transportation is one part of a larger system, a system planned, designed, constructed, maintained and operated at a level of stewardship that provides benefits on three scales of evaluation: ecology, economy, and equity.

At the end of the 35-minute discussion, one person from the group was asked to post their group's ideas at the front of the room, organized under the appropriate heading of National Policy (NP) or Practitioner (P). Facilitators checked to see if participants agreed with how the ideas were assigned to either NP or P. During the review discussion, ideas that were very closely related (or duplicative) were combined onto a single sheet when appropriate. The title of the new combined idea was posted, with the replaced ideas retained for documentation purposes. This consolidation of ideas was driven by the intent to reduce the number of ideas to 8 to 10 answers for the prioritization voting exercise at the end of the workshop.

Workshop participants then rotated to a different, pre-assigned topic area, where the facilitators provided a brief orientation to the second topic and reviewed the ideas posted by the first group to generate ideas for that particular topic. The second group was then asked:

*Do you see any missing research needs from the ideas posted?
If so what is missing?*

Participants in the second rotation provided their additions, noted on a different color of paper to distinguish their ideas from the ideas generated during the first rotation. The second rotation was also asked to note their responses to the additional set of questions for each research idea (listed on previous page). The intended output from the first and second rotations was to have 8 to 10 research ideas for each of the four cross cutting topics. Time constraints, however, limited the discussion of combining and consolidating ideas. As a result, each topic area had some 20 or more ideas. Appendix B provides a full listing of all ideas and related subideas generated during the pre-conference workshop.

Facilitators also asked participants to provide any input they have regarding the conduct of research. Again, time did not allow for discussion of conduct of research. The questions planned for this discussion, however, were provided to all conference attendees who noted their responses to the following:

- What can be done to more effectively engage interdisciplinary practitioners in the development, prioritization, outreach and dissemination of research products?
- What tools and techniques can be deployed to inform and educate public, private and non-profit organizations and agencies on research findings?
- What needs to happen to better translate how research products can help practitioners' with project planning, development and delivery.
- What can be done to improve the administration of research, including review panels, staff support, and researcher selection processes, to ensure strong research projects and valuable deliverables?

Responses to these questions are presented in Appendix C.

Following the second breakout session, all participants returned to the plenary session room where they were next asked to prioritize the full set of research ideas. Using a ‘dot voting’ procedure, participants were asked to use their 10 dots to vote in response to the question:

Which ideas are the most important for us to fund in the next 5 years?

The outcome of the dot voting was a list of prioritized research needs based on votes from participants. The results are presented in Section 3.

Overall, the pre-conference workshop provided a wealth of information in return for the relatively short amount of time invested. The sessions were intense for participants, but facilitators managed to extract a wide range of responses from the participants. Some participants felt uncomfortable because they were assigned to topic areas not closely related to their areas of expertise. The random group assignments, however, ensure highly inter-disciplinary discussions and a broad range of ideas, and pressed participants to think outside their usual area of work.

The dot voting did provide a ‘first cut’ of priorities among the large number of ideas generated during the workshop. This prioritization may have been more meaningful had time allowed for more synthesis of the ideas generated and discussion to ensure a common understanding of each of the ideas. Still, the voting did offer up a set of ideas that received broad support among all workshop participants. The results of the voting are presented and discussed in the next section of this report.

Conference Activities

Immediately following the workshop, the full list of ideas generated during the workshop were transcribed and printed and then distributed to all conference attendees (handout provided in Appendix D). Further, the conference attendees were asked to review the ten highest ranked ideas from the workshop for each cross-cutting topic and vote their priorities using the ten dots provided in their registration materials. The four posters used for this prioritization are presented below in Figure 1 along with the tally of votes from both the workshop and the conference.

To ensure the fullest participation from conference attendees in generating research ideas, all attendees were invited to propose research ideas using a short form and submitting the form to a drop box, made available near the registration desk throughout the conference. (See Appendix E for a listing of all ideas submitted during the conference.) During the conference, session moderators were also asked to solicit session attendees for research ideas. Ideas and comments collected by session moderators are provided in Appendix F.

