Research Agenda for the 21st Century

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As noted in the Conference on Refocusing Planning for the 21st Century (hereafter referred to as the refocusing conference), held in Washington, D.C., much has changed over the 40 years that we have been holding such conferences. Not only are the types of issues different, but the technology of planning has evolved so rapidly that we are now contemplating analyses at the microscale of the individual traveler. Only 10 years ago these analyses would have appeared like something out of "Buck Rogers." As I pointed out in my background paper for the refocusing conference, the future could hold even more challenges for the planning profession.

This paper describes a framework for a research agenda on refocusing transportation planning for the 21st century. This is truly a daunting task given the diversity of interests and needs that are represented by those who plan and by those who (we hope) use the results of this planning. The results of the refocusing conference serve as the basic point-of-departure for this agenda, but the proposed research framework is designed to allow constant revisions to the agenda to reflect changing societal and technological contexts, many of which we cannot even imagine today. This flexibility, after all, is one of the important characteristics of a successful research program.

FRAMEWORK FOR A NATIONAL AGENDA FOR TRANSPORTATION PLANNING RESEARCH

The refocusing conference resulted in substantive recommendations from 52 different workshop areas (see Appendix A: Workshop Reports, p. 199). Each of these workshops provided a list of action items or research needs specific to that workshop topic. These 52 areas were further aggregated into 11 issues that appeared to cut across all topic areas. The overall goal of the research program (the so-called umbrella issue) was to develop a more robust planning process (see Figure 1).

Linking the results of the first conference to a national planning research agenda is difficult without having some framework that shows how proposed research relates to key issues and how one research result relates to another research effort. Simply taking the 11 issues shown in Figure 1 and stating them as research agenda items misses some of the building-block aspects of more fundamental research that is critical in understanding the underlying phenomena being studied. A national agenda for transportation planning research should thoughtfully identify those fundamental issues that (a) lead to new insights into the context of planning, (b) suggest new tools and approaches for enhancing the planning process, and (c) put in place an early warning system for research needs that will prepare the profession for the exigencies of the future.

• Human performance and behavior (e.g., combating fatigue, reducing human error, enhancing performance, readiness testing, and operator overload);

• Sensing and measurement (e.g., sensors embedded into structures and vehicles to provide information on performance and location, to monitor weather conditions, and to provide real-time weather information);

• Advanced materials (e.g., high-performance concrete, new steel alloys, composite materials and adhesives, and new approaches to corrosion control);

• Computer, information, and communications systems (e.g., systems design and software engineering, wireless communications, integration of the Global Positioning System, and "high-confidence" systems);

• Energy and environment (e.g., advanced propulsion systems with reduced emissions, such as electric drives, flywheels, and hybrid engines); and

• Tools for modeling, design, and construction (e.g., models and simulations to support design and planning, construction, operations, and transportation logistics).

Research in each of these areas was viewed as "enabling" the further development of approaches and technologies that would lead to an improved transportation system.

It is interesting to note that during this workshop, participants concluded that two additional focus areas for enabling research were necessary: (a) focusing on social, economic, and environmental issues and (b) focusing on institutional issues. Both of these focus areas have a significant presence in the research needs that were identified during the refocusing conference.

The next level of research in the framework uses the understandings that come from enabling research to develop alternative tools, techniques, and methods for use in the planning process. An example of this level of research is the Travel Model Improvement Program, an effort to improve systematically transportation modeling in the United States. The enabling research in this context would be a better understanding of travel behavior and urban activity patterns and the relationships between the two. The tools would be the improved models that are based on this new knowledge. Examples of what this type of research can focus on is shown in the following three objectives that were established for this program:

1. Increase the ability of existing travel forecasting procedures so as to respond to emerging issues that include environmental concerns, growth management, lifestyle, and traditional issues;

2. Redesign the travel-forecasting process to reflect changes in behavior, to respond to greater information needs that are placed on the forecasting process, and to take advantage of changes in data-collection technology; and

FIGURE 1   Issues from refocusing conference.

