A New Paradigm for Transportation Planning

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For Presentation at: American Planning Association 2009 National Planning Conference
Minneapolis, Minnesota, April, 2009

Introduction. Fragile Foundations[1] , published in 1988, alerted Congress and the public to the terrible state of American infrastructure. After decades of investing in highway and bridge programs, and in urban transit systems, this report by a Federal Commission found that much of that infrastructure was not in a state of good repair, and that our States and Cities were unable to meet the needs for future demand. Today (2009), growing congestion, rapid increases in goods movement, sustained problems with air quality, and rapidly rising energy costs have made concerns over our infrastructure no less important. Exacerbated by the price tag of infrastructure improvements and additions coupled with growing inability to find adequate funds has sharpened the need for new discussions on how to plan for and invest in our critical transportation infrastructure. This paper addresses the transportation planning process and its limitations for addressing such a complex discussion. It brings to the table new thoughts on Institutions, funding and applications of new technology that must be applied towards understanding and planning for 21st C. transportation investments. The paper begins with a review of the current process and the defining mandates and then examines aspects of these newer dimensions.

Transportation Planning Origins and Mandates. The Federal Aid Highway Acts of 1916 and 1921 had a profound impact on the shaping of the national transportation landscape for the remainder of the 20th Century. Defining elements of Title 23 USC, the body of law and regulations describing Federal aid to highways and bridges, still determine how our surface transport systems are planned, designed and funded. No matter how influenced by current standards of environment, energy use and economic considerations, Title 23 has kept the following requirements:

- In order to be eligible for Federal Aid to Highways, each State must have a Department of Transportation (originally, in 1921, a Highway Department), and
- Federal Aid for Highways will be given directly to these State DOTs.

From the second decade of the 20th C. until the 1980s, the thrust of the US Highway program was to add supply; to increase the paved miles of roads throughout the United States, and to continually improve the design and capacity of those roads. By 1960 there were 1.2 million paved miles of roads in the U.S.; this increased to over 2.2 million paved miles by 1990. The incentive for States to increase supply at such a rapid rate was given by the low amount of State funds needed to match Federal Dollars (10% -50% from the State depending on the level of the road). Transportation planning came of age during the post WW2 period. While planning makes good sense for States and Communities, the mandate to have planning as a requisite for funding was both the carrot and the stick. By 1962, the Bureau of Public Roads (BPR) required States to conduct long range

transportation planning in a comprehensive, coordinated and continuing manner (3-C process). In 1964, the Urban Mass Transportation Act added support for then hungry mass transit systems; finally in 1966, USDOT was formed bringing together the new Urban Mass Transportation Administration and the Federal Highway Administration (formally BPR) under one roof. But the funding for highways still was specified under Title 23USC and for transit under the UMT Act of 1964 (always amended). Because of this almost geometric growth of our transportation networks, the demands and competition for funds from the States was enormous. DOT continued – under the direction of Congress through succeeding highway and transit legislation – to place regulations, guidelines and restrictions on obtaining funds.[2]

The 1991 Intermodal Surface Transportation Efficiency Act (ISTEA) attempted to break the supply driven context of transportation planning. It allowed transfers between highway and transit programs, de emphasized new highway additions, stressed dealing with environmental issues – particularly congestion and air quality and even linked funding to meeting EPA air quality standards. Subsequent legislation, TEA-21 (1997) and SAFETEA- LU (2003) continued the thrust of ISTEA with sustained attention to environmental issues, but, in these successive bills new attention was paid to the growing crisis in the ability to fund increasing needs for infrastructure improvement and growth. However – throughout all of this legislation, no matter how tied to growing concerns over environment in the broadest sense, funding mechanisms and regulations were carried out through Title 23 (Highways) and UMT Act (1964 as amended – transit). Funds for roads continue to be directed to State DOTs and for transit to the transit operators.