Additional forms were available for attendees to express their interest in participating in the further development of specific research ideas. The list of contacts is provided in Appendix G, and will prove a valuable resource to TRB Committees, AASHTO’s SCOE, and research program administrators as they seek support in further developing the ideas. Interested individuals are further encouraged to reach out to others who noted their interest in developing particular topics and collaborating to refine topics of

mutual interest. Appendix H provides the forms used by conference attendees to report their specific interest in developing research topics and submit their research ideas.

The research ideas received considerable attention during the conference. The materials and forms were displayed prominently which provided an opportunity for all who attended the conference to engage in the development of the transportation research program for the years to come. As a result, the top-ranked ideas can be understood to have broad-based support from an interdisciplinary group of transportation researchers, practitioners, policy makers, and administrators.

Figure 1: Posters Displaying Highest Ranked Research Ideas from Pre-conference Workshop and Vote Tallies from Workshop and Conference

Livability				
NP or P	Research Topic	Workshop Votes	Conference Votes	Total Votes
P	Define livability and livability metrics, and identify implications for land use and transportation planning at the local-suburban-rural level (and consider the differences between urban and rural)	43	75	118
NP	Address livability in NEPA and other cross-cutting legislation	29	15	44
P	Integrating/strengthening the relationship of land use and transportation planning	27	104	131
NP	What are the financial implications of improving livability; costs and benefits	19	20	39
P	How livability affects community characteristics and identity or definitions, impacts, benefits and culture (demographics) and with other projects (safety, noise)	13	17	30
P	Engineering aspects of livability (case studies)	6	13	19
NP	Identifying and providing incentives to maintain communities that already embody livability principles	6	16	22
NP/P	Individual travel data (GPS, cell, toll)	6	8	14
P	Incorporating freight movement into the livability concept.	4	38	42
NP	What are the 'justice' issues around increasing modal choice vs basic access/mobility and dislocation	3	32	35

Climate Change				
NP or P	Research Topic	Workshop Votes	Conference Votes	Total Votes
P	Need better models and methodologies; sensitivity to mitigation strategies, quantifying GHGs/carbon, validating progress toward GHG objectives	44	74	118
P	How to address uncertainty related to climate change impacts (esp. cumulative impacts) in environmental impact analysis, planning, policy, etc.	43	71	114
NP	Trade-offs and consequences of different GHG/climate change strategies; realization that all options have consequences	26	22	48
NP	Communicating climate change to decision makers, practitioners, and system users	25	63	88
NP	How does transportation pay for adaptation in the context of declining gas tax revenues?	18	43	61
NP	Air quality conformity will be affected by climate change: often generators of pollution are outside the region. How can we collect mitigation fees from source polluters?	18	28	46
NP	Facilitation of wildlife movement vis-à-vis transportation networks and transportation planning in the face of climate change	16	70	86
NP/P	Extreme climate events—impacts to design and construction standards and specifications, including regional specifics	14	16	30
NP	Integrated planning approaches to address adaptation (multi-sectoral)	12	16	28
P	How are (or will) strategies for climate change on transportation projects take into account cultural considerations, especially with respect to environmental justice populations and historic values/historic preservation	12	75	87

Energy

NP or P	Research Topic	Workshop Votes	Conference Votes	Total Votes
P	Link energy and environmental modeling to support decision making aimed at energy efficiency for different scales	50	31	81
NP	How to change behavior (reduce energy use/impacts) through communicating effects, providing options/incentives, policies (i.e. pricing)	30	102	132
NP	Develop model plus communicate life cycle costs of transportation: system, fuels, vehicles, etc.	28	41	69
NP	What strategies including incentives could build local economies to reduce VMT, increase livability measures and minimize energy use?	26	68	94
P	Understanding how various alternative fuels and modes are best implemented	20	45	65
NP	Time scale of national implementation. What national-level energy policy changes are needed to fund and facilitate integration of multi-modal transportation systems?	16	37	53
P	Research for longer lasting construction materials	9	26	35
NP	How do you integrate transportation choice into school curriculum? (to support more efficient transport)	7	15	22
P	Incentives and barriers to using lower energy options for freight movement and idling reduction	7	36	43
NP	Establish method to increase transit service during fuel price shocks	7	15	22

