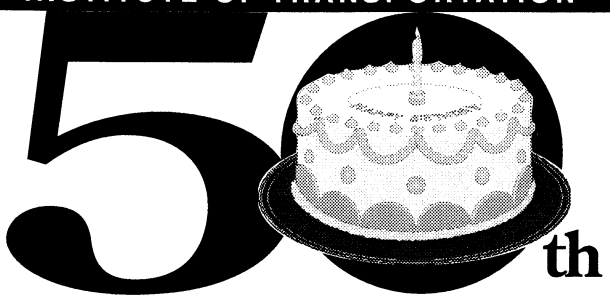
Proceedings

of the

INSTITUTE OF TRANSPORTATION



Birthday Symposium

April 23-24, 1998

CHALLENGES OF THE 21ST CENTURY

UNIVERSITY OF CALIFORNIA, BERKELEY

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Foreword

This report is a summary of proceedings from a two-day symposium convened by the Institute of Transportation Studies at the University of California at Berkeley in April 1998 to commemorate the fiftieth birthday of the Institute and to lay the groundwork for the Institute's second fifty years.

With the title, *The Transportation Enterprise: Challenges of the 21st Century*, the Symposium set out to generate thoughtful, active discussion in preparation for laying out an action plan for the Institute in the 21st Century.

I would like to express my gratitude to the Symposium Organizing Committee, under the leadership of Wolf Homburger, as well as the entire Institute staff for their invaluable assistance. I would also like to thank the speakers and participants for traveling to Berkeley and generating lively, uplifting discussions. Thanks are also due to the current Institute of Transportation Studies graduate students, who represent, after all, the future of the transportation enterprise, for their assistance with the symposium and for providing the posters for the poster session. Finally, I would like to thank Robert Bertini for his efforts to produce these proceedings.

It is the hope of the symposium organizers that this event has sparked an ongoing dialogue concerning the Institute's role in transportation education, research, information, and technology transfer. We look forward to your participation in our next fifty years.

Adib Kanafani, Director
Institute of Transportation Studies

Preface

This report summarizes key findings and discussions of the symposium. The symposium proceedings contain the key points discussed in each of the sessions of the symposium. The final portion of the proceedings contains a series of appendices which include the symposium program agenda, a list of speakers and brief biographies, a roster of speakers and participants, a list of the symposium co-sponsors and full text of certain addresses along with accompanying slide narratives and figures.

The proceedings provide a concise summary of the main points of each speaker and are not meant to be a verbatim transcript. To avoid confusion, throughout these proceedings the Institute of Transportation Studies is referred to as the Institute, while Intelligent Transportation Systems are referred to as ITS.

We would like to gratefully acknowledge Alan Erera for assisting with notetaking during the symposium and Barbara Erickson for valuable editorial assistance in the preparation of the session summaries.

Robert L. Bertini, P.E.

OVERVIEW

The symposium began with a Keynote by Wilfred Owen. In addition to noting the major accomplishments of the Institute over the past 50 years, Mr. Owen advocated the application of a true systems approach when considering future transportation problems. Most significantly, Mr. Owen challenged the participants to adopt a global view, with an emphasis on international research in the future.

Session 1, *Forces Shaping the Future Transportation Enterprise,* laid the groundwork for the symposium by discussing the important social, economic, environmental and technological context for transportation in the next century. It became clear that we need to continue to track and attempt to understand the changing demographics both in the United States and throughout the world. Given the astronomical population growth that is predicted, we need to continue to talk about the environmental impacts of such growth and the associated transportation infrastructure. We will also clearly need to adopt new paradigms in how we pay for transportation improvements. Finally, the technical future will consist largely of integrating the myriad of systems that are being developed independently.

Session 2, *Retrospective of the Past 50 Years,* presented an opportunity to review the specific accomplishments of the Institute since its inception. We learned that the greatest strength of the Institute has been the focus on attracting, retaining and recognizing the best people. In terms of traffic operations, the Institute has provided critical research results to the field and continues to provide relevant input through its research reports and technical assistance. In the area of air transportation, the Institute continues to advance new synergies and new research areas. Finally, through a strong relationship with the California Department of Transportation (Caltrans), the Institute has been on the forefront of the development of new technology for transportation. These efforts have set the stage for the Institute's agenda for the next 50 years.

The first two sessions were aimed at predicting the future societal forces that will influence transportation and reflecting upon what the Institute has accomplished over the past 50 years. In this context, Session 3, *Thinking About the Transportation System in the Next 50 Years,* was aimed at articulating how we should think about future transportation systems as we shape that future today. We saw that we should recognize the substantial uncertainties that surround our planning and decision-making. We also discussed the importance of looking back over our history. We can often learn a great deal by considering what has been done by those who came before. We also saw that much has been accomplished in the development of new vehicle technologies. However, we must focus our energies on continuing to define and develop a sustainable transportation future. Finally, we considered the future of urban form, and recognized that the future will likely bring more choices and greater variety in development patterns.

Session 4, *Defining a Vision for the Future Transportation Enterprise,* began to lay out a framework for how the future transportation systems will evolve. Knowing that the world is becoming smaller with dramatic developments in communications, we will need to remain vigilant in the future particularly with respect to civil rights and environmental impacts. We also contemplated the myriad of roles that a public transit system can and does play in our society. An update of the federal transportation legislation was presented, and we examined various means of deploying new technology. These presentations provided an exciting backdrop against which to consider the future mission of the Institute.

Session *5, The Institute of Transportation Studies Mission: Making It Happen,* provided the context for planning the Institute's role in transportation research and education in the next century. By discussing the importance of research, it became clear that we need to continue to apply lessons leamed in order to excel in the competitive environment of the future. Technology transfer remains a necessary component of a research organization and will continue to evolve. The educational environment is dynamic, and research organizations must grow and change to remain competitive. Finally, we saw that the Institute's premier Technology Transfer Program and Library are planning for the future.

In conclusion, these two days were enlightening, inspiring and challenging. The future will bring societal and institutional changes about which we are uncertain. However, with a well-conceived vision for the future, the Institute will continue to meet those challenges and lead in the development of thoughtful solutions to transportation problems. In addition, the Institute will continue to focus on educating well-rounded transportation professionals and providing technology transfer and information to the profession and the public. By continuing to value its human resources (including faculty, staff, students, alumni and the public), the Institute will have a bright future.

SYMPOSIUM PROCEEDINGS

INTRODUCTION

*Adib **Kanafani,*** Director of the Institute of Transportation Studies and Professor of Civil and Environmental Engineering, University of California at Berkeley

Editor's note: Professor Kanafani welcomed all participants to the celebration on behalf of the Institute of Transportation Studies (Institute) and co-directors Wilfred Recker (Irvine) and Daniel Sperling (Davis). Professor Kanafani expressed his hope that the symposium would allow all participants to gain a perspective on what the Institute has done in the past and how the Institute might continue to evolve in the future and to reflect on the role of the Institute as a new century begins. He then recognized the symposium organizing committee, those individuals whose generous donations made the symposium possible, as well as Professor Emeritus Harmer Davis, the founding director of the Institute, and Professor Emeritus William Garrison, former director of the Institute.

The Institute has endured its first 50 years by constantly changing, adapting and innovating, recognizing that "things must change in order to remain the same."

The Institute has not only changed in response to changing paradigms but has actively participated in creating the new paradigms themselves. By looking at the contributions that the Institute has made to the transportation field and by being critical of what the contributions have been, we can look forward to many future contributions.

WELCOME

Robert Berdahi, Chancellor, University of California at Berkeley

Editor's note: The Chancellor welcomed all participants to the Berkeley campus in anticipation of an enlightening symposium to celebrate the 50th anniversary of the Institute.

One of the early challenges at the Institute was to discourage Los Angeles drivers from driving up the off-ramps of the new freeways. The solution was the development of the standard signs now used across the country at the foot of freeway off-ramps. Here is an example of things we now take for granted being pioneered at the Institute.

The problems facing transportation now are more complex and the solutions are more involved. Consistent with this, the Institute's mission now encompasses a wide range of topics and locales, ranging from the Automated Highway System (AHS) to aviation and freight distribution in Venice, Italy. Further, the Institute has focused not only on the various modes of transportation but also on understanding the relationships between

transportation and social, environmental and economic factors. With 40 associated faculty and 100 associated graduate students and a $10 million annual research program, U.C. Berkeley is proud of the Institute and its 50-year history. Given the huge problems facing transportation at this time, the country welcomes new solutions.

Joseph Cerny, Vice Chancellor for Research, University of California at Berkeley

The Institute has been uniquely valuable to U.C. Berkeley, the state and the nation, by making important contributions over the last 50 years and will certainly remain so by making many more such contributions in the future.

The Institute is one of the few Organized Research Units (ORUs) created directly by the state legislature (most are created by local mandate), initially as a response to deferred maintenance of transportation facilities during World War II. The Collier Commission initially envisioned the Institute's role as conducting research and providing instruction for a new generation of transportation professionals. The Institute has transcended this vision by developing new partnerships, including those represented by the Partners for Advanced Transit and Highways (PATH), the Pavement Research Center and the National Center of Excellence for Aviation Operations Research (NEXTOR). Beyond this, the Institute has maintained its link to education on the campuses and through the Technology Transfer Program (TTP). The Institute is in excellent health and will continue to thrive given new challenges and conditions.

C. Judson King, Provost and Senior Vice President, University of California, Statewide

Research activities are vital to the economic growth and diversification of the California economy. Given that transportation is a prime concern to California, the Institute is the best example of how the university has dealt with state problems. With this multicampus approach, the Institute has integrated research across gulfs, including those separating engineering, social science and policy. All units of the Institute have accomplished much and demonstrated great competence, partly because the Institute developed a strong synergy between the university and Caltrans.

Rulon K. Linford, Associate Vice Provost for Research and Laboratory Programs

The entire university is extremely proud of the Institute's research accomplishments over the past 50 years. The public has benefited from the Institute in many ways, particularly by having a safer, more efficient and more environmentally friendly transportation system. The entire university anxiously anticipates the Institute's future contributions—in the face of many challenges—as well as many years of future service to the state and the nation.

Paul Gray, Dean, College of Engineering, University of California at Berkeley

The Institute's role in maintaining a steady flow of graduate students is most important. By addressing broad, multidisciplinary issues in teams that include representatives from government, multiple campuses, and industry the Institute has provided a great model for all areas of engineering, including information and biotechnology.

His Excellency Mohammad A. Al Shaikh, Distinguished Alumnus, Minister of State and Member of Council of Ministers, Kingdom of Saudi Arabia

Great vision and work have been devoted to creating and nurturing the Institute. It is important to recognize that all students and alumni are grateful for the chance to benefit from this enterprise. All participants are indebted to the Institute faculty, library staff and general staff, past and present. The Institute possesses a great wealth of information and commands the power to organize, synthesize and accumulate knowledge. The faculty inspired and continue to motivate their students with the confidence to expand their minds. The faculty also encouraged healthy skepticism—in the form of mind-expanding doubt. Thus, the practitioners, theoreticians, and philosophers interact. This type of environment, with a format of free debate and exciting dialogue (without dogma) is what is needed to develop the kind of leadership we need most in our society today. This dialogue and debate should continue after one leaves the university, particularly with today's communications technology. All alumni should engage in a continuing dialogue, so that with the use of memories and dreams, the imagination can be stimulated to brighten the future.

REMARKS

Hon. Dean Dunphy, Secretary, Transportation and Housing Agency, State of California

Those who started and developed the Institute as well as those who continue to implement the products that benefit California should be congratulated on this occasion. The Institute fosters cooperation with the state at a very high level and must continue to do so. There is no other institute in California to address transportation problems.

There are significant problems and frustrations facing transportation, and these have been especially evident in recent years. They include increasing congestion and the increasing cost of providing capacity. As a current example, an 8.1-mile segment of State Route 5 in Orange County, between State Routes 22 and 91 is presently under construction at a cost of $1.1 billion for expansion alone ($135 million per mile). This project is simply moving the bottleneck down the freeway at incredible cost, and we know we can't continue this; there must be alternatives.

there must be alternatives.

High-speed rail is one imperfect alternative; transit must be an alternative, though it is little utilized. There are several major challenges, including public apathy, which is demonstrated in a recent Los Angeles Times poll, where readers listed no transportation issues among their top six concerns. The next challenge is financial. We need to change travel habits by considering the economic cost of transportation and making revenue changes to address capacity increases. This might mean high-speed rail or more buses. The Institute's work on automated highway systems is extremely important, but the PATH program is the only one in the state addressing this kind of increased capacity.

We have many constraints, including how we fund transportation—with the gas tax—and this revenue is declining (despite more vehicle miles traveled) as automobiles have become more fuel efficient. Along with declining revenues, there are other problems, including population growth due to immigration from the Pacific Rim and elsewhere and westward migration within the United States. We don't have another 50 years; we need to study the issues, develop technology, transfer it to the private sector, and get on with it.

KEYNOTE
A Golden Opportunity

Wilfred Owen, Brookings Institution
(read by Professor Melvin Webber)

Editor's note: Mr. Owen offered his best wishes to the Institute and to Professor Harmer Davis as well as his congratulations to the Institute for pioneering innovative studies in California and throughout the United States, which have led to unprecedented levels of mobility and prosperity. The full text of Mr. Owen's remarks can be found in Appendix E.

SESSION 1
Forces Shaping the Future Transportation Enterprise

This session set the scene for the Symposium by examining the social, economic, environmental, and technological forces that will shape the nature of the transportation enterprise during the first decades of the next century.

Wilfred Recker (Session Chair), Director, Institute of Transportation Studies, and Professor of Civil Engineering, University of California, Irvine

The hallmark of any major institution is its ability to recognize and anticipate change and then muster the resources to focus on solving problems caused by such change. Since its

founding, the Institute has been an excellent example of this kind of institution. This has been shown from its response to the challenges of the highway building campaign of the 1940s; the Institute's formal recognition in the 1970s that transportation is not only engineering but also includes political, social and economic forces; and the Institute's pioneering adaptations of advanced technology in the late 1980s.

The title of the first session is *Forces Shaping the Future Transportation Enterprise.* There has never before been such a confluence of dynamic change in major factors affecting how we plan for the application of transportation resources. This will be the first period to develop and deploy systems for a population that has never experienced a non-auto-reliant world, that demands a high degree of mobility as an essential ingredient in the fabric of existence, that pays more than lip service to environmental issues related to transportation.

We recognize that the transportation infrastructure we must plan and design creates swaths through neighborhoods, consumes the bulk of the world's resources, is literally cast in concrete, and requires almost preposterous funding levels. This relatively unchangeable infrastructure is at odds with the dynamic nature of transportation demand and the increasing capacity that is called for. Fortunately, we have a great opportunity to meet these challenges technologically with Intelligent Transportation Systems. Our panel has been organized to look at future changes that will affect the transportation enterprise and the impacts of those changes.

DEMOGRAPHIC AND SOCIAL CHANGE

Alan Pisarski, Transportation Consultant

Editor's note: In order to establish a context for considering the future, Mr. Pisarski referred to a number of charts and graphs during his presentation. In this summary, we have tried to capture the major trends displayed by the visual aids. Mr. Pisarski's outline for his remarks can be found in Appendix E.

When considering future transportation and social patterns over the coming decade, one finds forces of stability and forces of change acting on the society. One might say that "demography is destiny." First, in terms of forces of stability, we see the lowest rate of population increase since the Depression, with immigration a key modifying variable; we also see slowed growth in new households, and saturation in driver's licenses and auto ownership. In terms of forces of change, we see that the age of our population is moving into the high travel-propensity years *(45-55* years). We will also see a big impact as baby-boomers turn *65* after 2010, as racial and ethnic minorities join the majority with greater auto ownership, resulting in democratization of the transportation system, and we will see the continued dispersion of a wealthier population.

Population growth is projected to continue along a straight-line trajectory. There will be

changes in the underlying age distributions, particularly due to the aging of the baby boom population. The population between *50-59* will increase *50%* by 2005. When this group turns *65,* we will see major changes in our transportation system.

We also see flattening trends in auto ownership, with limited growth in two- and three-vehicle households, now that the majority of households have more than two vehicles. Beyond this stability there are sharp differences in vehicle ownership by racial and ethnic groups, with car-less households at approximately 7% for white households, higher levels in Asian and Hispanic households, and 30% in black households.

We expect that the non-drivers of today's society will arrive at general mobility in the future, meaning that they will become drivers. Immigration will have dramatic impacts in some areas. In California, *25%* of the population is foreign-born, compared to 10% for the entire U.S. We see that immigrants are going to traditional population centers but are more suburb-oriented than those in the past. In terms of moving patterns, young people move more than the older population, and internal migration is mostly intrastate (with low interstate moving rates). In the Midwest, immigration is providing almost a 1:1 replacement for population outflow from central cities. The comment by Wilfred Owen in his keynote address regarding the need to plan for orderly dispersal is a very sophisticated thought, and is in fact very important.

Turning to modal trends, we see that trends in mode share rates are uniform throughout the country. The auto share is increasing and transit holds at about a 2% share of travel (except in New York, Chicago, and Philadelphia where transit shares are above 10%). Mode use by metropolitan area size is dominated by drive-alone except in areas with over 3 million people. Looking at mode share by gender, we see that women's jobs and travel patterns are becoming more like men's, but that women still use transit slightly more than men. Mode choice varies little by age group. When we study mode by income, we see that for incomes above $25,000 travel is almost all auto (note that the black population has a median income of *$25,000).*

We also see that 70% of workers live in households with two or more workers, suggesting that living near work is a difficult question for most households; and that carpooling has truly become a family phenomenon, meaning that carpools are primarily comprised of members of the same family.

Considering travel by race and ethnicity, we see that most growth will essentially be in the immigrant and minority populations in the future. In long-distance travel, black and Hispanic growth rates, although the same as or greater than that of the white non-Hispanic population from 1977 to *1995,* are still below the rates of the white non-Hispanic population back in 1977. When we study population by geographical area, it is clear that suburbanization is continuing. The suburb-to-suburb commute is now dominant, with a strong reverse (city-to-suburb) commute. We expect that jobs will continue to follow skilled workers in the future.

To summarize, we have 275 million people, with 25 million added per decade, 200 million vehicles of all kinds, increasing at about the same number per decade as people. We have one billion local (one-way) trips per day, and one billion long-distance (round) trips per year.

We have noted that traditional sources of growth have stabilized and that major growth will occur in the immigrant, black, and Hispanic populations. We will also continue to see further dispersion of society, since all new technologies are dispersing technologies. With the aging of the population, we expect immense potential for growth in long-distance travel. We must consider the forces of change versus the forces of stability in the contexts of public policy and public behavior. We have opportunities to reduce transportation as an inhibiting force and to realize our economic and social aspirations. We can achieve this by "destroying distance" as a factor in our lives.

BALANCING ENVIRONMENTAL AND ECONOMIC CONCERNS

Elizabeth Deakin, Professor of City & Regional Planning, University of California at Berkeley

In consideration of how to balance economic and environmental concerns, it is important to make several salient points. First, it is not really a question of balancing environmental and economic concerns as either/or with tradeoffs but how to find the right mix, considering long term growth, and the health, prosperity and progress of our society.

The environment and the economy are wholly intertwined enterprises, objectives and ideals that we are trying to pursue. First, we have come a long a way in this area. Credit is due to people at the Institute who have helped push and prod policy and politics so that we can see our choices more clearly and move in a progressive direction.

One major environmental victory has been the reduction in new auto emissions by 60 to 80%. California has pioneered the development of new technology to move us on a trajectory to cleaner air. In fact there are few areas with severe air pollution problems in our state. Another victory has been in the area of wetlands: we are now recognizing that biological functions have value and are developing more sophisticated designs to restore, replace and protect wetlands. We are also learning to design with nature in such a way that we can meet the needs of society and respect the natural and built environment. Here we have recognized that works created by humans are as important as the natural environment.

The economic regulation of the air, rail and truck industries has been eliminated, necessitating the development of new ways of doing business. From the inside and outside of transportation, new relationships between the public and private sectors have been identified with new partners and new financing schemes. We have been trying a palette of financing mechanisms—from gas taxes, sales taxes, benefit assessments and

impact fees to marginal cost pricing on State Route 91. The Institute has been instrumental in thinking through the consequences of such pricing mechanisms.

In delivering transportation services, we have provided a broader set of options than before. We have been asking whether this matters, owing to the fact that the auto has remained the dominant mode. We have delivered creative ways of operating freeways, and in air transportation we have pioneered new ways of operating.

The globalization of the economy has been made possible by inexpensive transportation for most of us. It doesn't cost much to move automobiles and parts from Asia, and it costs little to move information and people in the global economy. In just-in-time manufacturing, the trucks and planes are the only warehouses some businesses have, due to the ubiquitous and reliable transportation system.

We are seeing critical changes in the way we perceive the economy and the environment. First, in the context of the environment, the focus is moving from the obvious and immediate to the indirect and long term, as exemplified by the differences between the effects of air quality and global warming. Our perspective is thus shifting from local to global,-and consideration of impacts is moving from the direct, to the secondary, tertiary, and systemic. The social/environmental boundaries are also continuing to blur. Due to the progress in mitigating the impacts on air quality, solid waste, hazardous waste, and noise in the U.S., many of these issues have become less problematic. However, these concerns have become much more severe in developing countries, and we should also pay more attention to the health effects of noise.

In the context of the built environment, we have moved from systemic notions of problems (such as acid rain as a function of emissions and water/soil pollution problems) to the notions of larger ecosystem impacts of transportation. Before, the idea was that we had only to catch up with suburban growth by building highways, tackle inner city blight, and worry a little about neighborhood traffic disruptions. Now we focus upon managing suburban growth, knowing that land use and transportation must be planned in conjunction with sustainable development and with a blurring of the suburban/inner city quality of life.

We now must consider the question of environmental justice, with equitable access for non-auto owners. With this systematic thinking, the overlapping disciplines can no longer be treated by specialists alone but also by people with specialized knowledge in broader fields. We must understand better how transportation investment decisions affect location decisions. We must also address how our quality of life and environmental quality will change as the California population grows to 60-80 million people in the future. We must talk about the environment, economics, land use, political decision-making, and policy making, in an inclusionary way that can move us forward. The Institute has been a groundbreaker in the areas of air quality, materials, freeway operations, etc. In continuing our work at the Institute we must continue to develop graduates that are as multidimensional as our problems are.