An integral part of the planning process as defined by Federal Regulations is the estimate of travel demand for new projects and for TIP certification. Travel Demand Models now used and implicitly approved by FHWA and FTA had their origins in simple computer models designed for regional transportation studies in the 1950s. Developed primarily by civil engineers and economists, the objectives of these models were to estimate transportation network changes due to changes in system demand and supply. Over the last several decades these models have become increasingly sophisticated, using applications from travel behavior theory and from economic utility maximization to help planners determine how and why – and at what cost – individuals travel. The aggregate numbers from these trip purpose and mode choice models are then put into networks to help establish supply – demand relationships – and finally answer a basic question – “Do we need new capacity” and its corollary – “If so, where and in what form”. This level of sophistication has arisen from the nexus of funding agencies, primarily FHWA and FTA and the travel theory community. FHWA and FTA have the responsibility of vetting projects for funding, using EIS and BCA in a highly competitive arena; the results of model outputs, especially peer accepted models, gives comfort to their final decisions. For the greater part of the second half of the 20th C. these tools and regulations driving the planning process were valid. But we now face a planning dilemma. Something is broken in the quality of our transportation and in our ability to put in place a 21st C system. The models have come from an institutional framework that needs to be fixed. There are several forces that are building a need for new approaches to the planning process. Among them are:

- The huge funding gaps between infrastructure needs and available dollars (from any source)[3],
- The difficult and time consuming process of implementing mega projects,

- Emerging questions about the role of the car in a sustainable and high energy cost environment,
- The pressures of globalization and its influence on regional investment decision making,
- National cultural shifts, seen in changing household structures, immigration and increasing national diversity, and a growing generation of totally wired people, and
- Global warming, sustainability and the environment and their evolving impact on quality of life decisions, and the transportation impacts of those decisions.

The shift. The period 1950-1980 could be characterized as one dedicated to the growth of transportation supply in an era of cheap energy and robust national economy. This supply, as has been so well documented, had profound impact on the structure of our urban and suburban areas, the economics and politics of those areas and the varied lifestyles they supported.

The period 1980-2000 marked a slowdown in the growth of supply as community and environmental concerns became predominant. Managing infrastructure became the initiative of transportation agencies and institutions, while energy still remained cheap.

The current period – 2010 and beyond - represents a radical shift in planning and managing our transportation infrastructure. While Post WW2 planning started with regional goals and objectives, 2010 planning adds the pressures of globalization and the elevated importance of economic growth. Energy has become expensive and will become scarcer. And the debate over policy approaches and responses to global warming has opened the question of whether any auto oriented urban form – even "green autos" should still be the preferred form of lifestyle for most Americans[4]. And this debate includes the role of the government in policy approaches that will be sufficient and appropriate to address this complex, but major 21st C problem. To cope with this shift, changes in the transportation planning process, and the regional planning process must be made.

The next sections of this paper will address three factors that must be incorporated into a newly invigorated transportation planning process. These are: (1) new approaches to finance infrastructure, (2) institutional change and (3) the implications of the adoption of new technologies – in particular computers and communications technology into aspects of transportation operations and management as well as into every ones daily lives.

Current limits to infrastructure finance. The current period (2009 -) is one of transition from well designated program funding of infrastructure needs to a very uncertain long term funding future. Old funding mechanisms, arising over decades of program specifications are inadequate.[5] The means of financing infrastructure, that proved so well until the last part of the 1900s came from programs designated under Title 23 and the UMT Act 1964. The source of Federal funds, user fees paid into the Highway trust funds (HTF), has reached its limit. Many predict the HTF will be out of cash as soon as 2012.

