MTI Report WP 07-03

Creating an Educational Network in California to Assess and Address its Future Transportation Education Challenges

MTI

Mineta Transportation Institute

Created by Congress in 1991

MINETA TRANSPORTATION INSTITUTE

The Norman Y. Mineta International Institute for Surface Transportation Policy Studies (MTI) was established by Congress as part of the Intermodal Surface Transportation Efficiency Act of 1991. Reauthorized in 1998, MTI was selected by the U.S. Department of Transportation through a competitive process in 2002 as a national "Center of Excellence." The Institute is funded by Congress through the United States Department of Transportation's Research and Innovative Technology Administration, the California Legislature through the Department of Transportation (Caltrans), and by private grants and donations.

The Institute receives oversight from an internationally respected Board of Trustees whose members represent all major surface transportation modes. MTI's focus on policy and management resulted from a Board assessment of the industry's unmet needs and led directly to the choice of the San José State University College of Business as the Institute's home. The Board provides policy direction, assists with needs assessment, and connects the Institute and its programs with the international transportation community.

MTI's transportation policy work is centered on three primary responsibilities:

Research

MTI works to provide policy-oriented research for all levels of government and the private sector to foster the development of optimum surface transportation systems. Research areas include: transportation security; planning and policy development; interrelationships among transportation, land use, and the environment; transportation finance; and collaborative labor-management relations. Certified Research Associates conduct the research. Certification requires an advanced degree, generally a Ph.D., a record of academic publications, and professional references. Research projects culminate in a peer-reviewed publication, available both in hardcopy and on *TransWeb*, the MTI website (http://transweb.sjsu.edu).

Education

The educational goal of the Institute is to provide graduate-level education to students seeking a career in the development and operation of surface transportation programs. MTI, through San José State University, offers an AACSB-accredited Master of Science in Transportation Management and a graduate Certificate in Transportation Management that serve to prepare the nation's transportation managers for the 21st century. The master's degree is the highest conferred by the California State University system. With the active assistance of the California Department of Transportation, MTI delivers its classes over a state-of-the-art videoconference network throughout the state of California and via webcasting beyond, allowing working transportation professionals to pursue an advanced degree regardless of their location. To meet the needs of employers seeking a diverse workforce, MTI's education program promotes enrollment to under-represented groups.

Information and Technology Transfer

MTI promotes the availability of completed research to professional organizations and journals and works to integrate the research findings into the graduate education program. In addition to publishing the studies, the Institute also sponsors symposia to disseminate research results to transportation professionals and encourages Research Associates to present their findings at conferences. *The World in Motion*, MTI's quarterly newsletter, covers innovation in the Institute's research and education programs. MTI's extensive collection of transportation-related publications is integrated into San José State University's world-class Martin Luther King, Jr. Library.

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Overview

The network proposed in this paper would focus on several possible future scenarios for transportation in California, assessing their potential impact on citizens of the state and elaborating appropriate policy responses. Some of the proposed transport scenarios could be considered and ultimately acted upon by policy makers.

Introduction

Because of California's significant economic size and extensive domestic and international trade as well as its vast and diverse transportation sector, one can argue that its ability to maintain an efficient economic system is of tantamount importance to maintaining effective economic links with other states and the rest of the world, and can contribute to its trade growth and overall economic prosperity. Without effective and efficient transport services, the lives of most Californians would be significantly deteriorated. Yet, despite transport's critical role in enabling California's economic development, there exists no significant coordinated, multidisciplinary and systematic effort to understand where this state's transport network is heading, could or should head or how it can be more effectively linked to other domestic and international transportation networks.

Analysts in industry, government, non-profit sectors and universities already engage in a wide range of very high quality and valuable research projects. However, there is a great need for statewide research program to integrate these efforts and to generate synergies from the resulting findings. A multi-disciplinary exploration of California's transportation future offers the best opportunity to help leaders in industry and government reach the decisions they will face in resolving problems that are now on the horizon and thus help with the effective development of California's transportation sector as well as its overall economy.

California's current transportation trends are unsustainable along at least three dimensions, presenting significant challenges that industry and government must address or continue to address during the next decades. These include:

- Transport's global energy demands will have outstripped the supply of moderately priced hydrocarbon-based sources during the next decade, precipitating an urgent need for new applications and adaptations of transport technology that will affect all mobility modes.