Sustainability

NP or P	Research Topic	Workshop Votes	Conference Votes	Total Votes
NP	Develop sustainability indicators for systems architecture: ecology, economy, efficiency, equity	47	41	88
NP	Research on travel forecast models account for rising gas prices (VMT), economic variability, generational perspectives and personal behaviors	42	21	63
NP	Measuring sustainability: metrics (How are we doing? What can be done to improve performance measurements? What are the baselines?)	34	71	105
NP	Balancing transportation sustainability with affordability	32	29	61
P	How do we involve individuals, communities (i.e. the local context) in order to better understand and address sustainability?	25	36	61
P	Redefining value engineering to encompass non-monetary values (not just economics)	23	59	82
P	How and when to apply sustainable transportation criteria/characteristics at varying levels of decision making	19	21	40
NP	How can local, state, watershed and regional resources planning be integrated? (Scale matters for Transportation, Conservation, Land Use and Watersheds)	16	53	69
P	Methods for comprehensive sustainability planning: where and how?	15	14	29
P	How can DOTs enhance natural environment with their facilities (e.g. creating habitat in right of way)?	15	55	70

3 SYNTHESIS AND DISCUSSION OF RESEARCH IDEAS

It is noteworthy that both workshop participants and conference attendees gave top priority to an equal number of topics that are related to national policy questions and to practitioner needs. This indicates the need for any national research agenda to be balanced between policy-related research, which is likely to address long-term needs and questions, and practitioner-related research, likely to address shorter-term questions and gaps in knowledge, and highlight best practices.

Of further interest, conference attendees placed 5 research ideas related to Climate Change in their highest ranked list of ideas. In contrast, workshop participants ranked only two Climate Change ideas in their top ranked list but included 4 ideas related to Sustainability. While it is certainly the case that these two issues have much overlap, it is clear that among conference attendees Climate Change is a hot topic.

Although neither group's prioritization of ideas can be considered as more relevant, the two groups substantially differ in their top ranked ideas. This is somewhat expected given that the two groups had quite different experiences with the research idea activities. Workshop participants engaged in focused discussion with colleagues from their own and other disciplines as they developed and prioritized the topics. Further, workshop participants voted on the full set of 104 ideas generated during the workshop, while conference participants were presented only with the top 10 ranked ideas from each of the four topic areas. Therefore, workshop participant voting is more diluted among ideas. Still, conference participants did not prioritize ideas in a vacuum: they had ample opportunity to engage in discussion with fellow attendees and with information presented in conference sessions. Observers remarked about the discussions among attendees and activity around the voting station. As a result, their prioritization was far from a static and isolated exercise. The top ranked ideas from each group are presented separately here to reflect the differences; see Tables 1 and 2.

Differences between what the two groups ranked as their highest priorities are striking. Only 5 of the 10 highest ranked ideas from the workshop were ranked among the top 10 by conference attendees. Again, this is somewhat a function of the process employed: workshop participants voted on the full set of ideas generated during the workshop, while conference attendees voted on a subset of 40 ideas (the ten highest ranked ideas in each topic area).

Looking across the four topic areas, several overarching themes are apparent in the research ideas generated by workshop participants. First, it is notable that there were topics related to defining, measuring and communicating about policies and their respective impacts, especially for the topic areas of Sustainability and Livability. This was also reported as a research need in the white papers. Second, several highly ranked research ideas focused on questions about how to integrate new challenges into existing processes such as NEPA, long range planning, environmental justice analyses, and technical modeling work. Again, this is to be expected as the transportation industry faces a set of new challenges. Despite the considerable focus on the human environment and social issues, topics specific

to the natural environment are found in each group’s top ranked research ideas. Third, topics related to economic issues, including lifecycle costs, economic implications of policies, and cost-benefit analyses, highlight the recognition of the importance of careful and robust work to understand and optimize the relationship between transportation and economics.