Most planning attention is driven by capital needs – new roads, ITS additions, new transit starts and rolling stock. For capital projects, usually 50% or more come to a State, City or Transit Property from Federal funds. Often the remainder comes from

combinations of the issuance of debt and from various local taxes. But the critical decision point to go ahead with a capital project is often tied to the availability of Federal funds. The availability of the Federal share is, with few exceptions, the strongest determinant driving local planning choices.[6] The history of the competition for such funds and the nature of local success in achieving funds and implicit Federal approval for such projects have resulted in almost universal project cost under estimation. The result has been so-called large cost over runs, with impact on funds available for other projects and disruption of the awarded project[7] , and disregard for the federally mandated planning process. Because local match is a requirement for Federal funding, securing a project immediately ties up local funds – whether tax based or from the issuance of debt. Since 1980, as local funds have been harder to come by, assurance of Federal interest in and funding of projects has been a key step in local planning. Simply, funds drive the process. So strong are these efforts for "favorite projects" that Paaswell, Berechman and Chen noted (in ref. 3) that the regional planning process and true rationalization through the MPO process did not occur due to:

- The availability and targeting of funding, its source and limitations. Mega projects often so dominate local planning agendas that local planning issues (capital investments for traffic calming, non motorized vehicle lanes, and addressing goods movement) become afterthoughts in arriving at a truly strategic TIP.
- Funds at every level – Federal, State, Local are limited and fall far short of meeting national infrastructure needs. Local Bond limits and tax levels have reached limits of stakeholder resistance. This heightens the competition for available funds and plays into the hands of the most powerful agencies and authorities.
- The boundaries established by strong public agencies and dedication to their unique missions push each agency's projects to be evaluated singly and not in concert with reinforcing and conflicting projects. This leads to EIS and BCA being done on specific projects and not on network or systems.
- Lack of inclusion of operating needs and impacts. Searching for capital funds minimizes the discussion of "If you build it, you have to operate it". Will the funds be there?
- Political rationale and the use of transportation capital investments to attain non-transportation objectives such as economic development. Wildly fluctuating estimates of non transportation impacts often inflate the value of projects, but serve the need ("create jobs") to gain public support.
- Limits of analytical forecasting and planning
- Non-systematic decision process and lack of clear objectives and evaluation criteria

Because of how program funds, by law, are allocated, there is a direct link of project funding to a specific transportation agency (DOT, transit agency, planning board, etc.). Each agency has a well defined mission that narrowly defines projects to mission to maximize their chance of receiving project funds. Title 23 and UMT Act both contain carefully defined programs and the criteria that highway agencies or transit properties must follow in order to be funded. Planning in each agency means following the path of optimizing funding opportunities. In the last several decades, mega projects have taken center stage; smaller projects and asset rehabilitation – while critical – get less attention from planning and decision making. By law, the Metropolitan Planning Organization (MPO) is, on paper, the equalizer among agencies. In large urban areas strong agencies

(State DOTs, large transit properties) carry disproportional weight, influencing decision making in the attempt to maximize funding, especially for mega projects. Revamping of Title 23 and UMTA Act to give stronger power to a balanced MPO would be one step in bringing regional planning and funding into some harmony. But this cannot be accomplished without rethinking the mission of 21st C transportation agencies. Agencies must be more integrative with respect to regional goals while funding should be tested against goal optimization. Surface transportation planning must be done in the context of three major dimensions:

1. The context and environment for which transportation changes and additions are needed – land use, environment, equity, energy use and community/regional priorities. Such planning must have a sign off by those engaged with the responsibility for those issues.
2. Investment and risk – social benefit cost analysis must be applied
3. Good engineering practice – life cycle analysis applied to modern practice must remain at the heart of infrastructure planning.

A complementary issue is the need for obtaining operating funds for transit and operating and maintenance funds for roads and bridges. The ASCE grade of C- or worse for our roads, and the current condition that most US transit systems are at less than a State of Good Repair shows that regional and local governments have been unable to sustain the constant need of these systems for maintenance, upkeep and modernization. Fares, tolls and local taxes are the norm for funding. The current planning process is driven by the need for capital funds for system modernization and expansion; maintenance and operations remain under - funded local issues.