- The spatial effects of transport development in California over the past 50 years have exacerbated the sprawl of housing, raising infrastructure costs and causing large numbers of Californian's to engage in auto-dependent lifestyles with negative public health and social impacts.

- California's transport activities generate environmental consequences in terms of pollution as well as other costs primarily related to pollution management and cleanup. Transportation activities-related pollution significantly exceeds the absorptive capacities of local and global ecosystems, thereby harming all life. In situations where this is the case, children and the elderly bear a disproportionate burden of the related health and social effects. Because of these challenges, the concern of energy availability and affordability may have the most urgent importance.

Accordingly, this third factor dominates the initial elaboration of the transport scenarios that could be explored. Failure to adequately prepare for what will become an era of significant changes in the transport fuels that are used, and in how they are used, could have especially debilitating consequences for California's social and economic construct. Also pressing are the problems posed by locally and globally acting emissions from the use of transport fuels, including the avoidance of further climate change. California, primarily via federal leadership, is addressing its potential Kyoto Protocol obligations with great difficulty today, yet it possesses stricter environmental standards than most of the rest of the country. However, the challenges that could arise after 2012, a period for which further commitments could be sought, could well be much more difficult.

Meeting the energy, environmental, and social challenges posed by current transport federal and global trends will require new analytical approaches and imaginative mitigation strategies. A transportation research network that crosses disciplinary boundaries, with links to similar activities worldwide, offers the best opportunity to focus otherwise disparate research efforts and yield insights that can help put California's transport on a path toward sustainability. Knowledge of how to better address these problems at a systemic level will pay great dividends by informing more effective solutions.

FOCUS OF THE RESEARCH

Research Network Focus

Engaging California's leading researchers and academics with transportation expertise and in a common focus on the future will require a network that can accommodate wide-ranging disciplinary perspectives while synthesizing the often disparate findings of these different approaches and effectively communicating results to industry and government officials who could make effective use of them.

In elaborating and assessing California's possible transport futures and their impacts, and in developing appropriate policy responses, three specific types of issues need to be taken into account, including

- environmental and safety issues;
- resource and technological issues; and
- economic, cultural, social and governance issues.

It is difficult and certainly not desirable to ascertain disciplinary lines between these issues. Most of these issues reach across all three areas of focus. For example, economic factors significantly influence and are influenced by technological and health considerations; environmental factors profoundly influence and are influenced by technology and the economy.

Environmental and safety issues

The primary task of this network's area of study is the careful assessment of the relevant impact of chosen transport futures, and working with elements of resource and technological areas, along with economic, cultural, social and governance areas as appropriate. Topics of concern to this domain would comprise all aspects of transport's impact on human health and safety including but not limited to air, water or noise pollution. The implications of the transport futures for children, the elderly and other vulnerable groups would be of special concern.

Resource and technological issues

The primary task in this network's area of study will be the assessment of resource availability, and opportunities for technological improvements in fuel extraction and delivery, vehicles, and infrastructure within the overall framework of exploration of the chosen set of transport futures. This area of study would have some responsibility for development of the transport activity aspects of the chosen set of transportation futures, to the extent they are influenced by technological considerations. Economic and other aspects of human behavior are the primary drivers of transport behavior. This area of study would also have considerable responsibility for assessment of the environmental impacts of the chosen set of transport futures, particularly the production of pollutants and assessment of their impact on non-human species.

Economic, social, and governance issues

This network's area of study encompasses the widest range of factors, extending from economic considerations through implications for social cohesiveness and human well being to matters of governance. Perhaps more than the other abovementioned areas of study, it would provide for some integration of the overall study's findings, although the larger part of this function would be performed by the support service discussed in the next section. Economic considerations would include, but not be limited to, an assessment of the implications of the chosen transport futures for the economic security of the people of California, and elaboration of economic factors in the unfolding of the scenarios, including pricing and fiscal policies. Socio-behavioral considerations would include the interactions of transport systems and land-use arrangements, and the implications of the chosen futures for community social structure and social equity. Governance considerations would include, but not be limited to, matters of regulation and de-regulation, institutional factors, and the roles of local and state governments versus market and other factors in changing transport activity and in securing specific transport futures.