Table 1: Top Ranked Research Ideas: Workshop Participants

Rank by Workshop Participants	Topic	National Policy (NP) or Practitioner (P)	Research Idea
1	Energy	P	Link energy and environmental modeling to support decisionmaking aimed at energy efficiency for different scales, state plan, MPO, project development alternative analysis.
2	Climate Change	P	Need better models and methodologies (sensitivity to mitigation strategies such as land use and pricing; GHG emissions; quantifying GHGs/carbon –using GHG inventories or carbon footprint approach; validating progress toward achieving GHG reduction objectives)
3	Climate Change	P	How to address uncertainty related to climate change impacts (esp cumulative impacts) in environmental impact analysis, planning, policy, etc.
4	Livability	P	Define livability and livability metrics, and identify implications for land use and transportation planning at the local-suburban-rural level (and consider the differences between urban and rural)
5	Sustainability	NP	Research on travel forecast models account for rising gas prices (VMTs), economic variability, generational perspectives and personal behaviors. Do we need to change old assumptions?
6	Sustainability	NP	Develop sustainability indicators for systems architecture: ecology, economy, efficiency, equity
7	Sustainability	NP	Measuring sustainability: metrics (How are we doing? What can be done to improve performance measurements? What are the baselines?)
8	Sustainability	NP	Balancing transportation sustainability with affordability. Access elements of each and reach balance.
9	Energy	NP	How to change behavior (reduce energy use/impacts) through communicating effects, providing options/incentives, policies (i.e. pricing)
10	Livability	NP	Address livability in NEPA and other cross-cutting legislation

Table 2: Top Ranked Research Ideas, Conference Attendees

Rank by Conference Attendees	Topic	National Policy (NP) or Practitioner (P)	Research Idea
1	Livability	P	Integrating/strengthening the relationship of land use and transportation planning
2	Energy	NP	How to change behavior (reduce energy use/impacts) through communicating effects, providing options/incentives, policies (i.e. pricing)
3	Livability	P	Define livability and livability metrics, and identify implications for land use and transportation planning at the local-suburban-rural level (and consider the differences between urban and rural)
4	Climate Change	P	How are (or will) strategies for climate change on transportation projects take into account cultural considerations, especially with respect to environmental justice populations and historic values/historic preservation
5	Climate Change	P	Need better models and methodologies (sensitivity to mitigation strategies such as land use and pricing; GHG emissions; quantifying GHGs/carbon –using GHG inventories or carbon footprint approach; validating progress toward achieving GHG reduction objectives)
6	Climate Change	P	How to address uncertainty related to climate change impacts (esp cumulative impacts) in environmental impact analysis, planning, policy, etc.
7	Sustainability	NP	Measuring sustainability: metrics (How are we doing? What can be done to improve performance measurements? What are the baselines?)
8	Climate Change	NP	Facilitation of wildlife movement vis-à-vis transportation networks and transportation planning in the face of climate change
9	Energy	NP	What strategies including incentives and reducing VMT could be explored to build local economies (goods/services) to reduce VMT, increase livability measures and minimize energy use?
10	Climate Change	NP	Communicating climate change: is it impacting decision making?; is it credible/understood by decision makers? Does it inform transportation practitioners and users and shape behavior? What messages regarding climate change are most effective with what audiences?

Table 3 presents a synthesized, combined list of the ideas Tables 1 and 2, with ideas that are very similar combined. Each research idea is reformatted to question format for ease of review and the ideas are listed by topic area. Taken together, this list represents a wide ranging and ambitious national research agenda that responds to current and anticipated needs related to the four topic areas for practitioners and for the development of national policy.

It is worth noting that several of the ideas in Table 3 are addressed by recent studies or on-going research as noted in the white papers. To help identify the intersections between completed and on-going research, and the high-priority research topics identified by the workshop participants and conference attendees, a table combining these three elements is provided in Appendix I. Appendix I displays the compilation of relevant research, whether completed (from 2007 to present) or still in progress, and notes the research ideas from Table 3 to which they are related. The compilation of completed research and research projects in progress was developed as part of the pre-conference white papers by the staff at the Volpe Center (available online at: <http://www.cte.ncsu.edu/cte/EEConference/workshop/VolpeWhitePapers.pdf>) The compilation was focused on the four cross-cutting topic areas of Climate Change, Energy, Livability, and Sustainability. (Note: Full listings of Completed Research and Research in Progress are available at: <http://www.cte.ncsu.edu/cte/EEConference/workshop/VolpeMatricesofResearch.pdf>.)

Appendix I can be used in three ways:

1. As a resource to the practitioner, policy-making, and research communities who may not have access to the broad range of research outlets represented in the Volpe team's compilation, thus providing resources already (or soon to be) available that pertain to the research ideas
2. As a resource to those developing research problem statements to help more fully identify gaps in knowledge and to highlight areas where existing or forthcoming research may be leveraged in new research efforts
3. As a resource to those interested in the current state of knowledge about each of the four topic areas

TRB Committees, AASHTO Committees, and research program administration staff are encouraged to review this information in their efforts to identify the most pressing transportation research needs and to develop research problem statements that clearly reflect existing gaps, unexplored topics, and opportunities to leverage previous investments in research.