In its simplest form, Figure 2 shows a framework for developing such a national agenda. A key concept in this framework is that there are fundamentally different types of research efforts that build off of one another. At the base of the research framework is "enabling research." This term is borrowed from a recent Transportation Research Board workshop on enabling transportation research (1). Enabling research was defined in this report as "basic and applied research and technology development that supports...long term goals. The characteristics of this type of research that make it appropriate for federal funding are that it is long-term, high-risk, and cross-cutting such that no single private company could manage and benefit from the requisite investment." The six areas of enabling research in support of the long-term goals of the nation's transportation system include
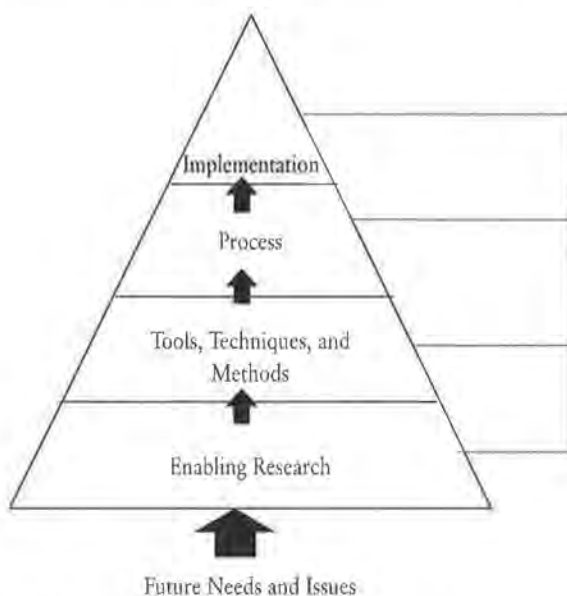

FIGURE 2   Framework for planning research.

3. Integrate the forecasting techniques into the decision-making process, providing a better understanding of the effects of transportation improvements and allowing decision makers in state and local governments, transit operators, metropolitan planning organizations, and environmental agencies the capability of making improved transportation decisions.

This type of research should be part of a national planning research agenda, however, not at so dominant a level that resource demands overwhelm other legitimate research needs.

The third level of research in the framework, and somewhat unique to the transportation community, emphasizes the process of planning. Research on the planning process could include the (a) investigation of interrelationships between transportation planning and other planning programs (e.g., transportation and air quality); (b) examination of the steps that are necessary to ensure a participatory and an inclusive process (e.g., public involvement strategies); and (c) assessment of the relationship between the planning process and political decision making or institutional contexts. Research on process is often multidisciplinary and reflects changing demands on transportation planners to produce new information on issues that are of great concern to today's political agenda.

The final level of research focuses on the steps that are necessary to implement new processes or methods, or both. This research could include such topics as innovative outreach efforts to educate customers of the planning process, professional development activities to train the existing professional community, and programs to educate the next generation of professionals. Although, in a strict sense, these activities are not often considered research topics, such investigations are critical elements of successfully translating research results into practice.

The framework that was shown in Figure 2 can be a useful point-of-departure for the development of a national agenda for planning research. One can simply apply this framework by asking questions that relate to each level of research, to the changing needs of society, and to our customers who drive the research agenda. Thus, the following sequence of questions appears appropriate for the development of a comprehensive and coordinated agenda. The first question was the focus of the refocusing conference.

1. What are the current and likely future characteristics of society that will affect travel behavior and how we provide transportation services? (which leads to)
2. What are the core economic, technological, and social research needs that relate to these characteristics, and which are necessary before the development of

tools, methods, and processes that will allow transportation planners to provide useful information to the decision-making process? (which leads to)
3. What tools, techniques, and methods are needed to better assess the impact of changing system and community factors? (which leads to)
4. What are the desirable characteristics of the planning process that not only use the outputs of these tools and methods, but also reflect a more responsive and open participatory approach toward planning? (which leads to)
5. What steps are necessary to implement both the process and the tools in a way that is understandable and useful to users and customers alike?

As an illustration of this construct, the following sequence of questions relates to one of the key demographic characteristics of the future—an increasingly older population. A possible research agenda on this issue might include the following:

• *Issue:* The percentage of urban Americans that are elderly will increase significantly over the next 20 years.
• *Enabling Research:* What are the important relationships between age and travel characteristics, especially given the likely mobile nature of tomorrow's older Americans?
• *Tools:* How do we incorporate consideration of an aging population into demand models and service strategies to reflect this increasingly important travel market?
• *Process:* How do we include the concerns of older Americans in the planning process, and which groups should be invited to represent this constituency?
• *Implement:* What outreach strategies can be used to educate this population (one that is likely slower in visual acuity and reading comprehension) on transportation needs and choices?

Note that in Figure 2 there are feedback loops so that discoveries or needs at higher levels of the research hierarchy provide input into fertile research directions that should occur at more fundamental levels. Thus, for example, process changes that require a closer linkage between transportation and sustainable communities might well need new tools and methods to measure "sustainability" in the context of transportation, which in turn, may require more fundamental research that examines the social, economic, and environmental relationships in an urban ecology. A successful national research agenda is constantly updating research needs as the decision-making context changes and as more information about the needs of the planning process becomes available.