Research integration: the network support service

Effective integration of the findings from each of the areas of study is an essential element to the network project success. Primary responsibility for this integration needs to reside with each component of the overall network, while the network support service would take the lead in combining all of these efforts into a coherent whole, particularly from a policy perspective. The overall network support service would guide initial development of the scenarios to be explored and modify those scenarios in the light individual research results.

Building on existing efforts

The California Transportation Futures Network would consider all relevant work in California but also in the United States as well as other developed economies around the world that possess coordinated multidisciplinary systems. The core argument in this proposal is a rational complement to the outputs of other national and international efforts that can provide important and tools for understanding the transport activity of individuals and communities in California, with some focus on the different roles that urban form can play in influencing travel behavior.

These tools could be invaluable in developing desired transport outcomes for the future, and in understanding the interplay of the factors relevant to securing or avoiding a particular transport future. We should always remember that California, despite its status as part of the U.S., is a sizeable and advanced economy in its own right with direct international trade links and transportation needs of its own.

An exiting U.S. network, STELLA (Sustainable Transport in Europe and Links and Liaisons with America: www.stellaproject.org) provides a framework and exiting and developed work program that can benefit California's efforts toward a multidisciplinary approach. Another possible relevant network is the Canadian Atlantic Project, a partnership to advance information technology services (ITS) research in Canada, in concert with European and U.S. partners, involving several Canadian universities, business interests and government departments.

Other efforts from the private sector include interest groups such as the Apollo Alliance (www.apolloalliance.org). The work of alliances as such should also be examined. Apollo is described as "… a coalition of business, labor, environmental and community leaders working together to catalyze a clean energy revolution in America that will simultaneously promote energy security by reducing our dependence on foreign oil, secure environmental stability by investing in renewable energy resources and conservation technologies and programs, and spread a new wave of broadly shared economic prosperity across our nation." The Apollo Alliance, being based in California along with its body of research could be of interest to the proposed network.

Education, the future transportation experts and professionals

No comprehensive research network that is focused on transport futures should ignore the matter of developing the skills that will be needed to turn California's transportation strategies into reality, given the symbiotic relationship of research and education. Aside from a small number of universities that graduate a handful of transportation professionals each year, postsecondary institutions across the state lack the number of faculty necessary to offer a comprehensive academic program in transportation. A network as the one proposed here could facilitate the pedagogical goals to educate the future of transportation professionals for California and beyond as

it would be poised to build capacity in transportation education by supporting students in several ways.

First, all researchers participating in the network would be expected to include graduate, and, where appropriate, undergraduate assistants in their research teams. The resulting flow of funds to students would significantly expand the current academic support that is now targeted toward transportation education at public and private universities in California. Such funding opportunities are a necessary component in attracting students into advanced transportation studies in engineering, the sciences, and business.

Second, by participating in research that yields insight into California's future transportation possibilities, students will be exposed to cutting edge analytical techniques and gain problem solving skills well beyond what they could acquire from existing courses.

Third, the proposed academic network would facilitate internships for students who have participated in research with industry and government agencies in California's transport sector.

There is a need for an approach capable of reaching across all relevant disciplines and pulling together their individual contributions. In full understanding of the numerous interdependencies, the next three sections set out illustrative research domains for each of the three kinds of factors.

SPECIFIC SCENARIOS TO BE CONSIDERED

1. **Business as usual with no energy constraints**. This means continuation of present trends modified only by ordinary market fluctuations and current or clearly anticipated government policies. In particular, oil is assumed to remain no less available than it is today, settlement patterns of homes and businesses remain similar to current configurations, environmental and health impacts of transport continue, and, most importantly, passenger and freight transport activities continue in more-or-less their present trends.

2. **Business as usual with energy constraints**. In this scenario, oil products, which today fuel more than 99 percent of transport activity in California, become increasingly expensive during the period 2010–2030 and remain so indefinitely. The

significant feature of this scenario is that major changes in California's transport systems—in the effects of that system on human health, and in the spatial development patterns that influence transport activity—do not occur until they are forced by a significant and sustained increase in transport fuel costs that are beyond California's control.