MEETING FUTURE INFRASTRUCTURE NEEDS

Tony M. Ridley, Professor and Chair, Civil Engineering Department, Imperial College, University of London

Reflecting on what Wilfred Owen said, much of which was inspiring and at the same time patently obvious, it is clear that the important question is not what shall we think, but what should we do and how should we do it? After a career in transportation it will be important to focus on what you have made happen, not just on the great thoughts you have had. The link between the academic world and doing things is of paramount importance.

Since 1962 we have consistently seen lack of political leadership, public objections, and a shortage of funds, all of which have led to inadequate infrastructure. There will always be an argument about infrastructure needs. Need is really a function of price, and all governments are short of capital for investment, given that they need to hold down taxation.

A recent issue of the Economist discussed the pending U.S. highway bill and claimed that fiscal discipline has been forgotten. A recent edition of the Washington Post included an analysis of the Washington D.C. Metro Rail where unmet maintenance is at $100 million per year. The London Underground wishes that they were only short $100 million per year! In other words, the U.S. has the same problems as the rest of us.

The political debate over transportation financing is hardly enlightened, given the combination of lobbies pressuring the decision-makers. It must be recognized that life is holistic and systemic, and we must take the broad view of issues and potential solutions. We know that car ownership is on the rise globally and that the demand for infrastructure is out of balance with the supply.

It has been said for years that land use and transport strategies themselves influence travel demand and that they must be planned together. But we have failed to deliver. Certain truths remain but are frequently ignored. We know that transport is about the movement of people and goods and that transportation is a derived demand. In terms of efficiency, reliability and customer satisfaction, there is great advantage m finding a balance in which flow is within capacity by a sufficient margin to ensure reliable operation.

There are three ways to achieve this margin between supply and demand: build new links, improve efficiency or restrain demand. Of course, a mix is required at any level of supply.

It is better to apply a mix of the three measures and get on with them. We need to examine how the three can be mutually supportive and address the problems of funding

The most recent debates about environment and funding have been contentious. The most

difficult aspect is bringing people together. Under privatization, the public sector no longer designs, manages construction, pays capital, or operates the asset; the public sector merely specifies the service requirements.

In paying for transport we must strive for improving quality and choice. Transport has suffered underinvestment, falling service standards, congestion, and failure to address environmental impacts. But demand continues. We need to fundamentally change how we plan, manage and pay for transport in the future.

PLANNING FOR THE TECHNICAL FUTURE

Robert Parsons, President, Parsons Transportation Associates
(Editor's note: The full text of Mr. Parsons' remarks can be found in Appendix E.)

This topic is quite a challenge, given that much of today's research will shape things to come. Intelligent Transportation Systems (ITS) will have cross modal benefits, with enabling technologies opening the door to unknown future scenarios. The ongoing computer revolution has opened the parallel expansion of Information Technology (IT). Another high-tech advancement has been in communication, especially satellite and cellular. The latter has achieved a market penetration almost as great as personal computers' and will grow even further with digital technology.

The establishment of a national architecture has attempted to change mindsets and ways of doing business. We know that the tools of the past will not work in the future. We must ensure interoperability and interchangeability so that we can deliver ITS service. The Internet is an example of how cost efficiency and wide scale use are achieved via interoperability.

In order to achieve near real-time management of the overall ground transportation system, we must integrate freeways and transit, both the micro- and macro-aspects of the system. We expect great development in the area of sensors, through miniaturization and lower costs. We also expect improvements in comfort systems, telecommunications, voice-activated systems, and safety features for suspension and braking. We have already started to see the development of collision warning systems, with adaptive cruise control, side-looking radar, lane-keeping systems, and the precursors of dedicated automated lanes. In this new automobile age, smart roads will be as important as smart cars. Both must work together, particularly with the prospective freeway merging guidance systems.

There will be computation and control improvements, but applications are lagging. In the area of surveillance, we see hardwiring being replaced with satellite. We have many opportunities, but past practices must change. Stand-alone facilities can't continue, and we know that existing surveillance, communication and control systems are sadly outdated. We must commit ourselves to educating the new generation and retraining to integrate the system using common resources.

Unfortunately, the system today is not really a system. It needs to be recognized that there are greater benefits in integration than in mere technology. Multimodal improvements are needed, as well as a new breed of transportation engineers. We must attract IT specialists and communication/control engineers to transportation, rather than just civil engineers.

With better-informed travelers and more attractive alternatives, we can spread traffic around. If this does not happen, we can apply more aggressive pricing as in other consumer services. In the future this could mean seeing ITS almost everywhere, more uniform use of our transportation networks and exploitation of niche markets, such as station cars and lean vehicles. We may also see high-speed rail connecting mega-activity centers.

In summary, we expect ground transportation to follow air transportation with demand-based pricing, the development of an integrated system, the filling of niche opportunities. In order to achieve this vision, skill changes are most certainly required, presenting an education and retraining challenge.

DISCUSSION

Professor Vukan Vuchik, University of Pennsylvania, pointed out that by looking at the overview of future problems and predicting future challenges, we see the same problems in all modes, where we need to integrate technology into broader systems. We should be careful about how we interpret statistics. If we just take numbers and trends, sometimes they show where we're going, not where we should be going. This doesn't mean we should neglect transit, for example. We should take a system view instead an individual view, not a policy view versus a people view. Looking at a long run view is different from looking at a short run view.

Alan Pisarski responded by commenting that the old Soviet system would explain the failure of a five year plan by saying that the public hadn't lived up to the government's plan and that the government should elect new people. This is the trouble with benevolent smarter people planning for the people.

Dave Rubitz, RAND Corporation, commented that no one mentioned fuel pricing and how it affects global warming. He asked whether the panel believed that fuel pricing is affecting our future.

Tony M Ridley responded by saying that in the UK the fuel tax has increased at a rate *5%* higher than the inflation rate. The evidence is that it won't make a difference. It might be reasonable to get out of your car in London, but it would be different for rural counties. Road pricing would be favorable at the point of congestion. Gas tax plays a role, but no single thing will solve the problem.

Betty Deakin responded that in the context of the carbon loading of the atmosphere, we need to look at fuel pricing differently than congestion. We need to match prices to social cost, and in order for us to be better off, this question must be on the table. It is difficult in the social-political environment where strong desires to lower taxes prevail, and it is very difficult to raise taxes locally with supermajority requirements.

SESSION 2
Retrospective of the Past *50* Years

Marking its 50th anniversary, this session established the context for the future role of the Institute of Transportation Studies by reflecting on the role it has played over the past half century.

Wolfgang Homburger *(Session Chair),* Research Engineer Emeritus, Institute of Transportation Studies, University of California at Berkeley

Editor's note: Mr. Homburger pointed out that the Institute does not give degrees but provides all of the library and laboratory support for graduate study. He expressed his thanks to Beverly Hickok, the original Institute librarian and introduced distinguished senior Institute alumni from before 1950, including Mark Kermit, Charlie Zell and Eric Mohr.

ENGINEERING THE STATE HIGHWAY SYSTEM

Carl Monismith, Robert Horonjeff Professor Emeritus, Department of Civil and Environmental Engineering, University of California at Berkeley

Today's story is a story about people. The Institute was established 1948, with director H.E. Davis. Professor Davis was proficient in many different civil engineering areas, and he was successful in attracting good people to Berkeley, among them Assistant Director D.S. Berry and Professor R. A. Mayer.

Activities of the Institute included undergraduate and graduate level instruction, extension courses and conferences, research, a library and publications. Activities were designed to further transportation improvement in California. These included work on significant human factors projects in crash safety at UCLA, as well as research in traffic engineering, structural engineering, economics, soils, pavements and asphalt materials at Berkeley. From the very beginning, the importance of the Institute Advisory Committee (which began in 1948) was recognized. The breadth of the committee was significant; it included people from many different state and national transportation organizations, such as Caltrans, the Highway Research Board, the Western Highway Institute, county, state, and local governments.

With the advent of the Institute, emphasis on transportation engineering in the Civil Engineering program was increased and a graduate program introduced. With respect to the undergraduate program, students were allowed to specialize in their third and fourth years. They took courses in economics, materials, highway engineering, soil mechanics, traffic engineering, asphalt analysis, and railroad engineering—many of which were new courses developed by the faculty associated with the Institute. The graduate students took courses in highway planning and economics, traffic engineering, pavements, and airport engineering.

The graduate courses were taught in the late afternoon and evening in order to encourage professionals to participate. In the late 1960s many more courses were added and the breadth of the program enhanced. Many of the Institute's students have gone on to top positions throughout the world.

The Institute Extension program, initially under the direction of Bob Glenn and, later, Bob Cron, consisted of short courses with upwards of 900 enrollees per year, designed as outreach to improve California transportation. Some short course examples include traffic engineering, highway drainage, pavements, soil engineering, geometric design and freeway operations. In addition, an annual conference was instituted and was referred to as the "Road School."

The library, through the efforts of Beverly Hickok, and publications, with Wayne Snowden in charge, made sure that publications were made available to the profession, and this was another important outreach step.

Research excelled with key individuals such as: Harmer Davis (administration, policy), Donald Berry (traffic engineering), Ralph Moyer (economics, vehicle operating costs, road surface characteristics), Bamey Vallerga (asphalt), H.B. Seed (soil engineering), James K. Mitchell (soils), Carl Monismith (Soils, asphalts, pavements), Richard M. Zettel (finance, policy, taxation—Zettel worked closely with the California legislature), Norman Kennedy (traffic engineering, urban transit—Kennedy also excelled at advising graduate students), Dan Finch (lighting, surface reflectivity), Robert Horonjeff (taxiways, runway lighting, capacity—high speed exit taxiways), William Garrison (planning, freight), Adolf May (traffic operations, control, simulation—working with Caltrans), Gordon Newell (traffic flow theory, queuing—fundamental thinking), Adib Kanafani (air transport, economics), Jim Kell (traffic engineering), Frank Moffitt (photogrammetry, surveying), Wolf Homburger (traffic engineering, mass transit), Clarence Chan (soil testing), and Gale Ahlborn (computer programming).

Norene Jordan, the Institute's administrative assistant for many years, deserves recognition for her dedicated service. In general, the Institute's success has been made possible through a combination of the efforts of faculty, staff, students, and extramural support from many California agencies.

COPING WITH GROWTH: TRAFFIC OPERATIONS PLANNING

Adolf May, Professor Emeritus, Department of Civil and Environmental Engineering, University of California at Berkeley *(Editor's note: Additional materials relating to Professor May's remarks can be found in Appendix E.)*

The Institute has established a framework that can be viewed as a cycle of activities. Research is the bottom, both theoretical and applied. Research feeds into the educational programs, which have led to technical assistance programs. These have led to applications in the field, giving experiences that lead back to researching what we do not yet know.

In terms of traffic planning, we must first identify different traffic operating environments and break networks into facilities and basic elements. With an appropriate analytical framework, we have specific inputs—demand, supply, and control. These are fed into analytical tools, both simple and complex, which predict performance, which can then be judged to be satisfactory or unsatisfactory. Then, proposed solutions can be fed back and reanalyzed.

The next step is problem identification and development of potential solutions. Here we must ask ourselves if demand at a point in the time-space plane is greater than capacity. If not, there is no problem. If demand exceeds capacity, then what? We then must work on increasing the supply-side, or controlling and/or reducing the demand side.

On the supply side we can build new facilities or make spot improvements. There is ongoing work in the area of operational improvements, such as maintaining free-flow conditions. Also, improvements can be made in incident management.

On the demand side we can look at four areas: spatial, temporal, modal, and total. We can spread demand over these classes.

In terms of analysis requirements, we know that as flow conditions move from undersaturated to saturated, models that are required to analyze conditions become more complex (a systems approach is called for as opposed to local analysis). We have a variety of analytical models, covered in the ongoing development of the 2000 Edition of the Highway Capacity Manual (HCM2000). We also have many simulation models available. In summary, the framework is here to study the problems that we face.

EVOLUTION OF AIR TRANSPORTATION

Adib Kanafani, Director of the Institute of Transportation Studies and Professor of Civil and Environmental Engineering, University of California at Berkeley

The Chicago Convention (1944), the Civil Aeronautics Act (1938) and the Federal Airports Act (1946) all spurred growth in air transportation. In the 1940s there was great optimism over the growth of civil aviation. In California in 1945 it was anticipated that aviation growth would follow the pattern of automobile growth between 1900 and 1910. This would have meant 500,000 airplanes in California alone by *1955.* However, in 1955 there were only 50,000 airplanes nationwide. As an example of this overconfidence is the fact that for the last 50 years the runway configuration at the San Francisco International Airport has remained the same. The idea in 1945 was that air transport would take the same importance as automobile transport. Neighborhood airports for commuters were envisioned as well as community airparks. We know that things didn't happen that way. People started to fly much longer distances. The growth occurred in revenue-passenger-miles, not emplanements.

Today we have close to two air trips per year for every U.S. citizen. Why has this occurred? Air transportation became much cheaper to provide. Speed doubled in the 1950s, with the development of jets and turboprops, and significant passenger diversions from the railroad occurred.

We also saw an increase in airline employee productivity, where fewer employees were required for output than in other manufacturing sectors, even though the employee costs were skyrocketing.

Accident rates also dropped dramatically during the late 1940s and early 1950s. From 1948 to 1998, passengers flown increased 40-fold, miles flown increased 100-fold, fatalities decreased 37-fold, labor cost in real dollars increased 5-fold, and seat-miles per employee increased 11-fold, so the cost of providing air travel became cheaper.

In the last 50 years of aviation, we have seen growth in demand as well as technological innovations in the areas of aircraft, safety, airports and productivity. Environmental impacts have become a concern. We have seen evolving markets and institutions—undergoing such changes as deregulation, liberalization, and economic rationalization. We now have an awareness of the many externalities, including noise, air quality, and ground interference with aircraft. All of these areas needed university research. With evolving markets and institutions, we have seen studies of deregulation, international liberalization, globalization, and privatization.

The Institute has been involved in aviation research throughout its history. In the 1950s

and 1960s this research focused on airport infrastructure development, including airfield pavement design and runway lighting. Pilots would come to the Richmond Field Station (RFS) facility to test the runway lighting systems. This was largely Horonjeffs work

In the 1960s and 1970s, Institute research focused on coping with growth. In particular, research on airport capacity concepts can be pointed to with great pride. Existing procedures for analyzing capacity were simply wrong, and it was easy to show why. New concepts, and today's capacity manuals come from this work. Also, work during this period included noise analysis. Professor Horonjeff and his colleagues developed metrics that are still used to this day.

In the 1970s and 1980s, Institute research focused on structural changes in markets. During this period, traffic forecasting became more elaborate. Airlines began to understand that they needed to enhance productivity, so the Institute undertook aircraft and network economics studies which were important in the era following deregulation. Airline deregulation in particular was influenced heavily by researchers on the Berkeley campus, especially those in the economics department.

During the 1980s and 1990s, work has focused on changing paradigms, for instance on the productivity of airports as economic entities, exemplified in work done by David Gillen and Mark Hansen. Additional work is being done in the area of air traffic management, because delays and unproductive time have unfortunately increased and air traffic control technology needs breakthroughs. The recently established NEXTOR center is building up an active program of study in air traffic management.

The future calls for new synergies. The work performed in developing advanced highway systems can be used as a model for the study of advanced airway systems. We certainly see that we continue to have new challenges fifty years from now: all the problems have not yet been solved.

FOUNDATIONS OF NEW TRANSPORTATION TECHNOLOGY

Hamed Benouar, Program Manager, Traffic Operations, California Department of Transportation *(Editor note: The full text of Mr. Benouar's remarks can be found in Appendix E.)*

SESSION 3
Thinking about the Transportation System in the Next *50* Years

If there is one thing that we can be sure of it is that the future will be full of surprises and unforeseen developments. What does this imply for how we think about the future evolution of the transportation system, how we plan, and how we make investment decisions today?

Daniel Sperling (Session Chair), Director of the Institute of Transportation Studies, University of California, Davis, and Professor of Civil and Environmental Engineering and Environmental Science and Policy

WHAT IS AN APPROPRIATE PLANNING HORIZON?

Melvin Webber, Professor Emeritus, Department of City & Regional Planning, University of California at Berkeley *(Editor's note: The full text of Professor Webber's remarks can be found in Appendix E.)*

WHAT DOES THE PAST TELL US ABOUT THE FUTURE?

William Garrison, Professor Emeritus, Department of Civil and Environmental Engineering, University of California at Berkeley *(Editor's note: To better accommodate the figures he refers to, the summary of Professor Garrison's remarks has been printed in Appendix E.)*

TOWARD A SUSTAINABLE TRANSPORTATION SYSTEM

Daniel Sperling, Director of the Institute of Transportation Studies, University of California, Davis, and Professor of Civil and Environmental Engineering and Environmental Science and Policy

Sustainability means different things to different people. The automotive industry is at the beginning of a technological revolution. If there is a will and a market, that revolution could be directed toward solving many energy and environmental problems. In transportation, because of the large externalities, the public sector plays an especially large role in this process.

The car has been a huge commercial success. Car registration and ownership has boomed, with a steep growth trajectory continuing everywhere in the world. In most industrialized countries, those belonging to the Organization for Economic Cooperation and Development (OECD), cars account for about 80% of motorized travel, despite high fuel costs, good transit and dense land use. The energy implications are uncertain. On the one hand, innovation in the oil industry is so great that the world is likely to have a lot of oil

for quite a while. On the other hand, we know that it is a finite source, and that most of it is located in politically unstable areas.

Looking at carbon dioxide (CO_2) concentrations, which influence climatic patterns, we see that they have been increasing steadily since the industrial revolution. Transportation is the source of one-quarter of these emissions. We expect that the concentrations will keep increasing, given our current usage patterns. The effects on climate are uncertain but likely to be disruptive.

Looking at ozone concentrations— in some ways a success story in the U.S.—we see that air quality has improved, and most metropolitan areas are likely to meet or come close to air quality standards except for a few areas in California. With attainment of standards, there are policy implications since transportation reform efforts have used air quality as a proxy.

With carbon monoxide (CO) there has been a more dramatic improvement, and CO is no longer a problem, even in California. The principal air pollution problem is now particulate matter, mostly associated with diesel engines.

The environmental issues associated with vehicles are still substantial, though qualitatively different from 20 years ago, and will intensify as vehicle usage continues to increase. What do we do about this? We can change either behavior or technology. In some cases, technology is changing and can deal with problems at relatively little cost and difficulty.

There are technology improvements available in the areas of energy storage, fuel cells and renewable fuels. The battery electric vehicle is one of those promising technology options, but in the U.S. will only be a niche vehicle and won't play a large role. There are many other technologies available.

Hybrid electric vehicles hold great promise. Based on the premise that engines in today's vehicles operate very inefficiently, hybrid electric vehicles let the engine run nonstop at high efficiency, with a smaller engine and electric motors. In Japan, the hybrid EV is a success and has had a positive reception, unlike the battery EV in U.S.

The fuel cell converts chemical fuel into electric energy and works best with hydrogen. It is very efficient, but the question is whether it can be produced at reasonable cost. Daimler Benz and several other major car companies have made large investments in fuel cells.

In any case, electric drive vehicle technology is very likely to be successful in the market. The future technology will likely be a mix of these battery, hybrid and fuel cell energy systems. Battery electric vehicles are a building block for other technologies. These technologies have the potential for virtually eliminating air pollution and greenhouse gas emissions.

The shift toward new technologies is aided by the trend toward vehicle specialization. Think of this as the tennis shoe syndrome: vehicles were once luxuries, then household necessities, then individual necessities, and finally we will see multiple/specialized vehicles in each household. No longer must all vehicles serve all purposes. With over one vehicle per licensed driver, households are more willing to accept, and even embrace, limited range vehicles and neighborhood cars.

But technology does not happen on its own, especially those impacting market externalities. Public policy plays a key role. More innovation and choice will come with regulatory reform, as well as new market instruments. In addition we will see a more integrated approach, taking account of regional differences. It appears that converging developments are leading to a second wave of vehicle technology.

The sustainable transportation agenda will include careful consideration of how to use technology in a more efficient way and how to match technology initiatives with better, more flexible incentive-based regulatory initiatives. This agenda will also include more diversity and experimentation with electric propulsion as the key technology.

We can still ask, "what is sustainability?" In a recent comprehensive study of the social costs of transportation (see work by Mark DeLucchi), we see that roughly 3/4 of the full costs of driving are borne by drivers, in the aggregate. Other costs, such as aesthetics, loss of community, inequitable access to goods and services, need to be addressed in a robust way. The sustainability issue can and should be dealt with through a wide variety of initiatives.

IMPLICATIONS OF A CHANGING URBAN FORM

Martin Wachs, Professor of City & Regional Planning and Civil & Environmental Engineering and Director of the University of California Transportation Center, University of California at Berkeley *(Editor's note: The full text of Professor Wachs' remarks can be found in Appendix E.)*

DISCUSSION

A participant asked the panel about smaller, lighter vehicles. ***Professor Sperling*** indicated that there are opportunities and niches for these in some places.

Another person asked what is so compelling about electric drive. ***Professor Sperling*** explained that in addition to reducing conventional air pollution, electric drive will sweep the market due to consumer attractiveness, cost, smoother acceleration, pre-cool and pre-heat capabilities.

SESSION 4
Defining a Vision for the Future Transportation Enterprise

This session presented four views on ways in which the future transportation enterprise will evolve.

Karl Hedrick *(Session Chair),* Professor of Mechanical Engineering and PATH Director, University of California at Berkeley

THE DISAPPEARANCE OF DISTANCE

T. R. Laksmanan, Professor of Geography and Executive Director of the Center for Energy & Environmental Studies, Boston University

It is not possible to look at the future unless you look at the past. We want to look at what forces led to the disappearance of distance and how the changing transportation system has affected individuals, society and the economy. These changes have also had major influences on production, consumption and cultural experiences, and there have been significant social and economic forces in operation with observable effects. We can talk about the near term future in terms of our recent history. We want to focus on the how, why and so what of the "Disappearance of Distance."