Table 3: Synthesized Top Ranked Research Ideas, Arranged by Topic Area

	Topic	National Policy (NP) or Practitioner (P)	Research Idea
A	Climate Change	P	How are (or will) strategies for climate change take into account cultural considerations, especially with respect to environmental justice populations and historic values/historic preservation, on transportation projects?
B	Climate Change	P	How can models and methodologies be improved with respect to sensitivity to mitigation strategies such as land use and pricing; GHG emissions; how to quantify GHGs/carbon, and approaches to validating progress toward achieving GHG reduction objectives?
C	Climate Change	NP	How can we facilitate wildlife movement vis-à-vis transportation networks and transportation planning in the face of climate change?
D	Climate Change	P	How will we address uncertainty related to climate change impacts (esp cumulative impacts) in environmental impact analysis, planning, policy, etc?
E	Energy	P	How can energy and environmental modeling be linked to support decisionmaking aimed at energy efficiency for different scales, state plans, MPO plans, and project alternative analyses?
F	Energy	NP	What strategies including incentives and reducing VMT could be explored to build local economies (goods/services) to reduce VMT, increase livability measures and minimize energy use?
G	Climate Change/ Energy	NP	What messages on climate change and energy are most effective with what audiences: decision makers, transportation practitioners, system users? How can we communicate effects, provide options/incentives, policies (i.e. pricing)?
H	Livability	NP	How can we address livability in NEPA and other cross-cutting legislation?
I	Livability	P	How can we integrate and strengthen the relationship between land use and transportation planning?
J	Livability	P	How do we define livability and what are the best metrics for measuring it? Are there different implications for land use and transportation planning at the local level and what are the differences in urban and rural contexts?
K	Sustainability	NP	Do we need to change old assumptions in our travel forecast models to account for rising gas prices (VMTs), economic variability, generational perspectives and personal behaviors?
L	Sustainability	NP	How can transportation sustainability be balanced with affordability?
M	Sustainability	NP	What are the sustainability indicators for systems architecture, to measure ecology, economy, efficiency, equity? What are the baselines and how can we improve performance measures?

Conduct of Research

In addition to research ideas, workshop participants and conference attendees were asked to provide input on the conduct of research. Many comments addressed improving the effectiveness of dissemination of research results and products. Suggested ways to do this include:

- Continuing the recent approach of webinars with research team presenting results; webinars need to have some consistency in format, schedule, etc. to be most effective. Expand webinar program to be more interactive and inter-disciplinary.
- FHWA Division staff could play a key role in condensing and delivering research findings to state, Tribal, and local agencies.
- Additional outreach tools could include briefs written in non-technical language so as to be accessible to managers and non-transportation audiences.
- Make a more concerted effort to reach out to agency leadership and engage them on developing research projects and delivering results to improve up-take of research findings.
- Provide an on-line media kit and speakers bureau to reach out to stakeholder groups.
- Use technology tools, including visualization, to help decision makers and the public understand the implications of research results.
- Hold follow-up sessions at related conferences to further develop ideas.
- Use research to foster pilot implementation projects, especially those that deliver projects more quickly and effectively.

The need to continue to improve outreach and deliver research results to transportation professionals is also pointed out by the number of research ideas that are closely related to or somewhat duplicative of completed research. Another area that received considerable comment was related to elements that should be given greater consideration in RFPs and proposal evaluation:

- Incorporate communication plans and strategies into RFPs
- Require respondents to RFPs identify individuals on the research team who have presentation skills to ensure research is well-presented at conferences
- Include a requirement for quantifiable deliverables in RFPs, such as for studies involving a survey, a minimum number of survey responses are required to ensure valid conclusions can be drawn

A third area receiving attention is the administrative and review panel structure. Suggestions to improve project administration and oversight include:

- Broaden the base of participation on review panels, perhaps by providing support for staff participation on panels

- Include non-transportation stakeholders on review panels
- Seek mixed project teams with closer collaboration and coordination between academics and consulting firms
- Use video conferencing or webinars rather than face-to-face panel meetings

See Appendix C for a full listing of comments received related to the conduct of transportation research, both during the TRB conference and the compilation of the white papers.