Available finance drives the capital process, and hence the current planning process. A shift of funding as new transportation systems are put in place would consider full project lifecycle costs, guarantees of operating support, improved project estimation – including better evaluation of risk and new institutional models for funding and oversight. At present there is concern among transportation agencies that the current user based system – gas taxes - are inadequate to finance future needs. Proposals for funding future systems include a broad variety of taxes – on users and businesses, tolls, private buy –ins and other means. They include new approaches to combine funding and environmental response that include carbon trading and carbon credits, and “pay as you drive”. Each represents a departure of funding tools from the last 60 years and would force a rethinking of transportation organizational structure, mission and responsibility.

Shifting Institutional Arrangements. Every public transportation agency or organization has a clearly defined mission statement and mandated rules and responsibilities. In 2009, rather than clarifying the steps from plans to implementation, these organizations make regional transportation planning quite difficult. Holguin-Veras and his co-workers[8] showed the complexity and costs of governing freight movements in the New York City Region by describing the number of regional agencies and bureaucracies and their constrained missions that influence or impact such movements. At a time when modern real time logistics drive 21st C goods movement, organizational structures that govern movements, intermodal activity, street ordinances, etc. are locked into the 20th C. Planning cannot overcome this handicap. As noted at the outset, the 21st C planning efforts must be directed to system management and integration, tasks not developed through 20th C programs.

In a rational transportation planning process, a public planning group, such as a Metropolitan Planning Organization (MPO), would have responsibility for undertaking the steps beginning with the formulation of regional goals and objectives and culminating with a recommended set of projects. These projects would be based on discussions with stakeholder groups, with assessments of regional economic and demographic changes, with regional strategies for growth or other specific desired objectives, and with knowledge of regional agency ability to deliver specific types of projects. In a large metropolitan such as New York, this type of procedure has become unworkable. First, the MPO does not possess the real power to carry out such a process. They do work on the mandated Long Range Plans and the Transportation Improvement Program, but these are outcomes of a negotiated process among powerful stakeholders. Second, individual public agencies have extraordinary powers, and specific legislated areas of interest and responsibility, rendering them difficult negotiating partners. Third, there are a number of persons or assemblies who are the decision makers; often, they are unable to come to consensus on specific regional projects that have emerged from a rational planning process. Table 1 below illustrates the nature and power of elected decision makers in the New York Region.

Table 1. Who makes investment decisions.

Decision Maker	Powers
State Governor	Suggests projects; appoints major Public Authority Boards – including MTA and PANY&NJ; Has Budget veto power; Appoints DOT Commissioners; Structures MPO. Has power to veto Authority Board decisions.
State Legislatures	Develops State Budgets and Budget special items; must have adequate majority to over ride a Gubernatorial veto. Has power to veto Authority Board decisions.
Mayor of City	Suggests budget; suggests programs and projects; appoints members to, but does not control major Transportation Boards
US Senators, Congressmen	Can specify local projects in Federal Budgets

A recent example (2007) is the conflict between the Mayor of the City of NY and the State Legislature which led to the defeat of congestion charging for lower Manhattan – a plan endorsed by all of the regional professional planners.

This is not unique to New York. Why is it that rational, but controversial plans and projects have difficulty in being implemented? Why do new projects – often politically chosen – get to the table and receive funding, although they haven't emerged from the LRP or regional planning efforts? One response could be the growing politization of capital projects. Another is that the agencies that arose in the 20th C. from the requirements of Title 23 and UMT Act (1964) are no longer able to meet the needs of 21st C stakeholders. Agencies, once designed and dedicated to their initial mission of building supply (or rebuilding transit) have become overly bureaucratic – locked in process and past practices. While these agencies attempt to modernize, they still must