In attempting to look at the change factors and consequences, we see changes in the technologies of movement and in the areas of transportation and information. These technical changes have been in the form of mutually reinforcing physical and social innovations, e.g., development of the compass and star charts led to new types of shipping; this is an example of changes in information technology leading to new physical innovations.

It is possible to look at three eras of transportation revolution: early modern, from 1500-1800; 19th century, characterized by fixed rail route transport; and 20th century, characterized by flexibility and global ubiquity.

If you talk about transportation and culture, any major technology alters a culture in three ways: it affects our interests, the things we think about; it affects our symbols, the things we think with; and it affects our arena of thoughts, by changing the nature of community.

We should look at the first transportation revolution, in the early modern era. The Portuguese developed a means of transporting cheap bulk cargo and brought the compass and star charts to shipping, thus lowering risk and the costs of information and mobility of capital. Next, the Dutch developed three-mast ships, which through mass production were inexpensive to produce. Finally the English, with better arms and higher maneuverability, were able to control the Atlantic Ocean, and one can see that, for

example, freight charges on tobacco steadily declined between 1618 and 1775.

The consequences of this first revolution were that production systems mutually created and were created by transportation systems: production increased by geographic expansion and productivity increased through long distance trade and regional specialization. There was a rapid drop in transport costs, increased modal mobility, and increased accessibility to ports. During this time, the idea of progress was born (the notion that tomorrow can be better than today), along with the ideas of capitalism and individual freedom.

The second era of transportation revolution is characterized by the exploitation of fossil energy and the proliferation of economies of scale. There was a technology explosion in communications. The telegraph influenced railroads and production systems. It was possible for the owners of capital to communicate every day, which enabled companies to get larger, to develop hierarchies, and to exploit economies of scale. The modern corporation was born.

The third era is characterized by the internal combustion engine, the concept of mobile fixed capital, more flexible routes and geographies. With the development of the airways, we have a truly ubiquitous global system.

This allows us to consider our contemporary change factors. In addition to globalization, we have seen a demographic evolution, such that women are increasing their participation in the labor force and activities are migrating from the home to the market, e.g., food making, child care, etc. New centers of activity and transportation patterns are evolving in concert with technical change.

There are new issues such as environment and civil rights, first raised by civil society and now of concern to private and public sectors. We can't think about transportation without consideration of these issues.

In the knowledge economy of today, with such a mobile workforce, what we have is no longer a hierarchy but a hyperarchy, where the important questions are how to develop, acquire, and nurture knowledge. With the future may come major organizational change in transportation—where we might be able to commercialize household travel for all members of a household for a monthly charge. This could be cheaper than the current cost of transportation, since each family has many people and several cars and a car is used on average one hour per day (low utilization of capital). Similar things are being done in the freight sector.

Of course there are differences in non-OECD countries. One idea of Armageddon, would be on a cold morning in 2020 when 300 million Chinese and 200 million Indians all start their cars to go to work!

RETHINKING THE ROLE OF PUBLIC TRANSPORTATION

***Sharon** Banks,* General Manager, Alameda-Contra Costa Transit District *(Editor's note: The slide narrative accompanying Ms. Banks' remarks can be found in Appendix E.)*

Imagine that AC Transit has brought in a think tank for discussing new roles for public transit. We know that public transit is in crisis, and we are confronted with changes in technology, and changes in the way people live and move. We need to think through our current roles and consider what AC transit could be doing. In addition to providing bus service, to move people, what hats is AC Transit wearing?

[Suggestions from the audience included:

advertising/information
eyes for the community
jobs
technology leadership
disabled mobility
equivalent of taxi service
school bus
police
emergency lifeline
job access
recreation
shaping the community/land use
small package delivery]

A crisis can be good news and bad news; people are afraid of it, but it also provides the first step for change. Change can be thought of as a friend. The kinds of businesses and services that have disappeared often faced a crisis and didn't change. In that context, let us consider the many hats that AC Transit is called upon to wear:

AC Transit is a mobile childcare specialist and partner with parents, who entrust 60,000 school age children to AC Transit each day. AC Transit is also the transportation department for libraries, museums, training programs, stadiums, movies, concerts, and welfare to work. How do we do it better in the face of changing demographics and new technology?

AC Transit also provides dependable drivers for non-drivers (teens, adults, and seniors) to and from school, college, work and extracurricular activities. Reliable and safe travel is also provided for seniors and the disabled, in the form of both fixed route transit and paratransit. AC Transit is also an authentic and original vanpool operator and a partner to

casual car-poolers, *95%* of whom take the bus home in the evening.

AC Transit also provides emergency and routine medical trips and provides housing in the form of warm, safe, dry mobile homes for the homeless. The transit district switchboard also acts as a telephone lifeline for people who have no one else to call.

It is important to ask whether AC Transit should be serving these roles and to determine whether we should obtain additional funding or get out of certain roles. We think about how we want to provide services for access to shopping, whether to shopping malls, or home shopping via television or the Internet, particularly for long haul travel.

We are also protectors of the environment, which can be thought of as a burden and a benefit. We are looking for alternative fuels and are mandated to comply with regulations for clean wastewater and hazardous waste disposal.

We are partners with our workforce, through increasingly participatory management, where we share the gains and the risks. New technology is an important part of transit's future. However, we must be wary, since it is often found that only *50%* of technology will actually do what its proponents say it will and only a small percentage of proposed technologies will actually get implemented. Through collaborative problem solving we are implementing new models of getting people and institutions to change. Finally I refer you to the new TCRP Digest which summarizes ways of thinking about new roles for transit.

PROVIDING NEW INFRASTRUCTURE

Mary Moehring, Special Assistant to the Regional Administrator, Region 9, Federal Highway Administration *(Editor's note: The full text of Ms. Moehring's remarks can be found in Appendix E.)*

The title of this presentation really means we want to know how we are going to get the necessary funding for future projects. In order to explore how future infrastructure will be funded, it is important to look at how the federal highway aid program will be delivered in the future and at how the FHWA will be changing in the future as a result of pending reorganization.

The largest piece of domestic legislation is the pending multiyear transportation bill. We know that the Intermodal Surface Transportation Efficiency Act (ISTEA) expired last September 30. Congress then passed a 6-month extension, which will expire in a few days. The good news is that the Senate and House have each passed a bill and there is a conference committee assigned to resolve the differences. The conference report will then be voted up or down with no amendments.

The real issue is money: how much, who gets to spend it, and what for? The Senate and House are not far apart in terms of money. A significant issue is that both bills exceed the

balanced budget agreement, and the question is where to find the offsets. The Administration's bill was $175 billion, still an increase over ISTEA, and both the Senate and House bills are around $217 billion. The differences will be settled via an eventual compromise, but regardless the outcome will still be a substantial increase over ISTEA, perhaps closer to the President's original proposal.

With respect to passage of the new transportation bill, there are two sticking points: the demonstration projects (projects which are earmarked in the bill itself) and the requirement that each state reduce the legal limit of blood alcohol content. It turns out that the programs themselves are similar to ISTEA and most of the dollar increases will flow to state and local governments. The most probable deadline for passing the bill is seen to be Memorial Day.

How will the federal surface transportation program be delivered in the future? In the past, FHWA had a compliance-based business strategy where if states didn't comply with FHWA regulations, they didn't get reimbursed. In the future, FHWA will focus less on compliance and more on technology delivery to our partners. In this regard, FHWA is currently in the process of eliminating its nine regional offices and replacing them with four resource centers staffed by specialists who will be available to consult with the Division offices and state DOTs.

DEPLOYMENT OF NEW TECHNOLOGY

John Fearnsides, Vice President, The MITRE Corp. *(Editor's note: Images used to illustrate Mr. Fearnsides' remarks can be found in Appendix E.)*

The topic will be the emerging enterprise and implications for technology implementation. As an overview, we will consider information sharing networks such as air traffic management (ATM) and ITS. For these networks, what technology is needed, and how will it be implemented?

The Internet is reshaping the relation between suppliers and customers; are air traffic management and ITS becoming like the Internet? What are the implications for supporting technology?

In terms of the changing customer/supplier interaction, there is increased access to product information, chat rooms in which to actively compare actual performance, and bulk buying made possible by virtue of communication. Groups of people (strangers) who meet in these chatrooms can arrange to purchase large quantities of items.

With developments in Traffic Flow Management (TFM) the FAA is starting to make decisions based on economics. This consideration of economics adds a new dimension to traditional Air Traffic Control (ATC)—which was based primarily on safety. TFM adds an information component between the dispatchers and the airlines. As a part of TFM, collaborative decision-making (CDM) is a component of the concept of free flight, and is

a network to facilitate the transfer of information. One must consider the cost of delay, which is actually a poor measure of the productivity and efficiency of the ATM system.

It is envisioned that ITS will decrease congestion, improve safety, reduce emissions and expand public transit use. Implementation of ITS requires advanced computers and communications. The challenges in this implementation include the need for collaboration among agencies, the need to use the existing public infrastructure complemented by commercial providers, and the need to implement new operational concepts. It is important to recognize that individuals in cars are not professional dispatchers when using information.

In the future we will see more collaborative decision making and more information sharing. The FAA will continue to ensure safety, users of the system will focus on increasing efficiencies, and new collaborative behaviors will emerge. We will need to measure performance, despite the fact that we have never had a satisfactory approach to modeling the air transportation system. This may be addressed by the emerging science of "complexity."

In terms of ITS, there will be a unique deployment experience, since the system interacts so closely with the general public, not with a specially trained population. When considering how technology was brought into the auto industry over many years, it is recognized that it was evolutionary even if it was not planned that way. Continuing study of human factors in terms of how people (users) respond to technology will provide opportunities for applying lessons learned. It is important to understand how the micro-factors impact the macroscopic picture.

In the future we will see user benefits of collaboration. TFM is designed to address the current excess user costs of $3-S billion per year. It has been estimated that the benefits of free flight would be approximately ***$1.5*** billion per year.

When implementing new technology, it must be recognized that the design process for some future architecture begins in the present. In order to target some future architecture, one needs to invest time, knowledge and consider the technology evolution. You must leam your way, since operational requirements and technologies change along the way.

In any evolutionary deployment, one must think beyond the product and think about fielding new operational capabilities (making it happen). While thinking this way, we still have no idea of how people will use the new technology, so it is imperative to develop an open, connected, high capacity, high speed network that can provide value-added technologies and value added applications to advance the system.

DISCUSSION

An audience member asked ***Professor Laksmanan*** to elaborate on the second cultural development in transportation that was brought about by the various technological and

social developments, in addition to commercialization of transportation.

Professor Laksmanan replied that he wanted to discuss the notion of working in organizations where everything is outsourced where it is more difficult to evaluate performance. In the environment of performance based budgeting, even in the public sector, there is a greater focus on accountability and monitoring.

SESSION *5*
The Institute of Transportation Studies Mission: Making it Happen

This session examined ways in which the Institute of Transportation Studies mission can evolve to meet the needs of the next fifty years.

Martin Wachs *(Session Chair),* Professor of City & Regional Planning and Civil & Environmental Engineering and Director of the University of California Transportation Center, University of California at Berkeley

ROLE OF RESEARCH IN SHAPING THE FUTURE TRANSPORTATION SYSTEM

Robert Skinner, Executive Director, Transportation Research Board *(Editor's note: The full text of Mr. Skinner's remarks can be found in Appendix E.)*

TECHNOLOGY TRANSFER-PARTNERSHIP BETWEEN THE UNIVERSITY AND INDUSTRY

James Costantino, President, ITS America

To begin the discussion of Technology Transfer (TT), consider this anonymous quote: experience is a hard teacher because she gives the test first, the lesson afterward." What is TT? It can be defined as the conveyance of information, know-how, materials, patents or copyrights from a research institution to industry. Where did TT begin? With the Morrill Act of 1862, 51 states and territories were allocated land grant funds to form educational institutions. The Hatch Act of 1887 led to the development of agricultural experiment stations at land-grant institutions, and the Smith-Lever Act of 1914 led to the establishment of cooperative extension programs in agriculture and home economics in association with the U.S. Department of Agriculture.

These land grant institutions pioneered higher education at a low cost, with research as a legitimate function, focusing on public service, continuing education, and the elevation of the useful arts to academic respectability.

There are many methods of TT, including the proliferation of graduates themselves, the

use of internships and cooperative education, publications, consulting, sabbaticals, industry liaison or affiliates, and conferences. Typically, universities effect TT through focused research centers and labs, incubators, industry parks and short courses.

These focused research centers and labs are usually initiated with government money, and transitioned to industry support. (Of course, the solicitation of industry funds may bring problems.) Incubator programs are designed for faculty and students to initiate programs which generate fledgling companies that eventually grow and leave the nest.

University/industry technology transfer programs include such examples as PATH and Berkeley's development of emissions modeling techniques for the EPA. Also, MIT's Industrial Liaison Program provides industry access to MIT activities. The University of Minnesota has developed autoscope and GPS applications. The Translink Center at Texas A&M has focused on linking elements of the transportation system together.

Minority educational institutions and firms have had opportunities to contribute to the ongoing ITS research and development. The IDEA program, administered by TRB, focuses on high payoff concepts, with short duration and small budgets.

The Federal Intelligent Vehicle Initiative (LVI) program is aimed at accelerating the development and deployment of integrated systems that help drivers operate more safely and efficiently. The Professional Capacity Building program is attempting to ensure that there are enough trained professionals to deploy ITS.

The future will see a shifting research paradigm, whereby faculty centered research shifts to industry-relevant research, and single discipline research shifts toward multidisciplinary. As for the future, while we cannot foresee it with complete certainty, we must enable it.

DEVELOPING NEW SKILLS AND KNOWLEDGE

Michael Walton, Professor of Civil Engineering, University of Texas at Austin

There is a history of 50 or so transportation research organizations that have their beginnings tied to the U.C. system. We have many challenges and rich opportunities before us. This is certainly one of the most exciting periods in the transportation research endeavor. In the setting of a research institution within a higher educational institution, we tend to focus upon shaping stones for construction vs. building a cathedral. We focus on the development of new educational services, products, and degree programs. We do need to talk about the cathedral, which is traditionally not given enough focus and attention.

Given today's problems facing higher education, administrators are certainly interested in perpetuating and sustaining programs like the Institute, but they are under great pressure to cut budgets and demonstrate performance. Given our great future needs, we need to

ask how can we possibly address all of the issues and all of the opportunities before us. Transportation is a critical issue but is only one indication of the direction of society. In order to deal with the many competing areas of academic pursuit in the future, we must recognize that public and private institutions will each have different roles and responsibilities.

There is some question as to whether all institutions and particularly the research programs will survive. Should the research programs survive? Can we afford to bring resources to all current institutions? Some will not survive in current context. What is the proper forum for spawning needs, innovations, fundamentals? How will we be addressing this in the next decade?

The Institute will survive, as it provides a nurturing environment and attracts the best and brightest. Academic units are changing, but need to continue producing expertise for core competencies in transportation. Industry lacks the human capital and resources it needs now and this places pressure on academic units. We need to consider the skill needs now versus those in the future.

It seems that information technology is the basis of everything we do, but is it being taught? Also, engineering skills typically become obsolete every *2-5* years. How do we renew these skills? We need some guiding commitments such as lifelong learning.

Organizations will be changing in the future, with more public involvement, more recognition of the role of the transportation professional in society, and fast-paced technology change. This will mean more managerial positions, varied career choices, more opportunities in smaller/self-employment situations and globalization.

What are the strengths of the Institute? The legacy of the Institute and its momentum are strong. Further, the Institute has a strong constituency, an interdisciplinary approach and attracts the best and brightest. The Institute has established long-term relationships with Caltrans and other agencies. There is a need to continue to build and develop these kinds of working relationships. By maintaining flexibility among disciplines, the Institute can change and reinvent itself. The Institute must maintain its core competencies in key areas.

In terms of areas of weakness and threats: the Institute must protect itself against changing institutional priorities, in higher education and in the legislature, including the increasing desire for accountability and austerity. Another potential threat would be a change in priorities among partners, so the Institute must be positioned to help shape the priorities and move with them. Privatization in other countries has driven research institutions toward the pursuit of more applied research and work oriented toward a particular mission. Some say this is the role of the private sector only. If other countries are not investing in research, maybe this is an opportunity for the Institute.

The Institute's nurturing environment is essential and must be maintained, so that the exciting new challenges and problems can be met.

FROM THE INSTITUTE OF TRANSPORTATION STUDIES EXTENSION TO THE INSTITUTE OF TRANSPORTATION STUDIES TECHNOLOGY TRANSFER PROGRAM: SO WHAT?

Linda Howe, Director, Technology Transfer Program, Institute of Transportation Studies, University of California at Berkeley *(Editor's note: The full text of Ms. Howe's remarks can be found in Appendix E.)*

ITS Extension, like the Institute itself, was established 50 years ago. The program played a significant role in California by helping train those who designed, built, operated, and maintain the state's world class highway system. Today, ITS Extension has a new name: the Technology Transfer Program. And we have been brought back under the administrative oversight of ITS with the purpose of strengthening the relationship between ITS research and the needs of professional practice.

This year the Technology Transfer Program has a budget of ***$1.5*** million, twice what it was a decade ago. Our short courses reach 4000 people annually. We have a Web site, a newsletter, provide technical assistance in traffic safety to local communities, and support free access to the Harmer Davis Library by public employees. Two years ago a marketing study revealed that the program was perceived by our public as a little old-fashioned (maybe too focused on highways); today we are expanding into advanced transportation systems, planning, and modeling.

"Technology transfer" generally refers to the process of moving a technology from one venue to another. For this program, the transfer is from research into practice. Most transfers are two-way, and everyone learns as research ideas, methods, and products are tailored to fit requirements of specific users. Problems encountered during adoption of a change stimulate innovation as well as new research and applications.

The technology transfer process serves both sides well. Successful transfers of research results help justify the usefulness of the research activity to public funders. For practitioners, technology transfer programs help ease the trauma and uncertainty associated with implementing anything new.

Overall, the name change has reinvigorated the program and refocused it on our role in the planning and operating of efficient, sustainable, integrated, multi-modal transportation systems. Future plans include more of our core activities--training, technical assistance, and information dissemination, with focus on state-of-the-practice applications. We will nurture collaboration between ITS research and professional practice; conduct research on technology transfer; and use advanced technologies to expand the reach of our programs. You are invited to work with us to achieve our vision.

INSTITUTE OF TRANSPORTATION STUDIES LIBRARY: THE NEXT GENERATION

Catherine Cortelyou, Librarian, Institute of Transportation Studies, University of California at Berkeley *(Editor's note: The full text of Ms. Cortelyou's remarks can be found in Appendix E.)*

We are seeing a great change in cultural expectations of libraries, and information management is becoming a critical issue for the public and private sectors, one which is changing almost daily. With computer chip speed doubling every 18 months, we foresee astonishing achievements in the future. Despite the sometimes musty image of libraries, we are at the forefront of seizing and exploiting information exchange. We have witnessed the evolution from card catalogs to online catalogs, databases, and CD-ROMS that are essential tools today.

The Library is actively addressing the support and application of new technology, including participation in the Digital Library of the U.C. system. This effort is designed for open access, to facilitate reliable, organized searches. Of course, there are also social, economic and ethical issues associated with information management.

The Bureau of Transportation Statistics (BTS) is attempting to establish a National Transportation Library, not as a monolithic edifice but as a means to enhance and support existing transportation libraries in a networked fashion. This is an extraordinary opportunity for the Institute, Northwestern University and state DOT libraries. It is clear that change is happening. But, we know that technological, social, and cultural changes do not occur at the same rate. We are becoming more comfortable with technology, but we are not familiar with its limitations. We must face the realities of computer idolization, and understand that computers don't automatically spit out the right answer.

Our library has maintained a tradition of providing scope and depth in its collection, and we now serve a global transportation community. Emerging technologies are opening new ways of serving our users, but we know that personable and personal service can't be replaced by technology. We are committed to enhancing services to users by addressing accessibility needs and increasing the online availability of organized information. We are particularly committed to using emerging information technologies to enhance our service to the Institute of Transportation Studies at Davis, Irvine, and Los Angeles.

Demand for library materials and services now exceeds our capacity to deliver, and our collection now exceeds the capacity of our space there is no room to add desks, staff, or books, and the collection is growing at a rate of about 3,000 volumes per year. Major tasks are still ahead of us, particularly converting old card catalog indexing of journal articles to online form. The library is supported solely by the Institute, but we are attempting to broaden the base of support. For now, we are making do, but we must do better. The next generation of the library calls for help from all of you.

Closing Luncheon

CONFERENCE SUMMARY

Adib Kanafani, Director of the Institute of Transportation Studies and Professor of Civil and Environmental Engineering, University of California at Berkeley

It will be difficult to summarize the rich flow of ideas we have experienced. We have tightly compressed 50 years by our retrospectives and the presence of people who came here. This has been a rewarding celebration. The Institute has made tremendous contributions, and has influenced policy. We have engineered the highway system of the state, and have trained thousands of transportation professionals. We have been doing the right thing in the right way.

In order for things to remain the same, things must change to continue to achieve the excellence of the past 50 years. We must explore and contemplate future change and adaptation. We have generated an abundant set of ideas, and it will take a while to assimilate them. We can perform a reality check on what happened in the last few days. We have seen that we will have new challenges and new areas of research, and we have reiterated things we have all grappled with for decades.

There were several major themes, which are not necessarily new ideas but provide some new insights.

First we must take a BROAD VIEW. We must look around as we look back and forward. We should stretch our vision and take a broader perspective, in particular a global perspective. The failure to consider the scope of the criteria used to make decisions sometimes impairs decisions, and we must involve more and more actors in decision making. In the area of Air Traffic Management (ATM) versus Air Traffic Control (ATC), we see that we must work together rather think of the process as one of giving and receiving.

Next we must consider EQUITY. We need to look at the world as a whole to consider the vast majority of the people in this world rather than just a few of us who are privileged to have to choose between advanced technologies. As another example of the need to consider equity, we must continue to look at the wealth of roles that conventional urban transit system can play in society. We must also carefully consider the distribution and incidence of costs and benefits.

With the advancement of information technology, we must GLOBALIZE our way of thinking about transportation and consider how the environment within which the role of transportation is changing. We can see demographic trends as a potential source of

instability. By studying these demographic trends we also see the importance of understanding how households and employment structures of households are changing.