3. **Adjustment to energy constraints through anticipatory transport policy**. California's transport policy places a priority on reducing total transport fuel use, particularly use of hydrocarbon fuels, from 2015 or earlier, to ensure the minimum adverse impact on Californians when prices move, and stay, much higher than they are at present. Such preparation could involve implementing policies that reduce dependence on transport, encouraging use of less energy-intensive modes (e.g., rail rather than road), and improving the transport sector's fuel efficiency through a combination of new-vehicle technology and improved operational techniques. This scenario implies absence of strong moves to create an alternative fuel-based transport system.

4. **Creation of a hydrogen-based transport system**. In this scenario, the question as to whether oil prices will rise becomes mostly irrelevant because California's transport systems evolve during the period of concern to reliance on hydrogen as fuel rather than on oil products. Much more than the other three, this scenario relies on the accelerated deployment of as-of-today commercially unproven technology, notably fuel cells but also hydrogen production and storage systems. A particular feature of this scenario could be similar to the first scenario, with present trends in transport activity continuing (if the hydrogen economy were not too costly), although with fewer environmental impacts.

Scenarios 2 and 3 are predicated on the prospect that worldwide oil supply will not keep up with demand as is happening at this time. (Scenario 1 assumes this trend will not continue; Scenario 4 bypasses the question.)

It should be noted there is a considerable coalescing around the prospect that oil supply will peak early in the next decade, as represented in Figure 1. This chart shows what may be the best estimates of supply of oil and natural as liquids (by-products of natural gas extraction that are readily substitutable for oil). Note that oil is projected to remain available for many decades after the forecast peak supply in about 2012. It is not that the oil will run out, only those production volumes will not keep up with potential demand.

Figure 2 depicts oil discoveries and actual and projected demand. Most oil being extracted today was discovered before 1980. Since that year, discovery of new reserves has not kept up with demand. Current mapping techniques suggest that just about all oil that could become available has been discovered. Moreover, much of what has been discovered and not exploited is far from major markets, often in regions that lack basic infrastructure or have extreme climates, or both.

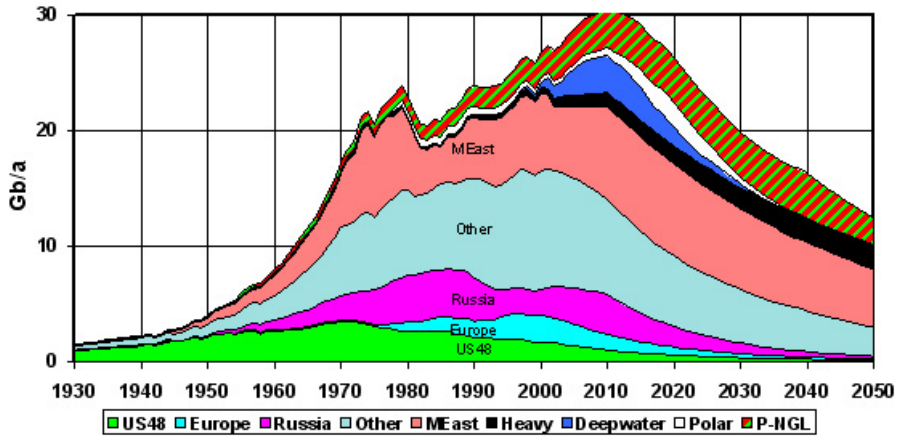

Figure 1 Actual and projected production of crude oil and natural gas liquids

Source: Uppsala Hydrocarbon Depletion Study Group (http://www.isv.uu.se/uhdsg/)

(Note P-NGL refers to propane and other natural gas liquids)