4 NEXT STEPS AND CLOSING COMMENTS

The 2010 TRB Environment and Energy Conference convened a unique and dynamic mix of practitioners, researchers, policy-makers, and program managers. Collectively this group generated over 100 research ideas that touch on a broad range of persistent and emerging research needs. These ideas, however, will need considerable refinement before they can be formally released as research projects. Many of the ideas are very broad, effectively consolidations of various subtopics, which might be better approached through multiple, more tightly focused research questions. Other ideas are very closely related to or duplicative of completed work or research currently underway; any new research problem statement will need to define the opportunity to extend existing research rather than duplicate it. Before submitting an idea, it is wise to consult databases of existing research (TRISOnline at <http://tris.trb.org>), research in progress (RiP at <http://rip.trb.org>), and research problem statements (TRB's RNS at <http://rns.trb.org> and AASHTO's TERI at http://environment.transportation.org/teri_database).

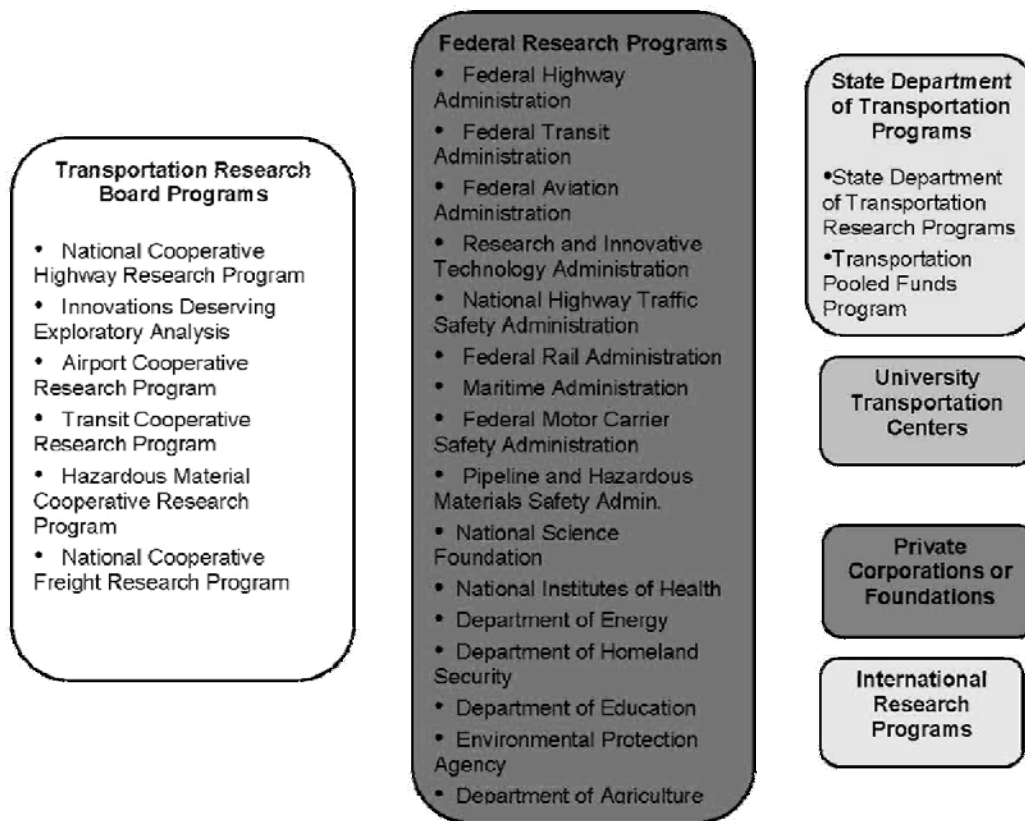


Figure 2: Funding Sources for Transportation Research²

² Figure source: *Funding Sources for Transportation Research. Competitive Programs*, TRB Conduct of Research and AASHTO Standing Committee on Research Committees, December 2008. Available at: <http://www.trb.org/ResearchFunding/ResearchPrograms.aspx>

Further thought and analysis is required to identify the best research funding pathway for each idea. Figure 2 provides an overview of TRB, Federal, State and other programs that support transportation research. Federal funding also supports the databases referenced above.