We have also discussed the intellectual challenges of transportation research and how we can no longer continue in our old hierarchical way of thinking.

We have also seen that we don't have a comprehensive means of dealing with land use. We do know that transportation can be used as instrument (one of many) for designing a particular urban structure and/or form.

ECONOMICS has been a recurring theme. We need to think of different ways of financing transportation infrastructure, and we need to think about finance in terms of globalization, given the changes in roles among the private and public sectors. We have seen fundamental changes in methods of shipping and how airlines make supply decisions.

With respect to congestion pricing, we have developed a strong theoretical underpinning, but we must recognize that there are real reasons why these mechanisms are not popular. In fact, few communities have been able to implement congestion pricing measures, other than in Singapore.

We have also seen the enabling power of transportation, with inherent external benefits. We continue to need skills and theoretical constructs to quantify these concepts for comparative analysis. We have seen how air transportation evolved, enabling technologies that were not where people were originally looking for innovation. Innovation in air transportation has occurred largely in the areas of communication and navigation, not with the plane itself. This demonstrates that we need to be able to look in all directions for innovation. The agenda is rich, and there is a lot more research to be done.

As a parting thought, the notion that we are bridging social sciences and technical and engineering sciences is not really tenable anymore. This bridging is not good enough, in fact we need to merge these fields of inquiry. Our largest challenge is in the university environment: the organizational structures are obsolete, but how do we redefine institutional arrangements? This is more difficult than reorganizing structure; it involves reorganizing the styles of inquiry and broadening the means, language, and symbols of communication. This requires assimilation of the fields of inquiry to sustain transportation. I am certain that the next 50 years will conclude with an upbeat conference.

APPENDIX A:

SYMPOSIUM PROGRAM

INSTITUTE OF TRANSPORTATION STUDIES

50th Birthday **Symposium**
The Transportation Enterprise:
Challenges of the 21st **Century**

UNIVERSITY OF CALIFORNIA, BERKELEY

Thursday April 23, 1998

8:00 **Registration** Sibley Auditorium, Bechtel Engineering Center

9:30 **Introduction** Professor Adib Kanafani, Director, Institute of Transportation Studies, University of California, Berkeley

Welcome Robert Berdahl, Chancellor, University of California, Berkeley
Joseph Cerny, Vice Chancellor for Research, U.C. Berkeley
C. Judson King, Provost and Senior Vice President, University of California, Statewide
Rulon K. Linford, Associate Vice Provost for Research and Laboratory Programs
Paul Gray, Dean, College of Engineering, University of California at Berkeley
Mohammad A. Al Shaikh, Distinguished Alumnus

Remarks The Hon. Dean Dunphy, Secretary, Transportation and Housing Agency, State of California

10:15 **Keynote:** "A **Golden Opportunity"** Wilfred Owen, Brookings Institution

(to be read by Professor Melvin Webber)

10:45 Break

11:00 Session 1: Forces Shaping the Future Transportation Enterprise
This session sets the scene for the Symposium by examining the social, economic, environmental, and technological forces that will shape the nature of the transportation enterprise during the first decades of the next century.

Session Chair Professor Wilfred Recker, Director, Institute of Transportation Studies, University of California, Irvine

Demographic and Social Change Alan Pisarski, Transportation Consultant
Balancing Environmental and Economic Concerns Professor Elizabeth Deakin, Department of City & Regional Planning, University of California at Berkeley
Meeting Future Infrastructure Needs Professor Tony M. Ridley, Civil Engineering Department, Imperial College, University of London
Planning For Technical Future Robert Parsons, President, Parsons Transportation Associates

12:30 Box Lunch at Bechtel Terrace

1:30 Session 2: Retrospective of the Past 50 Years
Marking its 50th anniversary, this session will establish the context for the future role of the Institute of Transportation Studies by reflecting on the role it has played over the past half century.

Session **Chair** Research Engineer-Emeritus Wolfgang Homburger, Institute of Transportation Studies, University of California at Berkeley

Engineering the State Highway System Professor-Emeritus Carl Monismith, Department of Civil Engineering, University of California at Berkeley
Coping With Growth: Traffic Operations Planning Professor-Emeritus Adolf May, Department of Civil Engineering, University of California at Berkeley
Evolution of Air Transportation Professor Adib Kanafani
Foundations of New Transportation Technology Hamed Benouar, Program Manager, Traffic Operations, California Department of Transportation

3:00 Break

3:15 Session 3: Thinking about the Transportation System in the Next 50 Years
If there is one thing that we can be sure of it is that the future will be full of surprises and unforeseen developments. What does this imply for how we think about the future evolution of the transportation system, how we plan, and how we make investment decisions today?

Session Chair Professor Daniel Sperling, Director, Institute of Transportation Studies, University of California at Davis, and Professor of Civil and Environmental Engineering and Environmental Science and Policy

What is **an Appropriate Planning Horizon?** Professor-Emeritus Melvin Webber, Department of City & Regional Planning, University of California at

Berkeley

What Does the Past Tell Us About the Future? Professor-Emeritus William Garrison, Department of Civil Engineering, University of California at Berkeley

Toward a Sustainable Transportation System Professor Daniel Sperling

Implications of a Changing Urban Form Professor Martin Wachs, Departments of City & Regional Planning and Civil Engineering, University of California at Berkeley

4:45 **Adjourn - Transport to Richmond Field Station**

6:00 Barbecue at Richmond Field Station and Poster Session
Research projects being undertaken by graduate students from several academic programs will be displayed in the form of posters. The researchers will welcome comments from, and interaction with Symposium participants.

Friday April 24,1998

9:00 Session **4: Defining a Vision for the Future Transportation Enterprise**
This session will present four views on ways in which the future transportation enterprise will evolve.

Session Chair Professor Karl Hedrick, Department of Mechanical Engineering, University of California at Berkeley

The Disappearance of Distance T. R. Laksmanan, Professor of Geography and Executive Director of the Center for Energy **& Environmental Studies,** Boston University

Rethinking the Role of Public Transportation Sharon Banks, General Manager, Alameda-Contra Costa Transit District

Providing New Infrastructure Mary Moehring, Special Assistant to the Regional Administrator, Region 9, Federal Highway Administration

Deployment of New Technology John Feamsides, Vice President, The MITRE Corp.

10:30 Break

10:45 Session *5:* **The Institute of Transportation Studies Mission: Making it Happen**
This session will examine ways in which the Institute of Transportation Studies mission can evolve to meet the needs of the next fifty years.

Session Chair Professor Martin Wachs

Role of Research in Shaping the Future Transportation System Robert

Skinner, Executive Director, Transportation Research Board

Technology Transfer-Partnership between The University and Industry James Costantino, President, ITS America

Developing New Skills and Knowledge Professor Michael Walton, Professor of Engineering, University of Texas at Austin

From the Institute of Transportation Studies Extension to the Institute of Transportation Studies Technology Transfer Program: So What? Linda Howe, Director, Technology Transfer Program; Institute of Transportation Studies

Institute of Transportation Studies Library: The Next Generation Catherine Cortelyou, Librarian; Institute of Transportation Studies

12:30 Closing Luncheon Bancroft Hotel

Luncheon Speaker and Conference Summary Adib Kanafani

APPENDIX B:
SPEAKER ROSTER AND BIOGRAPHIES

His Excellency Dr. MohammedAl Shaikh
Minister of State and Member of Council of Ministers
Yamama Palace
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Kingdom of Saudi Arabia

His Excellency Dr. Mohammad A. Al Shaikh is Minister of State and a Member of the Council of Ministers in Riyadh, Kingdom of Saudi Arabia. Dr. Al Shaikh is a most distinguished alumnus ofthe Institute ofTransportation Studies.

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Sharon Banks is AC Transit's chief executive officer and is responsible for overseeing the entire operation of the San Francisco-East Bay Area's public transit system. She accepted this post permanently in 1991 after serving in a six-month interim capacity as both General Manager and General Counsel. She came to AC Transit as General Counsel in 1990. As General Manager, Ms. Banks supervises the activities of 2,000 transit workers who serve the system's 235,000 daily riders. She is responsible for a $166 million annual operating budget and $7 million capital budget. Ms. Banks is the Chairwoman ofthe Transportation Research Board's Executive Committee and is the immediate past Chairwoman of the California Transit Association.

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Hamed Benouar is Program Manager, Traffic Operations, California Department of Transportation.

Robert Berdahl took office in July of 1997 as U.C. Berkeley's eighth Chancellor. He came to U.C. Berkeley from the University of Texas at Austin where he served as President since January 1993. Before assuming his post at UT, Berdahi served as Vice Chancellor for Academic Affairs at the University of Illinois at Urbana-Champaign from 1986 to 1993. Berdalil served as a member of the history faculty at the University of Oregon from 1967 until 1986. From 1981 to 1986, he was Dean of the College of Arts and Sciences at Oregon. He received his B.A. degree from Augustana College, Sioux Falls, South Dakota; M.A. degree from the University of Illinois; and Ph.D. from the University of Minnesota in 1965 as well as an honorary Doctorate of Science in 1997. Berdahl is the co-editor or author of two books and has written numerous articles dealing with German history.

Joseph Cerny is Vice Chancellor for Research, University of California at Berkeley.

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Catherine Cortelyou is Library Co-Director, Harmer E. Davis Transportation Library, Institute of Transportation Studies, University of California at Berkeley.

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James Costantino is the former President of ITS America. Prior to becoming the founding Director of ITS America, Dr. Costantino was Professor of Transportation and Engineering at George Mason University and at one time was an Associate Dean and Professor at George Washington University.

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Elizabeth Deakin is Professor of City and Regional Planning, and Acting Director of the Institute of Urban and Regional Development (IURD), University of California at Berkeley. Professor Deakin's research efforts focus on transportation related issues, including: *Land Use Impacts of Transit:* a systematic investigation looking at the 35 largest

metropolitan areas of the U.S. and documenting changes in urban structure and urban travel patterns over the past three decades; *BART at Twenty:* BART's effects on regional travel patterns, on the recent form of growth and development in the Bay Area, and on the fabric of regional politics; *Impacts of ISTEA:* a study of the impacts of the Intermodal Surface Transportation Efficiency Act (ISTEA) over the six years since its passage; and *Traffic Calming in the United States:* an exploration of the variety of actions implemented across the U.S. to avoid, minimize, effect, or compensate for the adverse effects of automobile traffic on residential neighborhoods and commercial districts.

Dean Dunphy is Secretary, Transportation and Housing Agency, State of California.

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Linda Howe is the Director of the Technology Transfer Program, Institute of Transportation Studies, University of California at Berkeley. Previously, she was the Assistant Director for Advanced Technology at Rutgers University and she taught in the Planning program there. She is presently the national chair of the Transportation Planning Division of the American Planning Association.

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Adib Kanafani is the Edward G. and John R. Cahill Professor of Civil and Environmental Engineering, Chair of the Department of Civil and Environmental Engineering, and Director of the Institute of Transportation Studies at the University of California at Berkeley. Professor Kanafani holds a Ph.D. in Transportation Engineering from U.C. Berkeley. Since joining the faculty at Berkeley in 1970, he has conducted and managed research on transportation systems, transportation engineering, economics, planning and policy. Professor Kanafani has authored over 130 publications on transportation, including a book on Transportation Demand Analysis and one on National Transportation Planning. He is a recipient of numerous awards including the American Society of Civil Engineers Walter Huber Research Prize and the Horonjeff Award. He has served on a number of National Academy of Sciences policy analysis panels, and has advised many governmental organizations both in the United States and overseas. He has participated in transportation planning activities in a number of countries in Africa, South America, and Asia.

C. Judson King is Provost and Senior Vice President of the University of California.

T.** R. **Laksmanan
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T. R. Laksmanan is Professor of Geography and Executive Director of the Center for Energy & Environmental Studies, Boston University, and former Director, Bureau of Transportation Statistics, U.S. Department of Transportation. He is the author of numerous books, articles, and papers. His books, authored and edited, include *Systems and Models for Energy and Environmental Analysis; Spatial, Environmental and Resource Policy in Developing Countries; Rural Industrialization in Regional Development in the Third World; Large-Scale Energy Projects: Assessment of Regional Consequences;* and *Economic Faces of the Building Sector.* His recent articles include "Full Benefits and Costs of Transportation: Review and Prospects," "Technical Change in Transportation: Social and Institutional Issues," and "The Changing Context of Transportation Modeling: Implications of the New Economy, Intermodalism, and the Drive for Environmental Quality."

Rulon K. Linford is Associate Vice Provost for Research and Laboratory Programs, University of California.

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Adolf May, Professor Emeritus of Civil Engineering, has a long career in the field of highway operations and capacity analysis. Prior to arriving in Berkeley, he worked on traffic operations on the Chicago Expressway system. At the Institute of Transportation Studies he has done extensive research for the state and federal governments, covering the vast spectrum from traffic design of rural roads to capacity enhancement on urban freeways and bridges. He has been a member of the Transportation Research Board's Committee on Highway Capacity for many years and chaired it for some time. Since retiring five years ago, Dolf has remained active both on Institute of Transportation Studies research projects and as a consultant with TransCore (formerly JHK & Associates).

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Mary AL Moehring is the Special Assistant to the Region Nine Federal Highway Administrator. Region Nine of the Federal Highway Administration comprises the states of Arizona, California, Hawaii, Nevada and the Pacific Territories. Ms. Moehring received her B.A. in history from the college of St. Teresa in Winona, Minnesota; her M.A. and law degree from the University of Wisconsin in Madison, Wisconsin. She is a member of the Wisconsin Bar and the Bar of the District of Columbia. From 1974-1978, Ms. Moehring served as a Legislative Attorney for the Wisconsin Legislature (a non-partisan position). From 1978-1983 she was Assistant Counsel for the Wisconsin Department of Transportation. In 1983 she accepted the position of Director of State Government Affairs for the American Trucking Association at its national headquarters in Washington, D.C. Ms. Moehring joined the Federal Highway Administration in 1993 to direct a multi-agency project to curb motor fuel tax evasion which included participation by the Internal Revenue Service Criminal and Civil Divisions, the Federal Bureau of Investigation, revenue agencies of all 50 states, and numerous representatives of the petroleum industry. She accepted the position of Special Assistant to the Regional Federal Highway Administrator in Region Nine, San Francisco, in 1997.

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Carl Monismith holds the longevity record for faculty associated with the Institute of Transportation Studies. He joined the faculty as a lecturer in 1951 and rose to become the Robert Horonjeff Professor of Civil Engineering. He began work on highway design in the early 1950s, concentrating largely on pavement design and construction materials. He founded and still leads the Pavement Research Center at the Richmond Field Station, headed a university consortium undertaking one portion of the SHRP program from 1989-93, and is Principal Investigator for the California Accelerated Pavement Testing Program. From all this you can hardly tell that he retired officially last year.

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Wilfred Owen has been one of the preeminent scholars and thinkers in the field of transportation for more than 60 years. His career is closely linked to the Brookings Institution in Washington, D.C., where he was Director of Transportation Research. His productivity can be illustrated by listing some of his major works, beginning in 1934 with his Harvard Phi Beta Kappa prize essay, *A Study in Highway Economics.* Major works include *National Transportation Policy* (with Charles Dearing, 1949), *The Metropolitan Transportation Problem* (1956), *Cities in the Motor Age (1959), Strategy for Mobility* (1964), *The Accessible City* (1972) and, while he was a Visiting Scholar at the Institute of Urban and Regional Development on the Berkeley campus, *A Transportation Strategyfor California's Development: Report to the Cal Department of Transportation (1975).* Mr. Owen is also author of numerous papers and articles.

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Robert Parsons was the first director of the successful PATH Program at the Institute of Transportation Studies, that has literally set the agenda for much of the Intelligent Transportation Systems development. He was also instrumental in establishing Mobility 2000 and ITS America where he served as chair of the architecture committee.

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ifornia

Alan Pisarski has been a major player in the development of transportation policy within the United States, both as a part of the U.S. Department of Transportation within the Office of the Secretary of Transportation as well as in his role as a private consultant. He has been best known for pioneering studies of urban commuting patterns, which have attracted attention in the technical literature and served as fodder for the media as well. He has appeared on a number of network broadcasts, 20/20, Nightline, and many others. He is the chair of TRB task forces on transportation statistics and transportation history.

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Tony AL Ridley has been Professor of Transport Engineering at Imperial College London since the beginning of 1991, during which time he has been the Director of the University of London Centre for Transport Studies. He has been Head of the Civil Engineering Department from September 1997. A civil engineer who worked for the Greater London Council in its early years, he has held Managing Director/Chairman/Board Member roles with the Tyne and Wear Passenger Transport Executive, Hong Kong Mass Transit Railway Corporation, London Transport, London Underground, Docklands Light Railway and Eurotunnel. His higher education was at the University of Newcastle upon Tyne, Northwestern University, University of California (Berkeley) and Stanford University. He was President of the Institution of Civil Engineers 1995-96 and is now Chairman of the Board for the Engineering Profession (BEP) of the Senate of the Engineering Council.

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Martin Wachs is Director of the University of California Transportation Center at U.C. Berkeley, where he is also Professor of City and Regional Planning and of Civil Engineering. Prior to joining U.C. Berkeley, he was a Professor of Urban Planning at UCLA for 25 years, and served three terms as head of the Urban Planning Program. Professor Wachs has written four books and over one hundred articles on transportation planning, transportation problems of the elderly, transit finance, transportation demand management, and ethics in planning. Professor Wachs has also conducted research evaluating regional ridesharing regulations of the South Coast Air Quality Management District and chaired a joint committee of the Transportation Research Board and the National Research Council on congestion pricing for American transportation systems.

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Michael Walton is Professor of Civil Engineering at the University of Texas at Austin and holds the Ernest H. Cockrell Centennial Chair in Engineering. In addition, he has a joint academic appointment in the Lyndon B. Johnson School of Public Affairs. Concurrently he is actively involved in developing and defining transportation policy through his research, publications and national service to government and industry.

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Melvin Webber is Professor Emeritus of City and Regional Planning, University of California at Berkeley, and Director Emeritus of the University of California Transportation Center (UCTC). He is the founder and current Executive Editor of the celebrated UCTC publication *ACCESS.*

APPENDIX C:

REGISTERED PARTICIPANT ROSTER

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APPENDIX E:

FULL TEXT OF CERTAIN ADDRESSES AND SLIDE NARRATIVES AND FIGURES

Keynote: "A Golden Opportunity"

Wilfred Owen, Brookings Institution
(read by Professor Melvin Webber)

Birthday greetings and best wishes to the staff in McLaughlin Hall and their associates on the Berkeley campus. Congratulations on pioneering the innovative studies that helped California and the United States to achieve their current levels of mobility and prosperity. You contributed to the change of speed that made possible the speed of change.

An anniversary is a time to look back and to look ahead. But we should also look around. We share a planet that has become closely interdependent but where the participants are grossly out of balance. A small minority are mobile and affluent while the majority are immobile and destitute. It is a situation that is economically and politically unsustainable and from the standpoint of humanity unacceptable. That is why we urge you to expand the Institute of Transportation Studies to a world transportation studies center. On this golden anniversary you can grasp a golden opportunity.

There are 49 countries classified by the World Bank as low income. This group of countries represents more than three billion inhabitants, or over half the population of the Earth. Their income per capita averages about a dollar a day. Americans have average incomes 80 times higher. The poor countries suffer an enormous backlog of needs, from food and shelter to health care, schools, and every conceivable kind of goods and services. In a global economy there is growing pressure to alleviate these conditions, in part for humanitarian reasons and in part because continuing global prosperity is contingent on the high proportion of international trade and investment accounted for by the less developed nations.

Without transportation and access to jobs and resources poor countries are unable to contribute their share of world production to reduce the backlog of needs and to prepare for the two billion additions to the population expected between now and 2025.

The world faces the possibility that insufficient transportation will lead to critical shortages and skyrocketing prices as well as a threat to world peace and growing prosperity.

While the poor countries have the most dramatic transport difficulties, our own country is not without problems. After years of positive trends in mobility some negative trends have begun. We refer to the general decline in the quality of transportation as traffic congestion and parking problems erode the vitality of cities and threaten the efficient operation of interstate highways. Commuter problems loom large in the expansive metropolitan areas and there is increasing pollution of the land and poisoning of the air. Often it seems that efforts have been so concentrated on keeping things moving that Americans have neglected the other aspects of living.

These conditions affecting the rich and the poor reveal that transportation problems are much the same around the world in spite of widely different stages of development. Most countries complain of traffic congestion, pollution, poor public transport, the lack of maintenance, high accident rates, insufficient funds and the disappearance of open space resulting from uncontrolled sprawl.

We conclude that if the problems are much the same regardless of differing conditions there may be some common contributing factors as well as some generally applicable solutions. Comparative international studies should be able to identify some ofthese underlying factors and help reveal some universal remedies.

Systems

We view transportation much too narrowly. It is not just a way to move, but to achieve the goals of society, whether the goals are growing food, commuting to work, expanding production and trade, building better cities, creating jobs, or reducing poverty.

A system approach calls for maximizing the ability to move but minimizing the need for moving. In that way there can be an appropriate emphasis on transportation without diverting resources from the many other needs of daily existence.

A universal problem is the resistance to transportation systems. The focus is on competition rather than cooperation. Some progress is being made in the organization of intermodal freight systems, thanks to containers and computers. There is a beginning awareness ofthe global reach of transport systems. There is even less recognition of systems that relate mobility to the sectors being served. These inter-sector systems call for system solutions that include not only the supply oftransportation, but policies and programs outside the transportation sector that generate the demand. They include the environment, community, design, telecommunications, housing, regional development, and the nature of work. In complex societies transportation problem solving includes both supply and demand-side solutions.

The problem nearly everywhere is that while there are many suppliers of transportation there are few solvers of transportation problems. That requires institutions authorized to build partnerships and engage in joint ventures. We need to be aware that while some transport problems require more mobility, others call for easier access. And most call for a mix. Your studies here at Berkeley have pioneered in system approach.

Another neglected area is the conservation of transportation. The transportation sector should benefit from how other areas of the economy are facing the pressure of mounting demand and leaming to conserve and innovate. Water supplies are being stretched by cleaning distribution channels, which often proves to be a better way to get more water than attempts to tap new sources.