APPLYING THE FRAMEWORK TO THE REFOCUSING CONFERENCE

If one accepts the framework presented in Figure 2 as a plausible approach toward defining research needs, then the results of the refocusing conference can be applied to this framework to determine where gaps might occur in a comprehensive research agenda. Figure 3 shows the 11 crosscutting issues that were defined in the first conference and how they map onto the framework. Note that it is possible for each issue to consist of research needs at all levels of the hierarchy. One of the observations that surfaces from this mapping is that the research category that relates to tools, techniques, and methods appears to be underrepresented. However, further disaggregation of the 52 workshop research topics shows, in fact, a more balanced set of research needs. These results are shown in this paper's appendix.

With this finer level of disaggregation of the research projects, we continue to see the importance of process-oriented research topics. However, the category of research on tools, techniques, and methods becomes much more expansive with ideas for tools and methods that span a variety of topics. The results of the refocusing conference thus provides a good point-of-departure for the identification of a national agenda on transportation planning research in each of the categories shown in Figure 2.

MY OWN THOUGHTS

The process of identifying a national agenda can be "directed" in a variety of ways. As noted earlier, a logical starting point is the identification of enabling research, that is, those issues, societal trends, and needs for knowledge that lead to subsequent research on the planning process and the tools that are used in this process. A national research agenda for transportation planning should anticipate the information needs of future decision makers and immediately put in place the creation of knowledge that will inform these decisions. Although the list of enabling research topics that is presented in the appendix of this paper is a good beginning, it is by no means comprehensive (and thus should be examined first at this conference).

To provide some imagination to this process and to "test" the comprehensiveness of the refocusing conference results, I have listed the following scenarios from a recent "futures" book. As noted by the authors, "these high-probability forecasts become assumptions in understanding how any particular area may develop under the influence of new scientific, technological, social, political, or economic developments...the convergence of evidence indicates that these 107 developments are of such high likelihood that they form an intellectual substructure for thinking about any aspect of the year 2025" (2). Only those forecasts that are directly relevant to transportation or to travel behavior are listed here.

- Everything will be smart, that is, responsive to its external or internal environment.
- More people in advanced countries will be living to their mid-80s while enjoying a healthier, fuller life.
- Remote sensing of the earth will lead to monitoring, assessment, and analysis of events and resources at and below the surface of land and sea.
- Per capita energy consumption in the advance nations will be at 66 percent of per capita consumption in 1990; such consumption in the rest of the world will be at 160 percent of 1990 per capita consumption.
- Throughout the middle and prosperous class of the advanced nations, face-to-face, voice-to-voice, person-to-data, and data-to-data communication will be available to any place at any time from anywhere.
- Ubiquitous availability of computers will facilitate automated control and make continuous performance monitoring and evaluations of physical systems routine.
- Virtual reality technologies will be commonplace for training and recreation and will be a routine part of simulation for all kinds of physical planning and product design.
- The fusion of telecommunications and computation will be complete. We will use a new vocabulary of communications as we televote, teleshop, telework, and tele-everything.
- New infrastructures throughout the world will be self-monitoring.
- Interactive vehicle-highway systems will be widespread...rather than reconstruct highways, engineers may retrofit them with the new technologies.

FIGURE 3 Crosscutting issues applied to framework.

• Applied economics will lead to greater dependency on mathematical models embodied in computers. These models will...routinely integrate environmental and quality-of-life factors into economic calculations. One major problem will be how to measure the economic value of information and knowledge.

• Family size will be below replacement rates in most advanced nations.

• The majority of the world's population will be metropolitan, including people living in satellite cities clustered around metropolitan centers.

• NIMBY [not in my back yard] will be a global-scale problem for a variety of issues, ranging from hazardous-waste disposal to refugees to prisons to commercial real-estate ventures.

• Worldwide, there will be countless virtual communities based on electronic linkages.

• The absolute cost of energy will rise, affecting the cost of transportation. Planners will reallocate terrain and physical space to make more efficient use of resources. In other words, cities will be redesigned and rezoned to improve efficiencies in transportation, manufacturing, housing, etc.

• Sustainability will be the central concept and organizing principle in environmental management, while ecology will be its central science.

• Going to work will be history for a large percentage of people. By 2020 or 2025, 40 percent of the workforce will be working outside the traditional office.

• Privatization of many highways, particularly beltways and parts of the interstate system, will occur.

• Fuel cells will be a predominant form of electro-mechanic energy generation.