The funding entities vary considerably in their research focus areas, so for a research idea to evolve into a funded project, several aspects must be fully considered. According to the TRB/AASHTO report, these aspects include: ³

- **Geographic Relevance:** How widespread is the problem? International, national, certain regions of the US, one or two states, or a smaller number of more local places? Bear in mind that a research statement focused on a more localized problem while explaining how the research product could benefit a national audience can be successful in securing support.
- **Transportation Mode or Topic:** If the research focuses on a specific mode of transportation, the decision about the funding source may be simplified, because many research programs focus on such modes. If, on the other hand, the research need focuses on policy, administration, or other modal-neutral transportation issues, the appropriate program may be less clear cut. In addition, some research programs fund only certain topics.
- **Funding Required:** Research programs vary widely in the maximum amount of money provided for each project. It is important to understand the funding-level guidelines and limitations of a research program when considering a research statement submittal. Proposing a \$400,000 project to a program that funds projects of \$100,000 or less will not get the research statement funded. At the same time, the budget must reflect the complexity of the research question, the anticipated staffing requirements, and the general project timeline. Looking at the budgets of similar projects that have been successfully funded will offer guidelines on general funding requirements.
- **Urgency:** Research programs vary in their time frame for delivery. Finding a research program that matches the urgency of your research statement is critical. In some programs, it may take up to 3 years from the submission of a research statement to publish a research report. Other programs are designed to deliver results much more quickly, with turnaround in as little as 6 months.
- **Type of Research Needed:** Transportation research can be as fundamental as testing materials for transportation infrastructure or as detailed as a statistical analysis of large data sets to identify the public's response to rising gas prices. Applied research exists somewhere in the middle of the spectrum, using fundamental research to solve technical transportation problems, improve current practices, or explore policy implications.

³ List adapted from *Funding Sources for Transportation Research. Competitive Programs*, TRB Conduct of Research and AASHTO Standing Committee on Research Committees, December 2008, p. 7-8. Available at: <http://www.trb.org/ResearchFunding/ResearchPrograms.aspx>

- **Partnerships Offer Opportunities for Cost Sharing:** Some programs require cost sharing or a local match. The selection of your project may require that your research statement include information on where additional funding is available. For other research programs, cost sharing may not be required but could enhance the project's chances for success.

Careful attention to these characteristics of a research idea will help properly frame the work needed and bring it to the funding entity most likely to recognize the value a specific project will deliver to the transportation industry. At the same time, even well-crafted problems statements have no guarantee of being funded; for example, of the 100 or so problem statements received each year by the NCHRP, approximately 35 are funded.⁴

Additional details about the various research programs, including generalized schedules for submitting problem statements, are available in the TRB/AASHTO report.⁵

Developing a sound and successful research problem statement, especially one that addresses a cross-cutting topic such as the four topic areas highlighted at the Cross-Cutting Environmental Research Needs Workshop, requires collaborative work. To support collaboration, the names and contact information of individuals interested in collaborating in the development of research problem statements were collected. A tabulation of names and contact information for those who reported specific interest are provided in Appendix G. TRB Committee Chairs and their respective research needs subcommittees are encouraged to use their Committees as a convening point to coordinate and engage individuals interested in developing topics that coincide with Committee interests. For further reference the complete listing of conference attendees is provided in Appendix J.

In closing, the TRB Environment and Energy Research Conference provided a unique opportunity to initiate a conversation on transportation research needs. That conversation began during a pre-conference, Cross-Cutting Environmental Needs Workshop that generated some 100 research ideas which address the needs of national policy development as well as improvement of practitioner approaches. Over the following three days, an additional 100 ideas were submitted by conference attendees. All of the ideas are related to four topics of cross-cutting interest and concern, both within the transportation sector and among our stakeholders. As the entities that support transportation research develop their research agendas for the coming five years, the ideas and priorities developed during the workshop and the conference should help them develop research programs that are timely, focused, and of value as the industry seeks to live up to the conference theme: Better Delivery of Better Transportation Solutions.

⁴ Reported on the webinar *Writing an Effective Problem Statement*, presented by TRB, July 2009.

⁵ *Funding Sources for Transportation Research. Competitive Programs*, TRB Conduct of Research and AASHTO Standing Committee on Research Committees, December 2008. Available at: <http://www.trb.org/ResearchFunding/ResearchPrograms.aspx>

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