Electric power companies give away energy-efficient equipment, knowing that a given amount spent on conservation can often produce more energy than the same investment in more generating plants.

Urban Livability

Urban systems are a neglected area of global study. America's inner cities and cities in much of the developing world should be able to profit from how one of the poorest countries overcame such problems and emerged to be numbered among the richest nations on Earth.

Singapore in 1960 confronted intense traffic problems in the downtown area and took a broad system view of what should be done to bring relief. It would go to the heart of the problem by giving priority to housing, jobs, and the income security of its people, launching a massive program of urban redevelopment and the creation of planned new communities on the outskirts to accommodate growth.

Transportation became the means of moving out of the congestion into the suburban new towns. It would help through street redesign and relocation to alter the use of the land in the old city slums, creating scenic boulevards, waterfront parkways, and new space for housing and industrial estates.

A tiny island republic is not the model one would choose for an American city, but despite the unique character of Singapore the experience demonstrated how transportation can be the means of achieving the goals of society. And the goals in this case were jobs, training, modern housing, and the creation of housing supply industries to support economic development.

We need to address the global problems besetting our rapidly urbanizing planet. Congestion on the streets of the principal cities has reached a level that threatens to destroy these major sources of economic development and social progress. There is an urgency to undertake major initiatives to use transportation and communications not to further concentration but to accomplish an orderly dispersal and to halt the disorderly spillover into surrounding countryside that is ravaging the land and transporting the slums to the suburbs.

Planned urbanization in recent years offers valuable guides to the use of transportation to build a better urban future. Most work has centered on monumental capitals and government headquarters or on communities designed mainly for upper income residents. A major concern not being addressed is the need to accommodate lower income families.

There is a wealth of material for international case studies of moderate income planned communities such as Tama and Senri and dozens of other Japanese new towns. Others include Tema in Ghana, and the Fifteenth of July, one of the new towns outside Cairo. There are many lessons to show how the role of mobility has affected the success and failure of city-building.

The uses of transportation and communications to move out of extremely congested areas into more livable and transportation-friendly communities could make city-building the world's number one industry, given an international commitment to develop the new institution and the financial and management assistance that are necessary. Research is needed to develop integrated systems of housing, urban development, and transportation.

Communications

Research on the substitution of telecommunications for transportation suggests a high payoff. One is especially impressed with how the first information highways came into being in the United States 100 years ago. When the Congress authorized funds for the Post Office to finance free delivery of the mails, farmers agreed to clear the roads for all-weather delivery of the mails in order to be declared part of the Rural Free Delivery System (RFD). What followed demonstrated that access to magazines, letters, and other sources information was greater stimulus to development than just the availability of transportation.

The effects of communication with the outside world were also visible when the first telephones came to villages in India a few years ago. While the dusty roads that had been available for decades resulted in no awakening, the new communications led to a marked increase in economic activity, political and social development, rising bank deposits, and a greater ability to finance transportation improvements.

As the low Earth orbiting satellites begin operation, highways should defer to skyways to speed development in low-income areas. Already centers with all the necessary telecommunications equipment are being made available to farmers and businesses, allowing persons unable to afford such hardware to use e-mail or fax equipment and create a web site to inform the world of products for sale or purchases needed. Telecommunications can lead the way to economic development in conjunction with transport improvements to support the resulting growth of trade and travel. Different investment strategies will be necessary in different circumstances to optimize the mix.

International Cooperation

How problems of globalization have overtaken us so quickly can be understood by noting the workings of Nature. The world has been equipped with built-in transportation rights of way to be used free of charge whenever humans leam to take advantage of them. The oceans are able to support great bulk cargo carriers and container ships that interconnect the continents. Aircraft carry people and goods on airways that have no need for construction or maintenance. Information and a host of services are delivered electronically through the atmosphere, and the floor of the sea provides the rights of way for thousands of miles of fiber optic cables with enormous capacity for global exchange.

But Nature provided no such gifts for transportation on land. Land transport was left to humans and the cost and difficulties of preparing the way for roads and rails have left most of humanity bogged down in the isolation of rural areas and in the frustrations of urban congestion. As a result free long-distance ties connect the cities but land transportation lags far behind the rest of the system and as a result the Earth operates at only a fraction of its potential.

Transportation studies can help in revising international aid efforts to further the global mobility system. Poor nations have so much debt that the annual charges for interest and repayment are eating into foreign exchange reserves and slowing current development programs. In some years the rich countries get more money from the poor than the poor get from the rich.

Aided countries also have difficulty maintaining the infrastructure financed on their behalf. Without funds for upkeep hundreds of miles of roads have fallen into disrepair and some have disappeared altogether. Machinery without spare parts rots in the fields. Low-income nations need not only capital but continuing help in management and operation, and international public-private partnerships that are lasting.

Successful international partnerships are being established in the telephone and telecommunications sectors and more recently in the supply and distribution of energy. In transportation the public-private partnerships created to supply international air cargo services need to be extended. More airports and highways are required to permit the operation of a much wider network to connect selected growth points and create a worldwide production and marketing system.

Research needs to be conducted on how land transportation can be globalized. International service providers are needed for rail and highway transport, urban public transport, and global transport companies that integrate land transport and link up with air transport and shipping.

Research opportunities have been vastly increased by the ability to exchange information and ideas through jet travel and telecommunications. The University's distance education programs will also enable affiliated scholars around the world to participate in research on the Berkeley campus.

In an era when services of all kinds are becoming globalized it is time to complete a global transportation system capable of supporting a more viable and accessible planet. International studies at Berkeley are counted on to help realize the global mobility that promises to benefit all of humanity.

Notes for the Presentation, Demographic and Social Change

Alan Pisarski, Transportation Consultant

The graphics and charts provided in my presentation support the point that there will be conflicting pressures on travel growth in the coming decade.

The keys are the following:

1. Lowest population increase since the depression; with immigration a key modifying variable.
2. Slowed growth in new households; historically a major factor in producing new travel demand.
3. Saturation in drivers licenses and auto ownership among the vast majority of the population.

But, factors suggesting growth for the future include:

4. Our population is moving into the high travel-propensity years, i.e. *45-55* years of age, suggesting heavy tourism, etc.
5. After 2010 the world turns a big corner as the baby-boomers reach *65* with immense impact on all of transportation.
6. Racial and ethnic minorities increasingly will be joining the majority as we democratize our transportation system with broadly-based private vehicle ownership and use.
7. Continued dispersion of a wealthier population will make for increased trip making and greater average trip lengths.

In sum, this will lead to diminished rates of increase in overall local highway demand with annual growth on the order of *2.5%* or less per year, contrasted to the 3±% of the past twenty years - in short about a one percentage point difference. Transit will do well to hold on to its roughly 6 million daily users. The intercity modes, especially international air and the cruise modes, water, tour buses, and perhaps some scenic long distance rail, will see 5-6% annual growth levels.

The pressures of time will dominate commuting and other local travel purposes, pushing trip-chaining and faster modes, i.e. the single occupant vehicle. Dispersal will be abetted by employers in search of skilled employees locating where those employees are or want to be. Employer location choices will be guided by the facts that they can locate almost anywhere near a mailbox, phone and airport; access to skilled employees who just might as well be in a nice place to be and the search for capacity - road and air. Continued efforts to squeeze people to get them to behave in "socially acceptable" ways will only generate more dispersal, as the public runs away from costs, crime, and congestion - and planners.

True tele-commuting, where a person is an employee with a work site to go to usually, but on an occasional, or scheduled basis, works at home or at a local work site, is suffering

from the negative reactions to some of the first stage over-enthusiasms. A lot of what was easily doable has been tried with varying levels of success. But the big future I foresee is that of working women, particularly working mothers, creating a strong force for more flexible working arrangements. In many instances increased pay will be secondary to better control of personal time. This will result in more flexible hours and days of work with some work being done at home. The key effects here are that these patterns will abet further dispersal of the population and further support orientation to the single-occupant vehicle. But small shifts here can take the edge off of peak hour travel demand and make for a more operable investment climate.

The good news in all of this is that we have largely passed through an extraordinary one-time event, a bubble, as the baby boomers marched through the life-cycle, frequently overwhelming our attempts to keep up with schools, roads and other public services. The decades of explosive growth in our metropolitan areas, particularly those of the Southwest, are largely behind us. The major factor there will be where do immigrants come from and where do they choose to locate.

Our problems in the future will be much more operable. We will add 25 million to our population each decade for the foreseeable future. Our ability to respond to that growth will grow faster than that. Our investments won't be overwhelmed by dramatic growth and our resources should be greater, as well, to deal with the smaller scale of problems we will face. It would be tragic if our failures to keep pace with the astonishing levels of growth of the last few decades would weaken our resolve to deal with the problems of the future.

This will create the opportunity to make a shift from continuously playing catch-up in our investments to acting more strategically and focusing our investments where potential economic and social benefits are greatest. We can separate current needs from future prospective needs and respond to them individually.

While there is a current tendency to believe that most of our high-payoff investments in infrastructure have already been made, The future holds great opportunities for investments in surface transportation with high economic and social yields. Overall our investment thinking will have to be "nimble," i.e. responsive to a rapidly changing world, and "smart" using well-trained people properly prepared with the necessary statistical data and analytical tools. Current research shows rates of return for the National Highway System on the order of 20%, superior to averages for private investment.

Among my high pay-off list:

1. Safety-related Investments - The deaths on our nation's highways are unconscionable, particularly because investments can be made that can sharply reduce the toll. Of course, a large part of the causes of fatalities are linked to vehicle characteristics and driver behavior, but all contributory factors linked to the highway itself must be addressed including highway condition and design. Much of this needed investment will be on the National Highway System, and is related to non-geometric

improvements.

2. The aging of the population will be another factor that contributes to increased traffic risk. The number of persons in their fifties will increase by 50% in the next ten years, equal to half of all population increase. We need to re-think and perhaps retrofit our highways, particularly the high speed facilities, to respond to the changing visual acuity, reaction times, etc. of our aging population.

   It is frightening to think that in the past we consciously accumulated highway trust fund revenues to artificially balance the budget and forego making safety investments that save lives. We must commit to a date certain in the future (10 years?) when these problems will have been addressed, with timely monitoring of progress. The public wants a menu for action which ISTEA lacked.

3. International Competitiveness - Expansion of interstate trade corridors between and into our metropolitan areas that serve our international trading needs can sustain and extend our international competitiveness. Major choke-points in and around metropolitan areas need to be addressed.

4. Operations Improvements - Investment in and greater application of traffic engineering and ITS technologies to expedite traffic flows and increase capacity of our highway systems, reducing waiting times and delays, can pay big air quality and time savings dividends. We will need to invest in the research, the technologies, the data and the skilled operators to make these systems work.

5. Job Access - We need to invest in better ways to get inner city residents to jobs that are now more likely to be at highly dispersed locations in the suburbs. Rather than "big" transit projects we should invest in jitney-like systems or van-pools, where, frequently, it will be inner-city entrepreneurs who become "small" bus company owners to meet these needs. This will take both some investment and some regulatory treatment. These are likely to be among the few successful transit strategies in responding to overall metropolitan and suburban travel demands as well. Other high payoff transit investments will be related to rehabilitating and upgrading many of the very valuable but aging transit systems of the Northeast.

6. Metropolitan Capacity - Finally, we actually are going to have to build roads in the suburbs and the outer fringes of our metropolitan areas. There will be a search for capacity across America in the coming years - both highway and air capacity - for both passengers and freight. Unless we provide some of that capacity in our metropolitan areas, businesses and high skilled employees will disperse even farther afield. Such investment will help keep our metropolitan areas competitive and make the life-styles of a majority of our population more livable.

The goal for transportation ought to be to reduce the effects of distance as an inhibiting force in our society's ability to realize its economic and social aspirations - to "destroy"

distance as a factor in meeting society's needs.

Planning For The Technical Future

Robert Parsons, President, Parsons Transportation Associates

It is indeed a pleasure to return to ITS to be a small part of ITS's big 50th Birthday Symposium to help set the course for the next 50 years.

My topic "Planning for the Technical Future" is quite a challenge. Perhaps I was naive to accept this role, but on the other hand I feel there is much research underway that will shape things to come. In addition, the different modes of transportation are on differing technical foundations and those less advanced can leam and benefit from the others that have deployed advanced technologies and transportation management schemes.

To be covered will be a few of the enabling technologies that could help cope with the problems we face today and may expect tomorrow. I will also attempt to illustrate a few transportation scenarios that could emerge in the future.

Before proceeding it is appropriate to briefly outline my background so listeners can better understand the rationale behind my views and personal bias regarding possible technologies that may shape our future transportation situation.

I am currently advisor to ITS America on system architecture "interoperability" concerns and testing approaches to assure that purchasers of ITS software and hardware products or subsystems may receive the interoperability features they need when they deploy these products into service. Other clients are Lawrence Livermore National Laboratory, JPL, and Virginia DOT.

Many know of my years on the ITS staff in my role as rail specialist and later founder and first director of PATH. Others may be aware that I managed the Las Vegas Super Speed Rail (and Maglev) Study for the City of Las Vegas under federal contract that led, in part, to the many California High Speed Commissions that have been established. A few may even remember the years spent on the U.S. Supersonic Transport Development in FAA and the Office of the Secretary of DOT and as Federal Railroad Administration Associate Administrator for R&D. But I'm almost certain nobody remembers the 1970's studies on Dual Mode applications or early DOT attempts to deploy PRTs. It is the combined experience from these activities and continual reading in these areas that form the basis of my views today.

Prevailing technology winds that will focus future directions include these that are shown on chart 3.

Better transportation system surveillance is in the cards for a big improvement, especially in the ground modes. Air is going through a big upgrade that will take years, but the

ground modes either don't have system surveillance or are still attempting to hard wire their sensors in a very expensive means to gain near real-time system status. There are better and much lower cost ways to do this, and we will see satellites, especially the low earth families, and super probes (roving smart cars) playing a role in low-cost surveillance.

I find the ongoing computer revolution to be the most far-reaching peaceful technology development to benefit mankind during my lifetime and that covers a long time. Better yet, it appears to still have plenty of momentum to continue its impact on all facets of our workplace and daily life for many years to come. It has opened the parallel expansion called "Information Technology" or IT. These are not strange terms here at Sibley Auditorium, as the Berkeley EECS researchers and graduate students have been a vital part of these developments. Effective management of our many transportation subsystems will be made easier via widespread IT application.

Another high tech advancement has been in communication, especially satellite and cellular. The market penetration in cellular has been almost as great as with PCs and I believe will advance much faster with the emerging entry, of digital wireless devices.

To assure that the Intelligent Transportation Systems movement captured the opportunities afforded by these technology advances the leaders at ITS America and U.S. DOT decided to spend some up front research to develop a national architecture and involve all stakeholders in that process. That made a relatively straightforward system engineering task much more cumbersome, but it surely was a necessary step.

The big challenge in transportation is to change mindsets and the way we do business today. Education is badly needed at all levels, and this system architecture process brought this fact home real quick. Transportation planners and engineers tend to continue old tricks. These tools will not solve tomorrow's problems.

Development of ITS standards is in full swing but it has become abundantly clear that more effort and planning is required to assure "interoperability" - families of products that support interchangeable software and hardware that together deliver the user services that collectively constitute ITS. Most of my working time today is in pursuit of an accepted interoperability process and testing criteria that will encourage vendors to provide the needed attributes in their products and either test and certify that they do interoperate with companion products or have some third party provide for such testing compliance assurance.

I hope that ITS will follow other successful IT applications wherein cost and wide scale use has been achieved via the interoperability route. The Internet is the best example.

One ITS goal is to eventually achieve near real-time management and integration of the various elements that together provide our ground transportation services - i.e., traffic management, freeway flow control, and emergency and transit management. This integration must include vehicles, smart infrastructure, and control and of both micro and

macro aspects of this new system.

The rapid growth in IT, as it applies to transportation, has been closely rivaled by the developments in sensor technology, basically a technology transfer and commercialization from the military after the Desert Storm war. Soon Smart Bomb technology was being used or planned for Smart Car, Smart Road, and Smart Travel applications. As costs continue to decline and reliability increases, we should see much greater penetration of advanced sensor applications as we restructure the nation's ground transportation system and other basic infrastructure as well.

The automobile industry was quick to seize on the sensor and computing technology as they offer vehicles with more comfort features - entertainment centers, temperature controls, and telecommunication capabilities. Safety improvements have also been made via sensor and computer-aided suspension and braking. This is just the beginning of what I see coming. Having driven our family Caravan for over 40,000 miles with a factory-installed Vorad collision warning system, I am bullish on the prospects of great safety benefits once Detroit steps up to providing ITS safety devices such as adaptive cruise control and side looking warning systems on new cars. Lane keeping should follow and eventually some locale will opt for dedicated automated lanes to significantly increase productivity, as PATH so dramatically demonstrated is possible in San Diego last August. We are on the threshold of a new automobile age - with extensive driver assists to extend the driving envelope similar to those used every day by commercial and some private pilots.

Smart Road technology will be just as important as Smart Cars. There is just so much one can do by limiting technology to vehicle applications. Cars and highways must work together in a similar fashion to the railroad mode if we expect great improvement in throughput and reduced accidents at the same time. Only control of the system aspects of vehicles and roads working in harmony can achieve this. Just consider intersection traffic avoidance. It is only feasible, in my opinion, via some sort of Smart Road technology coupled with Smart Cars. While this is no trivial task, I predict it will become a reality in the future, along with other needed road design improvements such as freeway merging systems to safely guide drivers entering or exiting ramps.

There is no need to spend time regarding the possibilities and feasibility of automated vehicle/highway control in this house. It was proven here at Berkeley and demonstrated to the world in San Diego. I hope Caltrans continues its support of automation until the US Government reassesses its shortsighted decision to only look at near-term applications.

In surveillance I see more improvement in all aspects - faster, cheaper, more capacity in smaller packages and on and on and on. It is up to transportation engineers to be informed and use these innovations in managing our transportation systems - technology is not the issue, applications are lagging.

The wasteful practice of hard-wiring cities will be replaced with less expensive and

innovative means to provide area-wide surveillance. I see expensive infrastructures being replaced with greater reliance on satellite coverage and use of super smart vehicles (probes). These could provide traffic and road conditions to improved management systems that will utilize artificial intelligence and predictive, adaptive strategies to suggest alternatives to users of clogged portions of the network.

There are many technology opportunities, but before they become benefits to society, attitudes and past transportation practices must change. The idea that every transportation element (traffic or freeway management, EMS, transit, etc.) in each jurisdiction must own and operate a standalone surveillance, communication, and control system is simply outdated - we can not afford it. In fact, in my opinion, this is the major transportation challenge today, and it is rooted in the education of a new generation of transportation engineers and planners and retraining of those in the field today. Transportation must be treated as a system and financed and operated by the sharing of resources and talents of elemental agencies comprising this system. Sharing is not the current practice in this business. Everybody wants their own.

Time may well prove that low technology approaches of surveillance such as real time incident or congestion reported by drivers to a surveillance and advisory reporting center can be used in certain locations instead of extensive smart infrastructure.

Needless to say, automation can provide large dividends when used to do many of the transportation system management tasks. Around the world, more systems are being installed or updated to run without operators, and transportation services can be dynamically provided to match demand in an almost real time basis. Automation used to assess system conditions and problems can also go a long way to avoiding major incidents and bottlenecks. There is no need to have large control rooms full of people staring at videos. Much of this process can and should be done by machine - we would enjoy better management with fewer people and resources.

I have already cited the problem of bit by bit transportation improvement - the lack of integration of system elements and the opportunities afforded once one does integrate and share resources. Unfortunately, today's ground transportation system is not a system, nor are most implementers system cognizant, but generally a collection of independent, sometimes competing, subsystems. This is the main reason we haven't been more successful in implementing ITS to date. There is much emphasis on advanced technology but not nearly enough emphasis upon the payoff of integration and resource sharing. In hindsight, I wish those who had coined the ITS lingo had called it "Integrated Transportation Systems." But those in charge of transport aren't organized or trained to promote systems improvement.

There are highway designers - who limit their trade to pavement and passive structure matters. There are traffic managers, but again they usually limit their work to one element of the problem, be it transit, emergency medical service, freeway control, etc. Those designing vehicles tend to consider only vehicle-autonomous solutions. Had the air and

rail modes stayed with this narrow approach we would not have the safe, high-capacity transportation systems we all enjoy in those fields today.

As can be seen from the remarks thus far, I feel strongly that we need a new breed of transportation engineers. UC and other transportation engineering schools must get in high gear. We need different skills to solve the system problems. One must understand the systems aspects of the problem and use proven system engineering tools to address the key issue of integration and control. It is obvious that there is a dire need to attract and retain IT and communication and control specialists for the transportation sector. Transportation requires more than civil engineering. Incentives are needed to attract and keep expertise in the other key disciplines.

Emphasis tomorrow will be on better-informed travelers, whether they drive or ride. California has been a leader in ITS traveler services, and I hope it continues to be. Better real-time information, coupled with convenient alternative transportation, will both spread highway traffic to less busy parts of the network and promote modal shift away from driving. If this doesn't happen, then perhaps pricing should be more aggressively pursued, as it is with other consumer services, such as in telephones, movies, restaurants. Even some gasoline stations offer discounts to attract business on normally slow days.

When the above strategies still don't solve prevailing congestion or safety problems, then one can call in selected automation. I envision that heavily traveled HOV lanes will be automated (initially in freeway sections servicing several bus routes) and travel limited to equipped vehicles. High Occupancy Toll (HOT), like route 91 between Anaheim and Riverside, may also offer an opportunity to provide an automated exclusive lane to those who are willing to install certified control equipment on their vehicles.

Once surveillance costs go down, using innovative means to collect traffic (static and dynamic) conditions, I predict massive ITS implementation around the country. Major urban systems will have full-blown coverage, integrated centers, which will service the various public and private organizations needing almost real-time network status information. Smaller regions will have systems more tailored to their individual needs. Even very small towns will have some format for providing traveler information, even if it relies on manual inputs from roving vehicles (buses, delivery vans, and trucks) and a route display for those entering town.

The road networks should be more uniformly used. Heavy traveled sections will either be priced or automated (maybe both). Modal shifts will result once practical and convenient alternatives are proven and known and accepted by travelers.