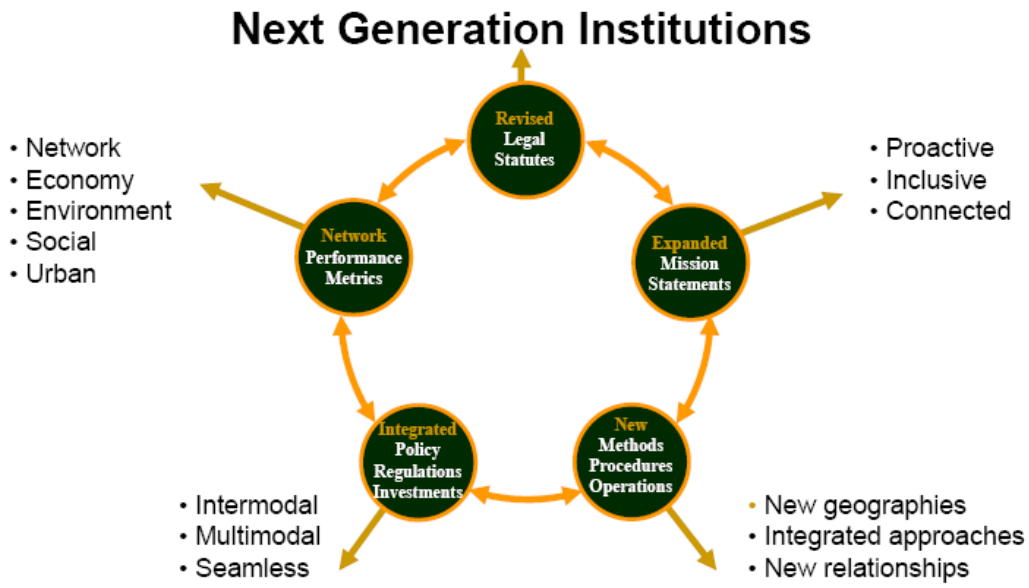
maintain and support existing assets, and find it difficult to transform into what is needed for the 21st C.
Figures 1,2 below illustrate the nature of change that must take place.

Figure 1. 20th C Institutions

Establish by Federal of State Laws: DOTs, MPOs, RTAs

- By their missions-inward and regional looking
- Supported by methods, procedures and practice developed for their unique missions

Figure 2. 21st C Institutions



Agencies must be restructured to accomplish the following needs to be responsive to planning:

1. The 21st C agenda for infrastructure will start with the environment, quality of life and sustainability. We have made enormous investments in infrastructure in the 20th C. They must be managed in the context of changing household structures and behavior, appropriate use and conservation of land and the emerging role of the car in the 21st C. And agencies must be transparent in their planning to be effective and responsive to stakeholders.
2. Stakeholders will be both regional and global; they will have professional capabilities and will be able to communicate instantly with 21st C planning organizations. Agencies will address both regional economic growth and local environmental needs. They must have the capability and leadership to do so.
3. New models of funding – not so dependent on fuel taxes must be put in place. More attention now is being placed on user fees and charges and beneficiary fees and charges as well as innovations such as carbon credits. Proper involvement of the private sector – whether as partners or contractors will focus the structure of agencies as oversight, planning, operating or funding entities. Great Britain and the European Union have, over the last decade, made significant changes in how transportation systems are planned, funded and operated. These changes include rethinking organizational responsibility and structure, separating planning and oversight from operations, involving more private sector participation and having planning agendas emerge from non transportation agencies. Asian models are significantly more entrepreneurial.

4. Agencies must not only be truly multi modal in structure, but must incorporate aspects of land use and the environment. Regional planning, zoning, development plans and environment and quality of life must not be seen as

external –"to be addressed" issues, but integral parts of what must be the outcomes of planning transportation changes and investments.
5. Agencies must embrace and make use of the availability of real time information and modern communications technology. This, in fact (discussed in the next section) is greatly changing both the supply of and demand for traditional forms of transportation.