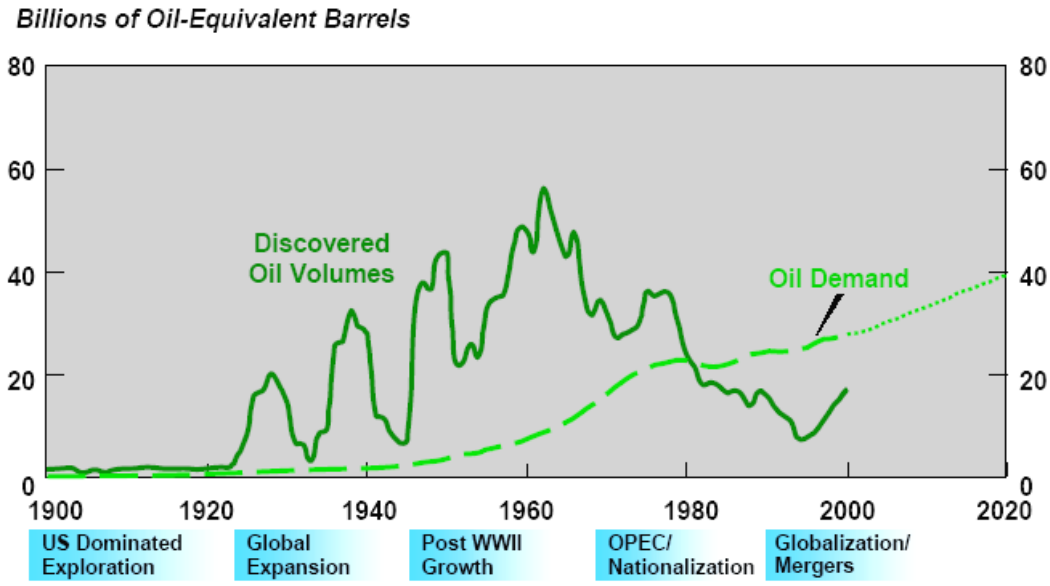

Figure 2 Crude oil discoveries and actual and projected demand for oil

Source: Harry J. Longwell, Exec. VP, Exxon Mobil Corp., Offshore Technology Conference, Houston, Texas, May 7, 2002 (www.exxon.mobil.com/files/corporate/hjlslide3.pdf)

SPECIFIC RESEARCH QUESTIONS

Specific research questions that could be pursued within this transportation research network are:

1. **Research questions common to all or most developed scenarios**

a) What is an appropriate measure for the economic productivity that is generated by California's transportation sector? How can this reckoning best account for the external costs and benefits generated by transportation activities?

b) What rates of return have been generated by investments in transportation infrastructure and operations since 2000? Are these sufficient to support any, some or all of the scenarios for the future?

c) What economic effects can be attributed to the potential commercialization of California's ports and airports?

d) What would be the likely impacts of each scenario on transport activity, both passenger and freight?

f) What would be the likely economic impacts of each scenario, on the economy as a whole and on transport industries in particular?

g) What would be the infrastructure requirements of each scenario?

h) What would be the likely climate-change impacts of each scenario?

i) What would be the likely environmental and health impacts of each scenario, including impacts on ecosystems and human health, broadly defined?

j) What would be the likely social impacts of each scenario?

k) Regarding the last two questions, what would be the specific impacts on vulnerable groups, e.g. children and the elderly?

2. Research Questions in regard to Scenario 1: Business as usual with no significant energy constraints

a) What are the likely impacts of committed and clearly anticipated measures to reduce transport's climate impacts?

b) What are the likely effects of committed and clearly anticipated measures to reduce emissions from transport into air, water, and land?

c) What, if any, technical or economic constraints other than energy or environmental limitations, or both, would limit the growth of transportation demand and activity under business as usual?

3. Questions in regard to Scenario 2: Business as usual with energy constraints

a) What are the prospects for a peak in world oil supplies during the decade after 2015 or later, but before 2035?

b) Could new technologies for saving energy and using alternative sources be introduced quickly enough to cope with or mitigate the effects of oil?

c) Would it be possible to quickly "decouple" the growth of California's economy from a proportional increase in transport activity?

4. Questions in regard to Scenario 3: Adjustment to energy constraints through anticipatory transport policy

a) What role would environmental and public health benefits play in offsetting the costs and concerns of those who would bear burdens from the transition strategy to a non-oil based transportation economy?

b) How could measures concerning transport safety and security support anticipatory policy that transitions California's transportation to alternative fuels?

c) What strategies appear most promising to "decouple" the future growth of California's economy from a proportional increase in transport activity?

d) How would land use need to change to support a significant reduction in energy consumption for transportation? What would these new spatial patterns look like?

e) What would be the likely roles of electric vehicles—battery and tethered—in this scenario, and their infrastructure implications?

5. Questions in regard to Scenario 4: Creation of a hydrogen-based transport system

a) What energy and technology policies would best enable the transition to a hydrogen economy?

b) What would the economic dimensions of a transition to hydrogen-powered transport systems look like?

c) How specifically might the environmental and health impacts of a hydrogen powered transportation system differ from those of the other scenarios, particularly Scenario 1?

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