Dense activity centers will see more use of personal rapid transit and people mover concepts. The station car concept Bob Cerva has been studying, or Bill Garrison's earlier work on the lean machine, or something like those ideas may offer commuters easy access or alternatives to line haul transit.

(Figure 1) The title of my presentation is "Coping with Growth: Traffic Operations Planning." This presentation on my experience at ITS and most recently also with SAIC.

(Figure 2) It has been suggested that presentations in this session particularly focus on the role of ITS. I believe that this slide captures the major roles of ITS, which has remained unchanged during ITS' 50-year history and will continue into the future.

The process encompasses research, education, assistance, and application. Beginning with research, which is the foundation of the process, both theoretical and applied research are included. Research leads to fundamental understanding, which is shared in the academic setting as well as in continuing education. Education continues beyond the classroom by means of information systems and technical assistance. The process continues in application, through experimentation and evaluation. And the cycle repeats itself through research, education, assistance, and application.

Turning to the technical content of this presentation, it is suggested that the highway transportation system be divided into operating environments. Operating environments vary from links and nodes into facilities, networks, and the urban system.

An analytical framework is proposed as follows. The input to the framework is the demand, supply, and control of the existing operating environment. Traffic performance is predicted by an analytical tool, and the operating environment is assessed. If performance is found to be unsatisfactory, modifications are made in the demand, supply, or control input elements.

If demand exceeds capacity, there are three alternatives to consider. Either increase the capacity, reduce the demand, or both. Capacity increasers can include High-Occupancy Vehicle (HOV) lanes, geometric improvements, incident management, and operational improvements. Demand reductions can include spatial, temporal, modal, and total travel responses.

(Figure 3) The analytical framework depends on the level of traffic flow. For undersaturated flow conditions, the analytical framework can be relatively simple in that a single link or node can be analyzed for one time period. For oversaturated flow conditions, the analytical framework will be more complex in that connected links and nodes will be analyzed for multi-time periods and include traveler responses.

(Figure 4) Traffic models vary from relatively simple speed-flow relationships and queuing analysis to more comprehensive traffic models. For example, the HCM 2000 is now being prepared which enhances these models into facility analysis for the oversaturated flow conditions. Simulation models will play a major role in the future for evaluating improvements in the highway system. Existing traffic models are being combined with planning models to provide a more comprehensive assessment of problems and opportunities for improvement.

(Figure 5) So what role will ITS play in the future? The same functions as shown in this slide earlier, but in a more intense and interactive manner. ITS has the unique continuing opportunity to undertake and integrate research, education, assistance, and application.

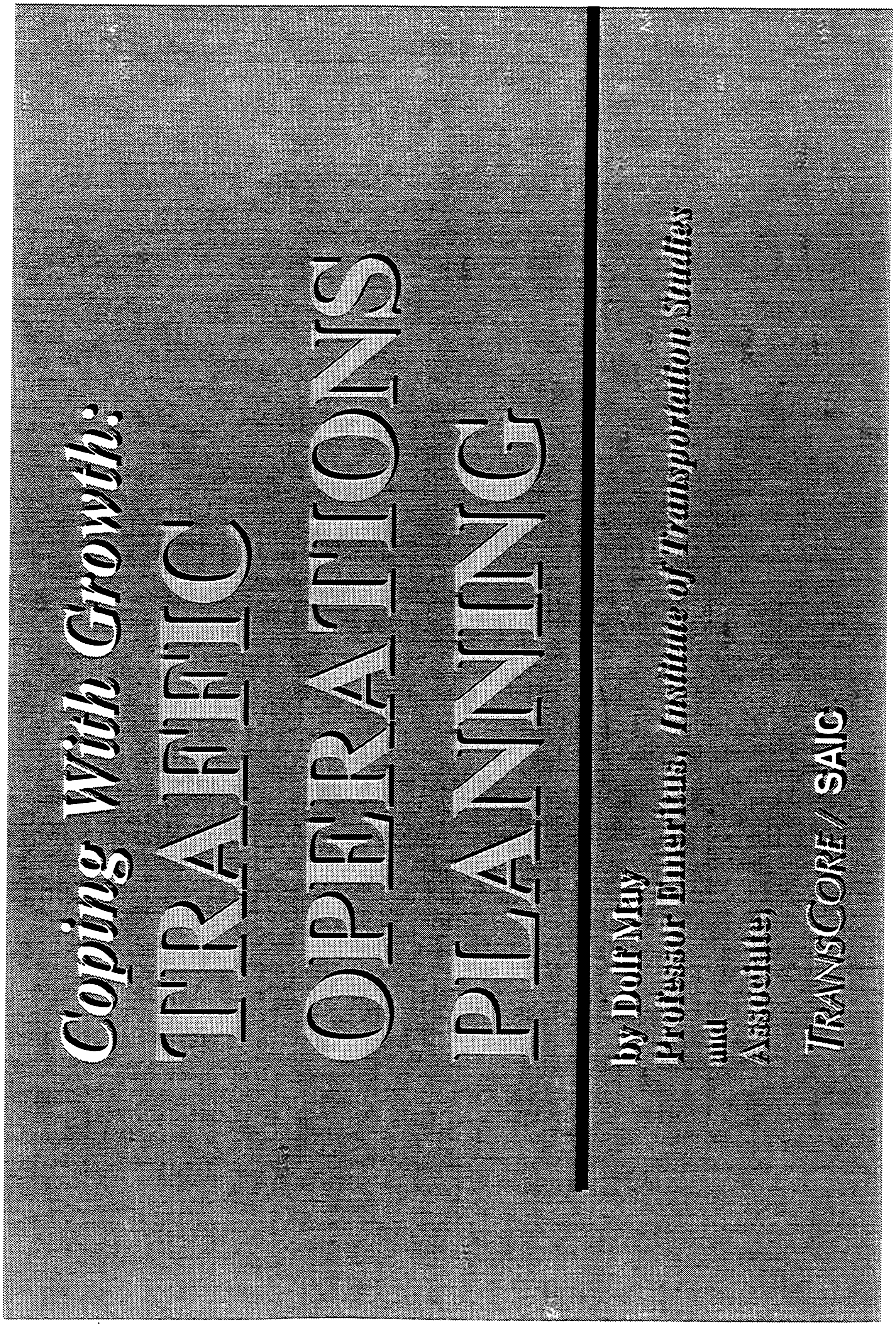

Coping With Growth:
TRAFFIC
OPERATIONS
PLANNING
by Dolf May
Professor Emeritus, Institute of Transportation Studies
and
Associate,
TRANSCORE / SAIG

Figure 1.

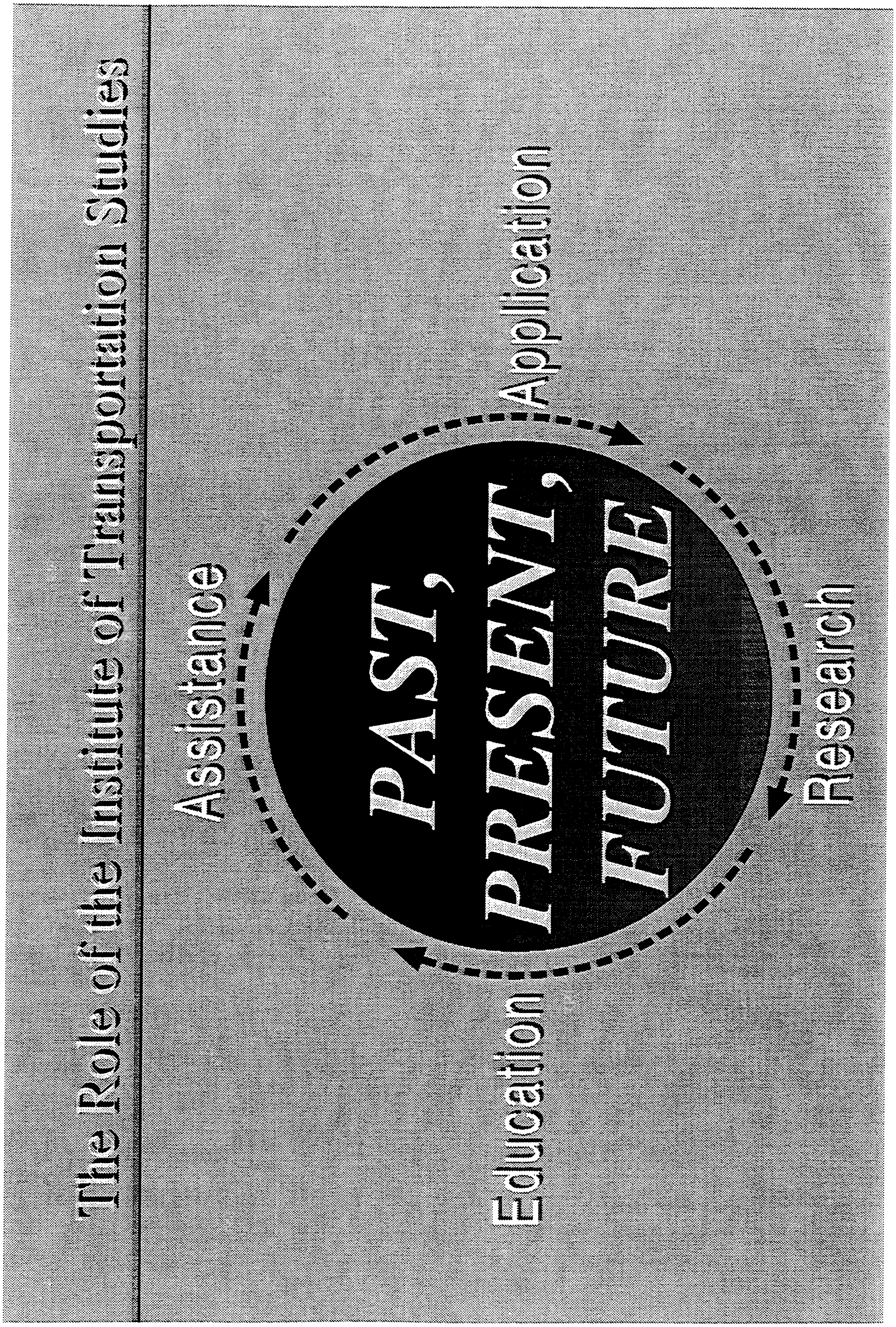

The Role of the Institute of Transportation Studies
PAST,
PRESENT,
FUTURE
Assistance
Application
Research
Education

Figure 2.

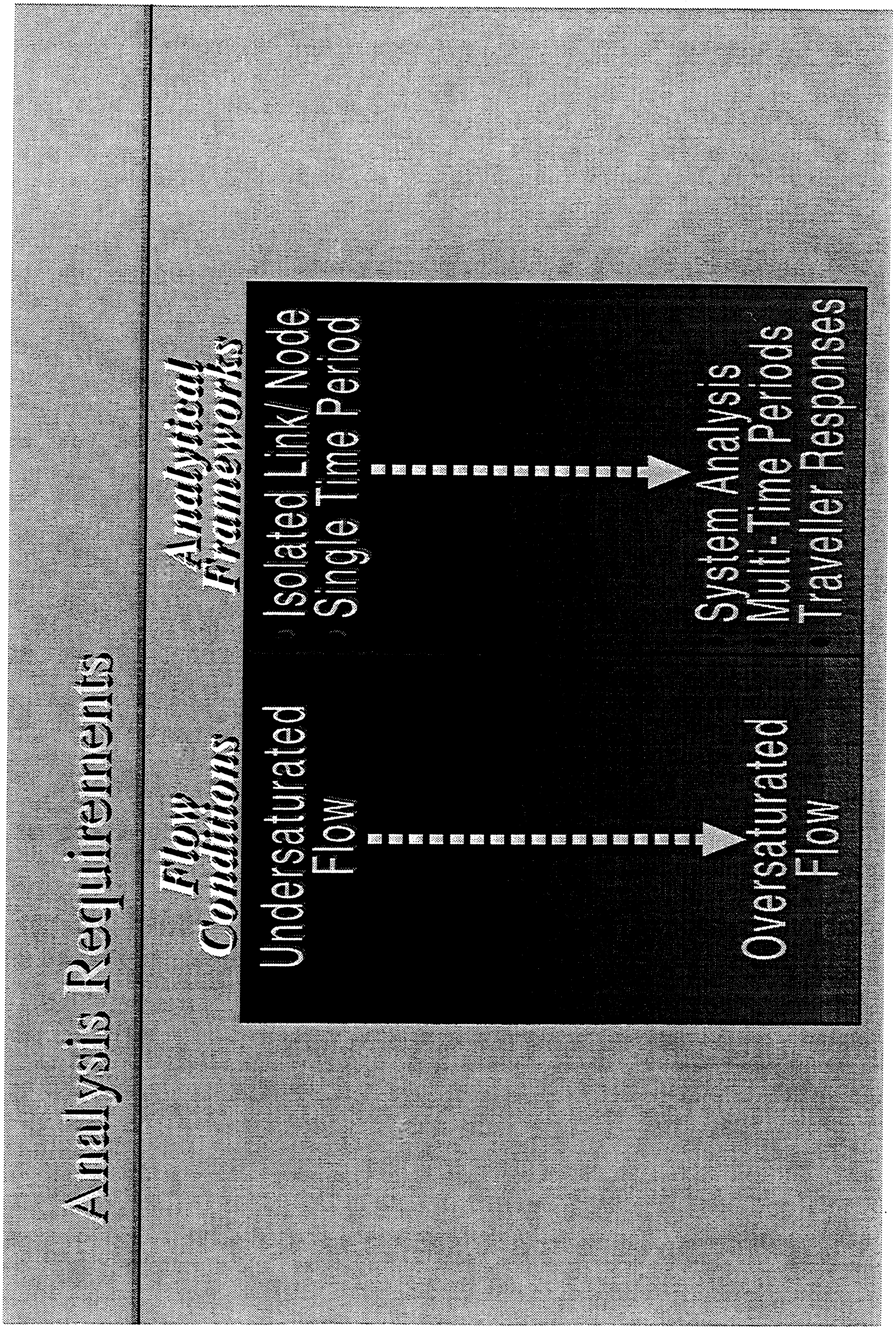

Analysis Requirements
Flow Conditions
Undersaturated Flow
Oversaturated Flow
Analytical Frameworks
Isolated Link/ Node
Single Time Period
System Analysis
Multi-Time Periods
Traveller Responses

Figure 3.

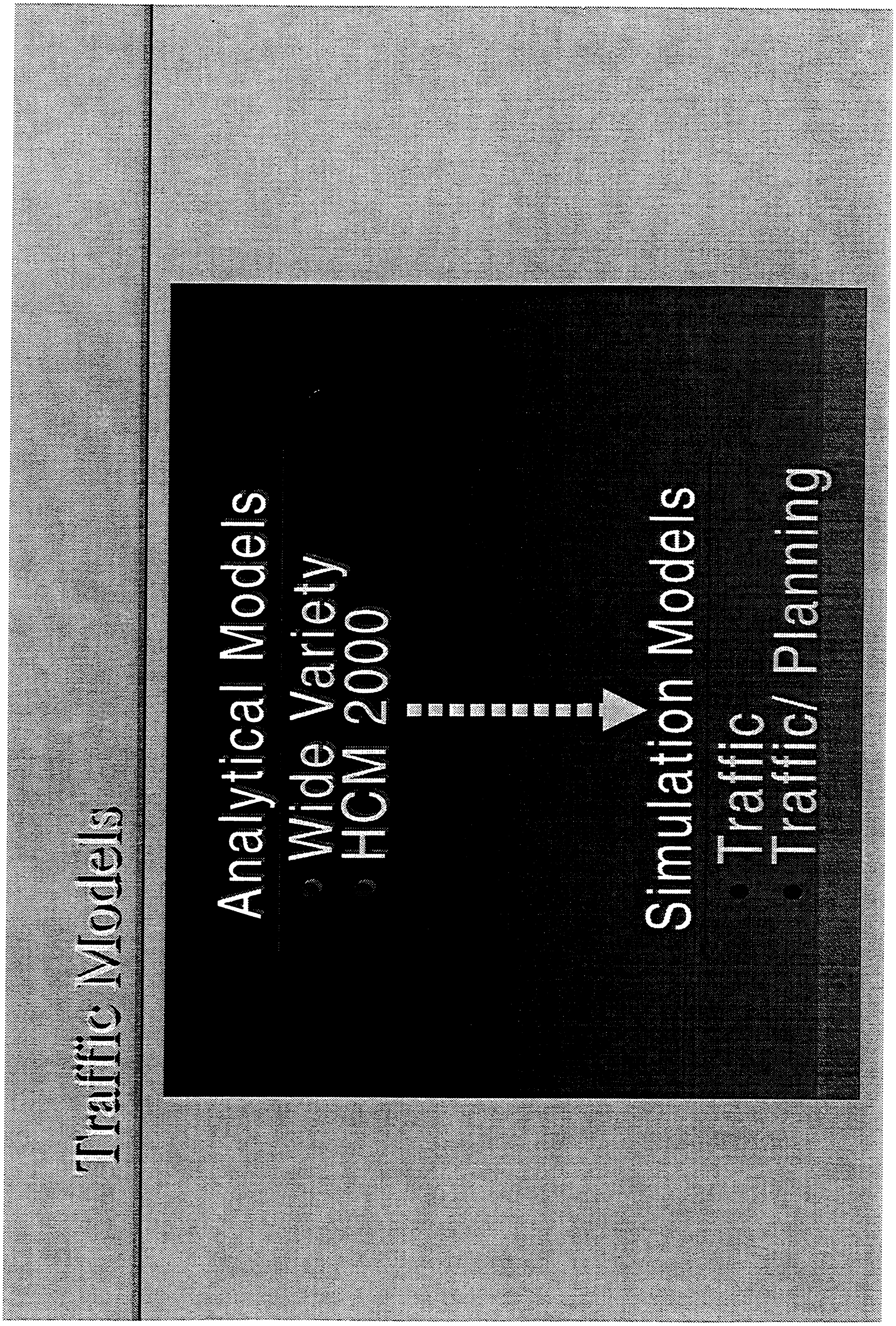

Traffic Models
Analytical Models
Wide Variety
HCM 2000
Simulation Models
Traffic
Traffic/ Planning

Figure 4.

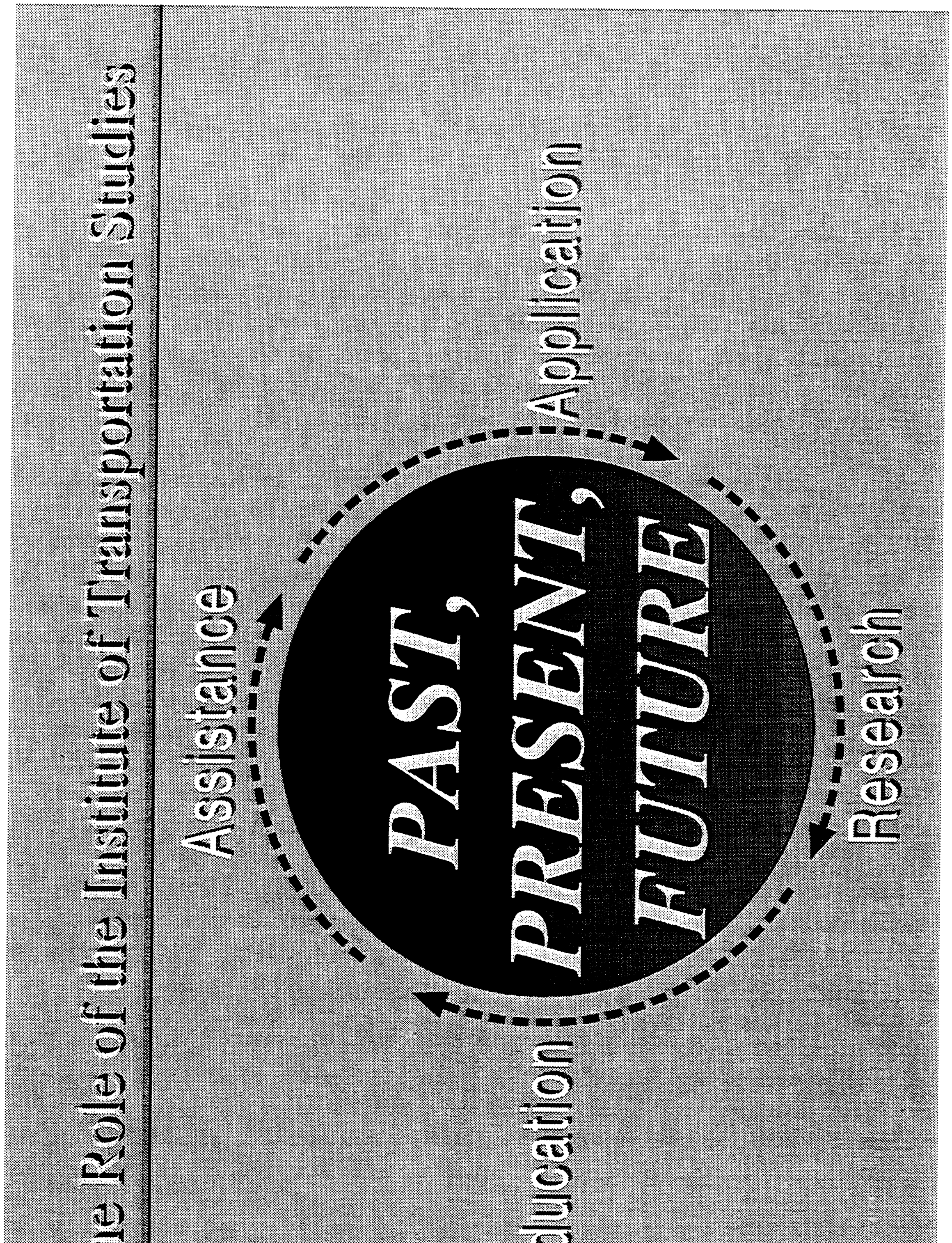

The Role of the Institute of Transportation Studies
PAST, PRESENT, FUTURE
Assistance
Application
Research
Education

Figure 5.