The stovepipe model of transportation is still practical for the implementation and operating of transportation systems and system components. But planning, funding, regulating and having oversight of the complex, information driven 21st C transportation systems must be part of new governance models. To sum:

1. Federal transportation legislation must be totally rewritten, integrating programs, funding and regulations governing all surface transportation. Agencies such as FTA and FHWA should still oversee the engineering practice requirements of specific infrastructure, but broad based planning – especially in the multi disciplinary context of environmental issues, must be focused in a multi-cabinet government policy unit.
2. Local and State agencies should mirror new Federal approaches to the planning, oversight and engineering of infrastructure. The regulations regarding MPOs should be written to insure that new regional and local goal setting – in the context of national priorities – are met.

Institutions and funding. 20th C models of transportation agencies, their approach to planning and the funding they apply have become old. New models, responsive to 21st C lifestyles, technical capabilities and approaches to investment must be put in place. The sections above dealt with our legacy from over a half century of transportation planning and suggest what must change so that investments resulting from a rational planning process are responsive to stakeholders. In the next section, the paper addresses the dramatic influence that information technology and communications is already having on both transportation systems and the users and how such changes will have great influence on transportation planning.

The role of technology. The advances in transportation planning after 1950 were due, in a great deal, to the rapid growth of computing power. Computers used to estimate simple planning models in the 1950s evolved to powerful – and small – personal computers that could calculate complex supply and demand models, operate traffic signals and control remote variable message signs. But from 2000 and beyond there has been a complementary revolution – one in communications technology. The impacts of the combination of modern wireless communications and ubiquitous computing power are having profound impacts on the supply, demand for transportation and on the culture of those using transportation. The planning process used in the latter part of the 20thC relied on fixed models of behavior and empirical but fixed data on demand and supply. While planning models became more sophisticated, integrating behavioral models of individuals and households, they were applied to test the adequacy of supply or the impacts of new policies (pricing, etc.) to address supply issues. The combination of information technology and instantaneous communications of large and complex data sets, and the computers that generate these data sets have changed the approach to both planning models and actual system operations.

Technology and supply. Most familiar to transportation planners are the advances from Intelligent Transportation Systems (ITS). Smart vehicles (motor vehicles and transit vehicles), smart infrastructure and smart materials all combine to provide real time information on all aspects of supply. Remote and in situ computers make possible knowing:

- Real time traffic patterns
- Performance characteristics of motor and transit vehicles
- Actual vehicle location and speed
- Vehicle to vehicle communication
- Driver performance
- Maintenance histories
- Material behavior (fatigue of bridge structural elements, etc)
- Vehicle loads (goods and passengers)
- Network traffic characteristics
- Capacities and availability of parking lots and spaces

Transportation operators can adjust traffic flow, or reschedule transit vehicles in real time, be more responsive to incidents, and be responsive to factors such as congestion and air quality. Vehicle to vehicle communications in congested area platoons can increase capacity to limits above those now set empirically. Transportation operators can relay this information to individual users through the internet or text messages so they can plan their journeys with pertinent information. Archived data of this type will have a significant impact on planning supply models as changes in supply and changes in responses are documented and as new travel behavior is observed.

Technology and Demand. The availability of real time data gives the transportation systems user many more choices than they have been used to. Whether mode choice – based on estimated arrival times, availability of parking, next bus coming and other factors, or route choice – mid journey, system users will derive new patterns of travel distinct from those based on past knowledge alone. Further, persons traveling in groups (HH partners, car poolers, colleagues attending a meeting – but traveling separately) can make instantaneous changes in plans should there be some type of incident or congestion or transit breakdown. Such changes can be made by phone and internet through texting or use of My-Space or other such communications. New activity choices can be made – not predictable by traditional models. New applications of GPS and mobile phones will make it possible for groups to know where each member is at all times, providing further input to both activity choice and transport choice to achieve the group's needs. The ability of both the system operator and the system user to have real time comprehensive information about system characteristics and performance will necessitate changing traditional (static) demand – supply models. New models will use real time information, meaning communications technology must be part of the operations and delivery planning process.