• 120-mi-per-gallon cars will be in widespread use. (2)

If these are indeed likely characteristics of the future, my own list of enabling research that should be found in a national agenda for transportation planning research is shown in the following list:

• Sustainable development, equity, and urban ecology;
• Technology and its impact on urban form, travel behavior, and planning;
• System management in its broadest sense; and
• Demographic changes and implications for transportation planning.

Although there are only four topics listed, each could be expanded to include a variety of different emphasis areas. These topics correspond nicely to the enabling research topics identified in the appendix of this paper. The enabling research provides "point-of-departure" knowledge that leads to other research needs that more directly affect the actual process of transportation planning.

SUMMARY

This paper has suggested a framework for conceptualizing a national agenda for refocusing transportation planning research. In addition, it has suggested areas of research for the initial step in the creation of an agenda-research that should lead to additional research that is more focused on process and tools. Such a framework is necessary to organize and link different research initiatives while providing a bridge to likely future issues.

There very well might be additional enabling research topics that are deemed important by this conference. However, this conference should make sure at the outset to have in place a research agenda that will provide the information and knowledge that is needed and desired to inform future policy and policy decisions. With input from the refocusing conference, we have taken a giant first step in defining the starting point. This conference will hopefully get us to the next level of detail and relevance.

APPENDIX: RESEARCH IDEAS LISTED BY CATEGORY

Enabling Research

• National poll to determine public satisfaction and desire for transportation service
• Understanding and support for management and operations
• Freight industry and movement of cargo
• Relationship between technology and travel behavior
• Technology and planning for sustainability
• Understanding information transfer and role in community
• Parking

Tools, Techniques, Methods

• Research on economic development and quality of life improvements that will help local groups understand impacts
• Produce tools, methods, and data to produce information for decision makers on relationship between transportation and broader issues
• Tools and techniques for freight planning
• Develop national and international freight-flow model
• Demographic and economic changes need to be reflected in models
• Management and operations consideration in analysis tools

- Benefit-cost approaches
- ITS data
- Performance measures
- Policy-sensitive models
- Access-to-job factors in models
- Incorporate outcomes into analysis methods
- Multimodal analysis tools
- Better air quality tools
- Quick response tools
- Multiobjective tradeoff analysis
- Sketch planning tools
- Database integration
- Revenue-forecasting techniques
- Induced travel
- Better pedestrian models
- Efficient motor vehicles
Environmental impact analyses of technology options
- Growth management-related tools
- Tools to analyze redevelopment potential of existing neighborhoods
- Multimodal infrastructure options
- Incentive programs for transit-oriented development
- Trip capture analysis
- Alternatives to an auto-dominated environment
- Comprehensive data on pedestrian use and safety
- Transit deregulation

Process

- How to engage the public and agencies in the planning process?
- Best practices on community engagement
- Public involvement and National Environmental Protection Act (NEPA) requirements
- Better means of communicating with and gathering information and ideas from public
- Toolbox for planning outreach
- Who will be customer of the future?
- Evaluate outside reviews
- Decision making and accountability-best practices
- What is planning influence on decision making?
- Identify relationships between transportation and broader outcomes
- How to shorten turnaround time for plan analyses and processes?
- How to make tradeoff analysis more understandable and useful to public and decision makers?
- Historical perspective on effectiveness of regional plans
- Strengthening criteria of the Intermodal Surface Transportation Efficiency Act of 1991 in plans and programs

- Create decision mechanisms that more closely tie plans to implementation
- How to break down planning activities into manageable units?
- Should an empowerment zone for planning be created?
- How to place planning in larger context of community responsibility and values?
- Best practices for visioning
- Planning approaches for freight
- Synthesize best practices on freight issues in transportation planning
- How to bring waterway representatives into the planning process?
- Better integration of technology choices into planning process
- Broaden scope to include systems perspective
- Increased participation of the private sector in planning
- Integration of transportation and land use planning
- Models on new cooperative relationships
- Institutional roles and responsibilities for sustainability
- How to incorporate NEPA into business decisions?
- Models for multimodal decision making
- Incorporating system engineering and operations planning into planning process
- Best practices on aligning planning and programming
- Rural and public lands best practices for transportation planning

Implementation

- Development of advanced software packages that provide forecasting capability
- Better information on international regulations, activities, and planning
- Professional training-capacity
- Federal funding support for institutional capacity building
- Educate public land managers

REFERENCES

1. *Summary Report: Workshop on Enabling Transportation Research.* TRB, National Research Council, Washington, D.C., 1998.
2. Coates, J., J. Mahaffie, and A. Hines. *2025—Scenarios of U.S. and Global Society Reshaped by Science and Technology.* Oakhill Press, Greensboro, N.C., 1997.