Foundations of New Transportation Technology

Hamed Benouar, Program Manager, Traffic Operations, California Department of Transportation

Transportation management technology has evolved quite a bit since the 1970s. In the 1970s there was already a focus on finding new ways of operating existing facilities more efficiently. The 1971 Los Angeles Traffic Management Center (TMC) was one of the first coordinated traffic management efforts that used several new transportation technologies. In fact, it was one of the first systems that are now known as Intelligent Transportation Systems (ITS) in California which include incident detection, freeway service patrol (FSP), loop detectors, video surveillance, etc.

In the 1980s, with the reduced ability to build new facilities, and with more advances in computers and telecommunications, more efforts focused on the development of measures to enhance the capacity of our existing system. The Mobility 2000 initiative (a precursor to ITS America) was created, which led to the Intelligent Vehicle Highway System (IVHS) Section of the 1991 Intermodal Surface Transportation Efficiency Act (ISTEA), now called ITS. Caltrans and the University of California Berkeley Institute of Transportation Studies have been partners for the last 50 years in the advancement of transportation technology and were among the major players in Mobility 2000, leading the ITS movement nationwide. This partnership was strengthened further since the creation of the Partners for Advanced Highways and Transit (PATH) in 1986. Two main ISTEA (ITS) efforts, the development of the National ITS Architecture and the National Automated Highway System Consortium, were spearheaded by Caltrans and PATH as major players.

In the 2000s, we anticipate a focus on system management from an integrated viewpoint, where utilization of available capacity is optimized and where the system includes state highways, arterials, transit, and air transport. The objective is to meet the growing demand for transportation service and to improve the quality of service.

Automated Highway Systems (AHS) is in our longer term future and is ultimately the route to substantially enhance highway capacity, safety, and travel convenience. Ultimately, emerging AHS technologies such as collision avoidance and longitudinal control will incrementally lead to improved travel while reducing the need for building major new facilities.

Caltrans' vision is for public transportation agencies, system operators and the private sector working together in a truly multi-modal sense to provide mobility and accessibility for California. The Caltrans Strategic Plan spells out a program of leadership for California's transport future, enhancing mobility for people, goods, services, and information and optimizing the performance as a system, improving intermodal connectivity.

The Caltrans Operations Program will continue to focus on the customer. We must manage

the existing system better. Improvements can be achieved through the use of traffic management systems, traveler information, and incident detection, management and prevention. Other benefits can be derived from geometric improvements, including auxiliary lanes, managed lanes, and improved ramps. All these improvements have to be coordinated from a transportation system perspective. Continuing research and development will greatly contribute to the development of the overall transportation system.

There is a complex interrelationship of information, infrastructure, and field elements, including FSP, maintenance, the California Department of the Highway Patrol (CHP), local agencies and other public and private organizations. In the future we see several major trends and issues: increasing demand, aging infrastructure, increasing funding flexibility, and deployment of emerging technologies. The challenge is to train a workforce that can understand the new technologies. Congestion management has become complex because very few road-miles have been built since the mid-80s, while population and vehicle miles traveled (VMT) have increased more than 20 percent. Delay is increasing, but adequate investment in technology and transportation management has the potential to reduce congestion.

The future outlook calls for safety improvements, coupled with transportation system maintenance and management as the top priority. Project prioritization should be based on benefit/cost analysis. The success of transportation management hinges on shared funding, shared resources, mainstreaming ITS and work force development. The end result is to provide our customers with enhanced mobility as measured by safety, reliability and accurate real-time information. The development and deployment of new transportation technology is vital to achieve this outcome (end result).

(Editor's note: illustrations that accompanied Mr. Benouar's address follow.)

FOUNDATIONS OF NEW
TRANSPORTATION TECHNO

50th Birthday Symposium
Institute of Transportation Studie
April 23, 1998

Hamed Benouar
Traffic Operations, Program Manager
California Department of Transportation
(CALTRANS)

OVERVIEW

- Highlights
- California Vision
- Managing the System
- Major Trends and Issues
- Future Outlook

1970’S HIGHLIGHTS

- Operate the existing facilities “Better”
- First TMC in Los Angeles
- Use of Technology and Operational Strateg
- Vision for the Future

1980’S HIGHLIGHTS

- Advances in Computers and Telecommuni
- Dependence on Capital Investments
- Technology Expands Options
- Caltrans New Technology Program and Ins of Transportation Studies
- Partners for Advanced Transit and Highwa (PATH)
- Mobility 2000

1990'S HIGHLIGHTS

- **Intermodal Surface Transportation Efficien**
  (ISTEA) and Intelligent Vehicle Highway
  Systems (IVHS).....now Intelligent Transpo
  (ITS)
  Systems
- **National ITS Architecture**
- **National Automated Highway System Cons**
- **Transportation Management Systems**

2000’S HIGHLIGHTS

- **Integrated System Management**
  - » **Optimize utilization of available capacity**
  - » **Improve quality of Service**
  - » **Maximize transportation system cost effectiven**
- **Automated Highway Systems**
  - » **Increase Capacity**
  - » **Improve Safety**
  - » **Enhance Travel Convenience**

CALIFORNIA' S VISION

- California' s transportation agencies and sys
  operators work together in providing a bala
  integrated, multi-modal transportation netw
- Thetransportationsystemisviewedasana
  the citizens of California.
- This system provides easy access and safe t
  to all of California' s employment, commerc
  cultural, and recreational opportunities.
- The transportation system enhances Califor
  competitiveness as a place to live and do bu

CALTRANS STRATEGIC PI

- **Vision**

  Caltrans provides leadership for California' s transportation future.

- **Goal**

  Maintain and improve mobility and access for p goods, services, and information.

- **Mission**

  Improve trip quality, including safety, reliabilit

- **Objective**

  Use technology to optimize the system and to in inter-modal **connectivity**

CALTRANS OPERATION PROGRAM

Purpose and Mission

In partnership with others, using the latest technological innovations as well as proven practices, we manage a safe and efficient mu transportation system for the greatest benefit customers.

00

SYSTEM MANAGEMENT PERSPECTIVE

Manage existing System better

- Transportation Management System
- System Performance
- Traveler Information
- Traffic Manager
- Incident Prevention & Management
- Strategic Partnerships
- Deployment of ITS

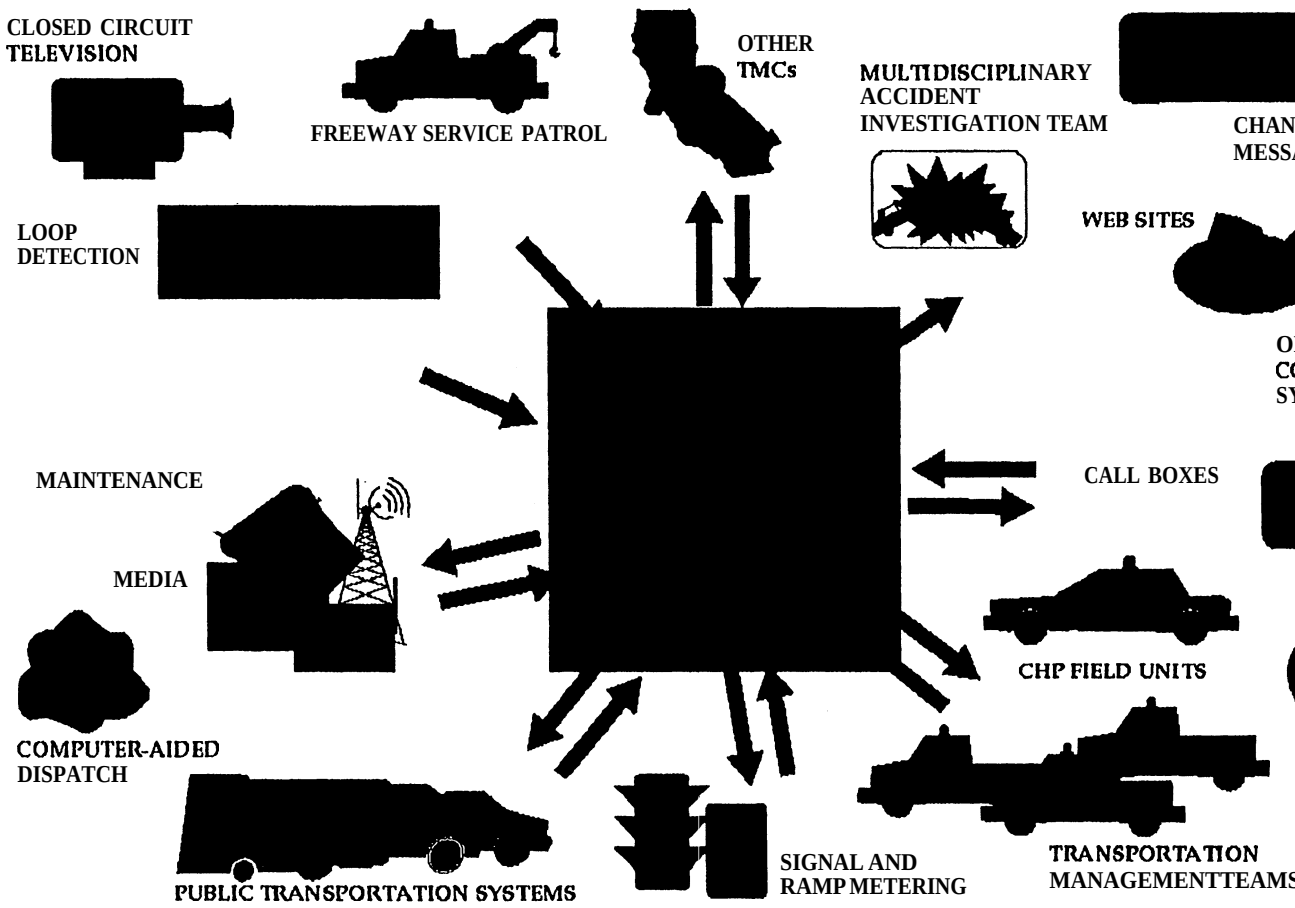
Geometric Improvements

- Safety
- Auxiliary lanes
- Improved Ramps
- Managed Lanes

Resea
Developme

- ITS User
- Field Op
- Tests
- New To
- Challeng

SYSTEM MANAGEMENT



SYSTEM IMPROVEMEN

all ı Tes

Southern California ITS Priority Corridor

MAJOR TRENDS AND ISSU

- **Increasing demand for transportation servic**
- **Aging infrastructure**
- **Devolution of inter-city rail and urban trans**
- **Categorical funding flexibility (SB *45*, IST**
- **Transportation management systems implem**
- **Deployment of Emerging Technology and I**
- **System Performance**
- **Workforce**

NEW TECHNOLOGY HEL
CONTROL "CONGESTION

Delay is measured when speeds are 35 mph or less for more than 15 mi

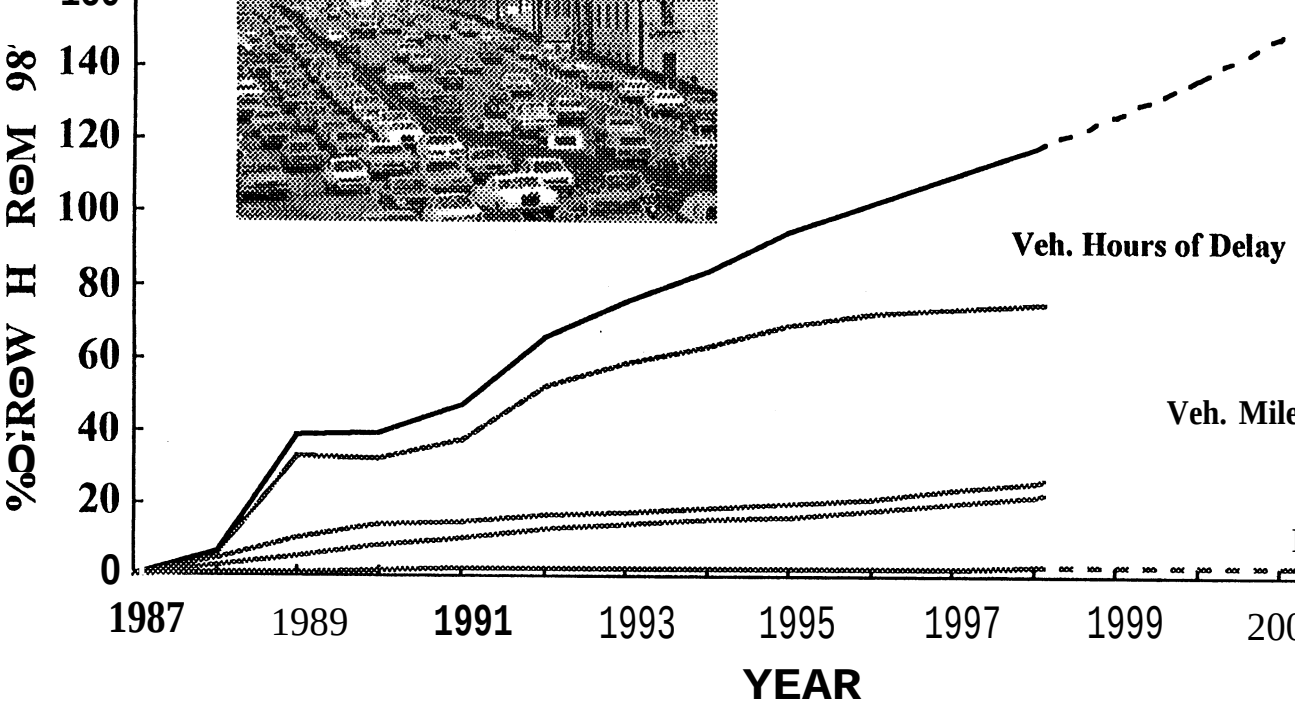


Illustration of congestion as a performance indicator

FUTURE OUTLOOK

- **Safety Improvements**
- **Transportation System Management**
  - » **Strategic Plan**
  - » **Project Prioritization “level playing field”**
  - » **Benefits and Costs**
  - » **Performance measures**
  - » **System Integration and Strategic Partnerships**
  - » **Shared Resources**
- **Mainstreaming ITS**
- **Workforce Development**

What is an Appropriate Planning Horizon?

Professor-Emeritus Melvin Webber,
Department of City & Regional Planning, University of California at Berkeley

It's very fashionable, whenever the calendar turns over a round number, to pretend we're capable of prescient foresight. And of course we'll all become especially foresighted when the calendar trips over the thousand-year mark. So today, what with 50th anniversaries and millennial changes, we'll all be acting like seers with our vision fixed on at least the year 2020. It's clear that we're in for an outpouring of reminiscences and predictions during the coming months.

I suspect we here are even more addicted to the delusion of foresight than most people. I confess to being more deluded than any of you. Because we're planners and engineers, we can claim we're smarter about the future, or more imaginative, or more sophisticated than other historians-of-the-future. Some of our more confident colleagues even talk about inventing the future."

I rather doubt that we're either smart enough or know enough to make that claim. Although it may be possible to predict the short-term future and to trace the near-term chains of consequences generated by projects we initiate, the long-term lies over the horizon and beyond view.

I want to suggest that, despite our considerable intelligence, knowledge, and creativity, we're all largely condemned to ignorance about the long-run future – that we're compelled to accept the more modest strategies of adaptation and accommodation to evolutionary, incremental changes that occur outside our control. The metaphor of the inventors implies greater powers than most of us can claim.

It's a pretty humbling test for futurists to look at the past record of predictions. Many major scientific discoveries and technological developments in the past have been extremely consequential, affecting the course of history, and yet they were not predicted. Even more important, their consequences were not predicted.

On a pop quiz, ask how many people foresaw the popularity of automobiles when they were first invented a hundred years ago. And we know, of course, that no one foresaw their subsequent influences on cities, the economy, or patterns of daily life. Now, ask how many transportation planners have an idea what the successor to the current automobile is likely to be.

Even some of the most knowledgeable people in the various industrial sectors have been incapable of seeing developments that were there before their eyes in their own fields.

Back in 1876 an internal memorandum within Western Union emphatically asserted, "This

telephone has too many shortcomings to be seriously considered as a means of communication. The device is inherently of no value to us."

In 1895 when Lord Kelvin was president of the Royal Society, he proclaimed, "Heavier-than-air-flying machines are impossible."

A few years later Marachel Ferdinand Foch, Professor of Strategy at France's war college asserted, "Airplanes are interesting toys but of no military value."

In 1920 before he created RCA, David Samoff was urging his associates to invest in radio, but they came back with a memo saying, "The wireless music box has no imaginable commercial value. Who would pay for a message sent to nobody in particular?"

And if you think no one could match these appraisals, the Commissioner of the U.S. Office of Patents said in 1899: "Everything that can be invented has been invented."

All right, you say, not everyone is foresighted, not everyone has the capacity to appreciate the latent power of new ideas or has the cognitive skills for prediction. You're right. Not everyone does. But, does anyone?

I believe some developments in science and technology are predictable insofar as they follow logical sequences. Each new theoretic or technologic development builds on the shoulders of preceding developments and typically cannot occur before the prior intellectual foundations have been laid. Until something was known about electricity, neither telephones nor radios were possible.

But, once a development has occurred and once a body of tenable theory has evolved, imaginative minds may be able to anticipate the logical next step. That's what inventors do, after all.

Some imaginative futurists have successfully anticipated potential consequences of discoveries in the natural sciences and inventions of new devices – perhaps even in time to forestall some potentially negative effects. The SST is the classic case. But what of predictability in other fields, especially in human affairs?

I suggest we've built a less than impressive record predicting the social consequences of developments in science and technology, and we've had a miserable record of predicting major developments in societal affairs:

Only a few wise observers anticipated the nation's switch from its initial economic base in fanns and mines, to factories, and then to offices. Then, it wasn't until it was already happening that the wisest among us were commenting on the emergence of the post-industrial service economy.

Few saw the Great Depression coming in the 1920s and so were able to deflect its worst

effects.

The social upheavals that accompanied the rise of the Soviet Union, the Third Reich, the Red Revolution in China, the collapse of the European empires worldwide all occurred without much anticipation by even the knowledgeable social scientists.

Add to that list the failure of virtually everyone to predict the recent and sudden collapse of the Soviet Union – perhaps as spectacular a failure of contemporary social science as we might mention.

The past two centuries have been years of explosive discoveries in the natural sciences, inventions in the applied arts, and political turmoil all over the globe, most of them unanticipated – unpredicted because they were unpredictable.

They were unpredictable in part because there can be no firm knowledge about the future. There can be no science of the future because there can be no empirical observations, no data describing future conditions.

The reason the social sciences have failed to predict those major changes in world history is, I suspect, the absence of an adequate theory of history – adequate explanations of the cause-effect relations that shape the course of human affairs. Among the reasons for the absence of theory are surely the extreme complexity of social affairs, the erratic actions of humans that follow no apparent pattern, hence the overwhelming uncertainties. Then, further, there's the possibility that societal affairs may lack the consistency we associate with the natural world.

I suggest that planners and engineers face a fundamental dilemma. Those who play the role of professional planner or engineer or forecaster or futurist are occupationally *required* to describe future conditions. It's an essential professional requirement that they explicitly anticipate both the future conditions a proposed project will fit into and the repercussions that their proposed projects will generate. And yet, the future is largely invisible.

Planners and engineers are folks who purport to know something about the future. As I've noted, in their less humble moments, they believe they can influence, if not shape, the future. But, given the deficiencies in theory, how might they do that?

One popular tactic is to trace a trend line and then to extend it into some distant time. But that of course assumes that whatever causal agents were at work in the past will continue to work in the future. Trend-line projection is an atheoretic forecast that there'll be no underlying change.

Where there are many players in the game, as in a large-scale market, planners may try to write regulations – like, say, zoning laws. By constraining individuals' behavior, fewer options are open, making it more plausible to predict behavior and hence outcomes. If the market processes are well understood, it is sometimes possible to rig the rules-of-the-game

and thus to induce market outcomes that are judged desirable. Current efforts to install congestion pricing reflect the expectation that some trips will thereby be diverted from the peak hours. The Federal Reserve Board's adjustments of the rediscount rate reflect their expectation that private investment rates will respond in predictable ways.

But what of situations that are either unpredictable or so overlaid by unknown probabilities as to be highly uncertain? What then?

Planners and engineers have long contended that they can overcome the difficulties of forecasting by precluding the need for forecasting through control. Where they can control future development projects and compel them to conform to a preformulated plan, one need only read the plan to preview the future. So, in the special cases where planners work for powerful agencies that can control the environment they work in, they can indeed determine what the future will bring – within the boundaries of their projects, of course.

A clear instance of such an agency is a British new-town corporation that owns the land on which a town is to be built and which is controlled by a single and stable political party whose leaders share the corporation's objectives. The parallel here is a private land developer with strong finances and large land holdings. Developments like Bishops Ranch in Contra Costa County are of that kind centralized controls by one owner and plans by one designer make for outcomes that accord with a fixed plan.

I guess an early variant on that model was the California Division of Highways in ITTE's early days. With a clear political mandate to build roads and bridges and the fiscal resources to write contracts, the Division was able to do its job to say which roads will be built where, then to assure they'd be constructed according to formal plans and specifications.

It was only later when popular opposition to that mission created strong counter-political pressures that Caltrans found it difficult to shape its own administrative conditions and to build the future transportation system according to its own designs.

Nowadays such centralized control is less common than in the past, as citizens have leamed to protest any developments in their backyards, as political pluralism makes for ever greater diffusion of political influence, and as markets replace command-and-control agencies.

Especially now, when contemporary history is so turbulent and when the pace of technological and institutional developments is so rapid and indeterminate, it's harder and harder to control whatever are the factors that induce contextual changes beyond the immediate horizon.

I once sat next to a chap on an airplane who described himself as a long-range planner for Dow Chemicals. I was rather stunned when he said his long-range planning horizon was 3 to 5 years. Beyond that he said, they weren't sure which chemicals they'd be producing, so

rapid was the pace of discovery and invention in chemistry at the time.

We on the other extreme claim the ability to plan for 20 to 50 years. Yet, our environments are buffeted by developments not only in chemistry but in every other field of science, history, engineering, politics, economics, and so on.

Especially in these turbulent times, I suggest that firm plans must inevitably be short-term, short enough to permit some confidence in the probabilities that anticipated events will occur. We can be pretty sure the sun will rise tomorrow. Some folks are pretty sure that the Dow Jones Industrial Average will also rise tomorrow, although there's less than unanimity in that forecast. In light of that uncertainty, wise investors will diversify their holdings, some will hedge their bets, and most will try to find an escape route for when expectations fail.