Technology and Culture. Information technology, successive generations of mobile communications and increasing computer power (and decreasing size) have already begun to change the habits and life styles of the wired generations. As noted, current mobile phones in the US allow the user to text groups of people, cull habits and suggest activities to groups on such sites as My Space and You Tube, order goods 24 hours/day over the internet, choose entertainment and buy tickets/make reservations on the spur of the moment, get traffic and transit information, transfer funds, be entertained, and, of

course make phone calls. European and Asian users can be prompted to make purchases when passing by stores, can use their phones as credit cards, and as keys. The wired generation does not resemble the post WW2 HH, this original context for travel demand modeling. While much of travel behavior theory has acknowledged that the 2009 HH is not like the 1960 HH, it has not addressed the fact that new types of travel models are needed. These new models must be activity and life style driven, responsive to the flow of information individuals receive during the day and the decisions they make (and the influencers of those decisions) and the transportation choices they make (from those available) based on the information. In addition, the wired generation is also responsive to issues of environment and sustainability – and many choices will be based on values arising from those issues. Travel costs and utilities will have to account for emerging sensitivity to the impacts of travel choices on the environment.

The new paradigm. The bodies of law and regulations that defined the highway and transit systems for most of the 20th C accomplished their tasks of building world class infrastructure throughout the US. But the era of massive additions to supply is over; the new era will be one of maximizing the capacity of the supply, accommodating transportation systems to new societal objectives and planning transportation as an integral part of land use, quality of life and environmental constraints. While the engineering methods of building, modernizing and maintaining our infrastructure remain – and the tools to do so are part of our traditional institutions (DOTs and academic institutions) planning must take a new and more global perspective. This paper is the start of a conversation on what that perspective should be – a conversation that must be joined by the generation of planners, policy analysts, economists and engineers now being trained or entering the workforce.

Acknowledgements Thanks to Richard Hanley, Cynthia Chen and Todd Goldman for their review and comments.

References

[1] "Fragile Foundations: A Report on America's Public Works", National Council on Public Works Improvement, Washington, D.C., Feb. 1988

[2] A good summary of the history of transportation planning can be found in , E. Weiner, "Urban Transportation Planning in the United States", USDOT, DOT-T-97-24, Washington, 1997

[3] In February 2009, Congress passed an economic stimulus bill containing billions of dollars for national infrastructure. While this attends to the urgency of finishing "shovel ready projects", it does not address the structural issues that have created both the long term financial gap in both implementing and maintaining infrastructure and the planning issues surrounding bringing plans to implementation in a reasonable amount of time.

[4] For an excellent discussion of the changing role of the US auto industry and the US auto see, E. Rothschild, "Can We Transform the Auto Industrial Society", New York Review of Books, Feb. 26, 2009

[5] NYSDOT held a major symposium "After the Gas Tax" in October 2008 to discuss this critical issue. Innovative financing, a catch phrase for "How do we do it?" was the subject. A conclusion was that there are many ad-hoc approaches and that new means had to be found to assure broad based long term capital and operating support for newly emerging programs.

[6] A discussion of such decision making can be found in R. Paaswell and J. Berechman, ""Models and Realities: Choosing Transit Projects for New York City", in Policy Analysis of Transport Networks, Geehuizen, M., A. Reggiani, and P. Rietveld (editors) Ashgate Pub, Brookfield, VT,2006. The problems arising from such decision making are discussed in, Robert E Paaswell,; Joseph Berechman, PhD, and Cynthia Chen, PhD, Infrastructure Investment Decision Making:

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[7] The most cited reference is B. Flyvbjerg, N. Bruzelius and W. Rothengatter, "Mega Projects and Risk", Cambridge, UK, 2003. In the 2nd paper cited in ref 4 above, the authors note that the sum of cost over runs in 4 key NY MTA projects currently under construction, $4Billion, could have paid for several other critical, but unfunded projects.

[8] Holguin-Veras J., R. Paaswell , New York Intermodal Freight Transportation Planning: Instituional Challenges, Transportation Law Journal Vol. 27 (3), pp. 453-473 Summer 2000