We can be certain only about uncertainty. So, one plausible strategy is to take small steps, whenever feasible — smaller projects that permit adjustments as the long-view changes; then to wait and see what happens; then to react defensively when things go wrong; or to reinforce those changes that seem okay.

That's pretty much what happened when persistently rising family incomes led to widespread auto and home ownership and suburbanization. Although suburbanization started back in early settlements when new residents located at the edge of the village, no one foresaw the extensive automobile-based suburban settlement pattern in post-war America until it happened. Then, outmigration from the metropolitan centers led to defensively reactive urban-renewal programs that sought to "save the central cities." At the same time the new suburbs' popularity led to massive construction programs and the installation of new governments, diverse urban services, et cetera, that reinforced the move to the metropolitan edge. Willy-nilly, American metropolitan areas continue to survive with both declining center cities and expanding suburbs, typically in the absence of anything resembling central controls over long-range plans.

It's now apparent that societal systems are guided by big internal gyroscopes that are only partly understood. It's also apparent that those systems are remarkably adaptive, that they are frequently able to accommodate by absorbing new discoveries and new technologies, sometimes even with equanimity.

That's not always so, of course. So a major function of those who propose public projects is to anticipate those projects' repercussions and to find ways of softening negative outcomes and exploiting positive ones.

That calls for a style of planning and governing that does not rely on centralized control or on long-range master plans. Instead it calls for an ongoing process of governing that relies on constant monitoring — constantly endeavoring to anticipate consequences of both externally generated events and of deliberately planned actions. That must be what Dwight Eisenhower had in mind when he said, "Plans are nothing. Planning is everything."

But, first, it calls for improved capacity for prediction – surely for doing far better than our predecessors have done. That means it calls for better theory that might expose cause-and-effect relationships within societal systems and thus permit prediction of how those systems might change when perturbed.

Above all, it calls for a large measure of humility and a capacity to accommodate to unanticipated changes that are outside our control.

It says, finally, that, however much we may aspire to a capacity for "inventing the future," we must first acquire the capacity for adapting to the future.

What Does the Past Tell Us About the Future?

Professor-Emeritus William Garrison,
Department of Civil Engineering, University of California at Berkeley

We will focus on what history says, with an emphasis on the benefits of investment and use.

Looking back is useful and necessary, given that we have large time constants for system deployment, on the order of 60-70 years. First, we can look at a classic S-shaped product development curve for pavement-feet per capita in the United States (see Figure 1). This is very similar to a curve of enplanements per capita, which may be composed of three S-curves corresponding to the introduction of DC-3, jet aircraft, and deregulation (see Figure 2). Another useful view is that of J-shaped curves for costs of providing services, for example in the air transportation realm (see Figure 3).

One must be careful of local anomalies in the long-term trends. It is also useful to look back in order to uncover hidden problems and opportunities. Some examples include bad railroad locations causing excessive costs (ca. 1906) and the idea of developing roads for motor truck transport only (ca. 1928).

Looking back through history can put crises in perspective. Further it is important to look back without a blank slate, since history tells us nothing unless we try to assemble some historical data to validate or disprove some theory or interpretation.

To aid in thinking about transportation, it can be considered within a system of systems. The zeroth order system consists of the building blocks; the first order systems are the modes themselves and combinations of modes; the second order systems involve combining systems that use the transport systems. The combining is the essence of innovation (Schumpeter, 1934).

Innovations are what make us as a society better off—that's how the benefits of transportation investment are generated. Why should we make transportation "better?" It

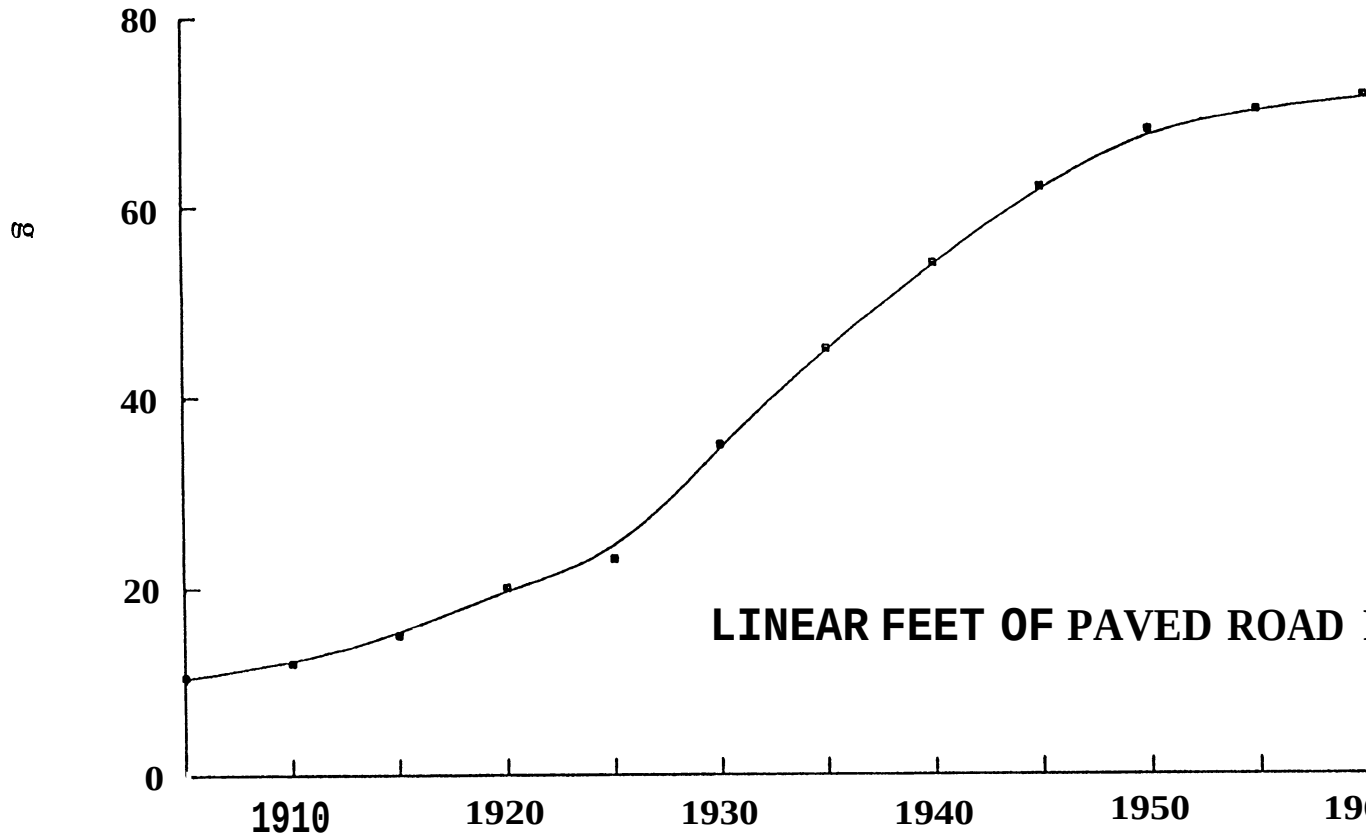
enables innovators to do their work!

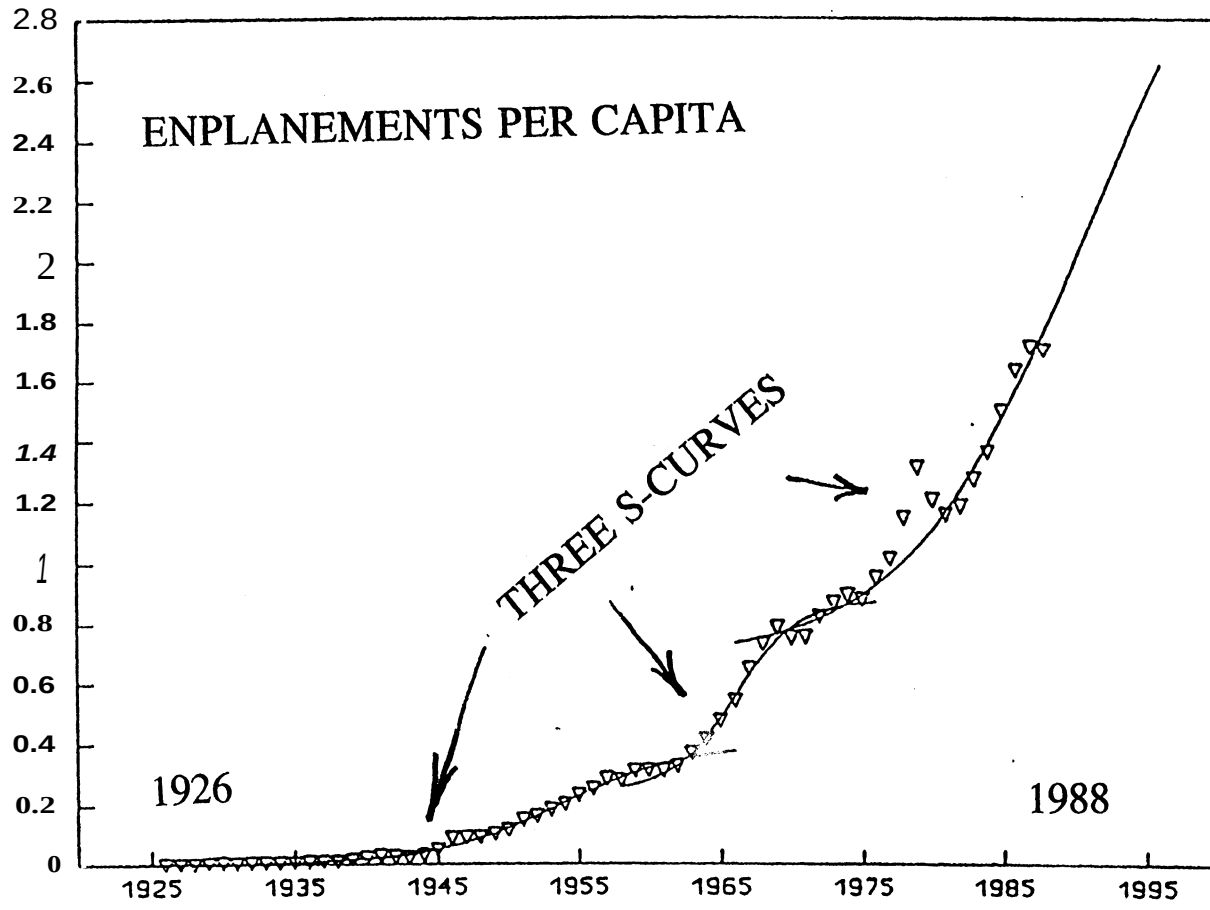
It is useful to look at ways that transportation improvements have made us all better off. In the area of farming, Cronon (1991) notes that railroads in Midwestern development allowed three-crop rotation and grain futures marketing. Transportation improvements were the great enabler!

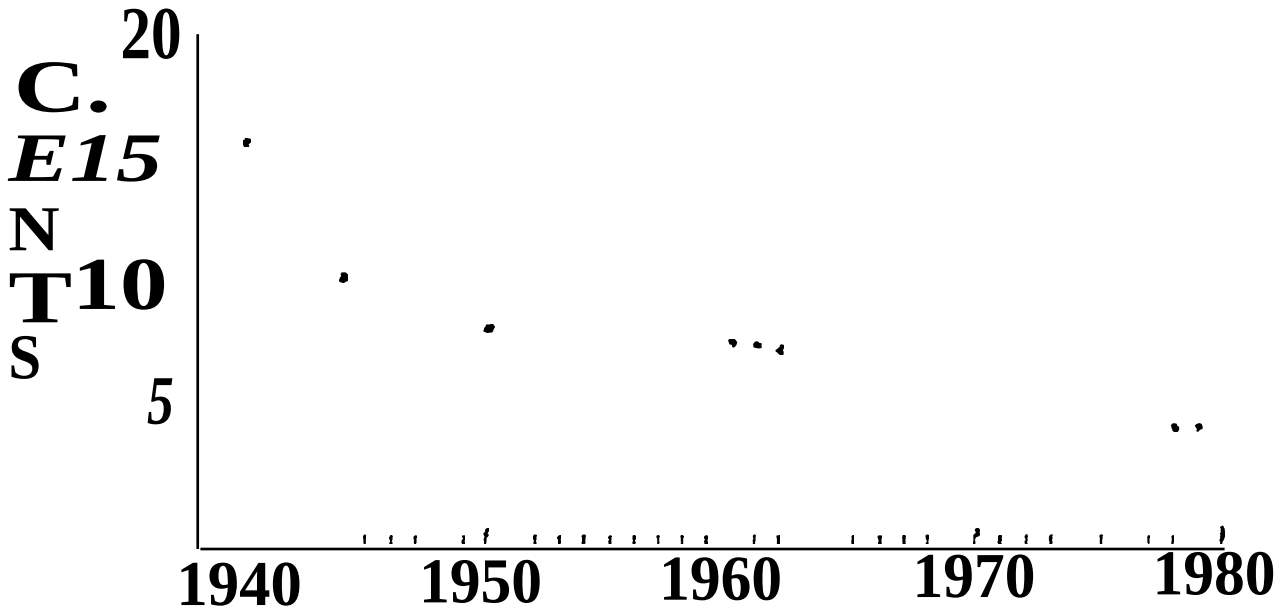
In the development of factories, Fogel (1956) explored a supposition that railroads had never been built and concluded that things would not have been different. He failed to see that railroad service was combined with other activities to allow an economic boom, such as large-scale production of iron and steel (raw materials, year-round operation, scheduling).

Suppose you superimpose transportation system deployment on a graph of growth in the U.S. Gross Domestic Product. You see that booms in economy are aligned closely with transportation investment. Here we see that benefits are triggered by transportation as the enabler (see Figure 4).

In 1844, Jules Dupuit summarized these ideas profoundly when he stated that the ultimate aim of a means of communication must be to reduce not the costs of transport but the costs of production.


80
60
40
20
0
1910
1920
1930
1940
1950
LINEAR FEET OF PAVED ROAD


ENPLANEMENTS PER CAPITA
THREE S-CURVES
1926
1988
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1925
1935
1945
1955
1965
1975
1985
1995



TOTAL EXPENSES PER REVENUE PASSENGER MILE OF U.S. DOMESTIC AIR CARRIERS, 1967 CENTS

Figure 3.

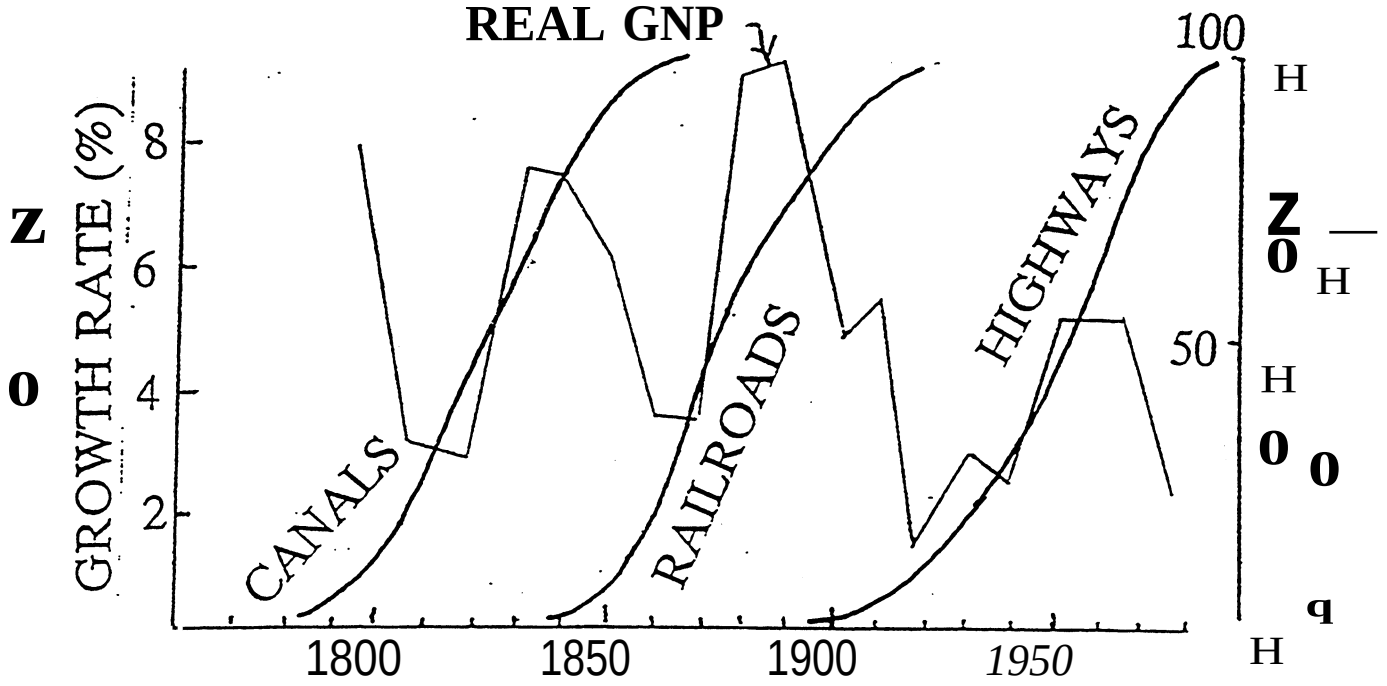


FIGURE 2: U.S. ECONOMIC GROWTH AND TRANSPORTATION SYSTEM DEPLOYMENT

Figure 4.

Implications of a Changing Urban Form

Professor Martin Wachs,
Departments of City & Regional Planning and Civil Engineering, University of California at Berkeley

Every technological advance in transportation and every capital investment project in transportation has influenced urban form, and every change in urban form has implications for transportation systems and their planning and policy. The trouble is that we all understand the relationship between transportation and urban form differently, and we strongly disagree with one another as to what the implications are of different actions affecting urban form and travel and their interaction.

In 1835 most people lived within walking distance of where they worked. By the start of this century, transportation had evolved rapidly from horsecarts to omnibuses to street railways, which allowed cities to expand dramatically. Still, cities were crowded, dirty, dense, congested places. The first national conference on City Planning and the Problems of Congestion held in Washing in 1908 was characterized by many speeches in which the leading thinkers of the day one after another insisted that the disease, poverty, darkness and vice of the American city was caused by the scourge of high-density living, and that it was the job of urban transportation planners to build public transit routes to outlying areas for the explicit purpose of lowering density. For example, Charles Horton Cooley stated in 1884: "Humanity demands that men have sunlight, fresh air, grass, and trees. It demands these things for the man himself and still more eamestly for his wife and children. On the other hand, industrial conditions require concentration. It is the office of urban transportation to reconcile these conflicting requirements; insofar as it is efficient, it enables men to work in aggregates and yet to live in decent isolation. The greater its efficiency in speed, cheapness, and convenience, the greater the area over which a given industrial population may be spread."

Mary Kingsbury Simkhovich, the only woman to address the first annual conference on city planning, urged that new immigrants be whisked to low-density suburbs before they had a chance to settle in lower Manhattan and be destroyed by the urban densities. Subways to the Bronx and Queens were urged, combined with low fiat fares, so that low-income people could afford to live at low density at the edge in order to avoid the pitfalls of inner-city living. Completely oblivious of the fact that it was conventional wisdom in 1908 that subways and streetcars would lead to lower density and encourage suburbanization and that was seen as a good thing, we today have a new conventional wisdom endorsed by Peter Calthorpe and Peter Newman and Jeffrey Kenworthy that our problem is that we suffer from terribly low densities and suburbanization, and that air pollution and disease and inequity and the sterility of the suburbs are the result of urban sprawl and that we ought to build public transit routes to outlying areas for the sake of increasing density and alleviating sprawl. Today's heroes are the neotraditionalists who urge us to restore what we consciously rejected 80 or 90 years ago, and to reject the suburban utopia that planners of 80 years ago were trying to correct.

Of course, I have overstated what has really been going on. The automobile, the telephone, the radio, and later computers and other forms of information processing have all facilitated suburbanization, and the lowering of densities has occurred to levels well below those that were envisioned by the planners at the turn of the century, and the neotraditionalists would like us to increase densities to the point that public transit might be viable and mixed use communities might be sustainable, but not to levels typical of the central city of 1850 to 1900. In fact, the lower densities sought by planners in 1910 were actually higher than the higher densities sought by planners in 1998, as we continue to seek some holy grail or golden mean consisting of sufficient density to create a stimulating and diverse urban environment in which public transit is a viable transportation option while not so dense as to cause crowding, traffic congestion, and various forms of contagion.

We don't really know what this golden mean is – what is an optimal urban density; yet we have divided ourselves unwisely into armed camps. One camp believes that the automobile is an unmitigated evil, polluting the air and consuming energy and encouraging sprawl. The other group believes that the automobile is the fullest expression of the best of capitalist society, providing freedom of choice with respect to travel and living environments.

We often stage debates between these perspectives, and there are books arguing that one future is better than another and ought to be pursued with vigor. I myself remain confused and indecisive. I cannot with any confidence offer any pronouncements as to whether future changes in urban form can substantially contribute to urban livability or reduced traffic congestion. I am not certain that increased density is either good or bad. I can, I think, predict with some certainty that the trend toward lower densities overall will continue as a general trend in the U.S., and probably even more so in other countries, with the greatest changes still ahead in developing countries where motorization is proceeding at the fastest rate. My hope is that we in the university, in this institute and elsewhere, can contribute some findings and facts and insights to the discussion of this issue, and lower the temperature of the debate somewhat. Don't think there are any rights and wrongs on this theme.

Empirically, it would appear that by increasing the density of residential and commercial activities in an urban area we do indeed reduce the number of daily automobile trips per household, as people rely more upon transit and walking and other modes. But, it would appear that over a reasonable range of densities, a doubling of residential density can yield something like a 15 percent reduction of trip generation per household. But, of course, while doubling the number of households reduces trips per household, it increases the number of households per acre or per square mile, so that total travel increases. New York produces more vehicle trips per unit of area than does Walnut Creek. But many planners and theorists urge us to densify our communities to have lower travel rates per household, while tolerating higher congestion levels per acre or per square mile because of the larger number of households.

On the other hand some other analysts argue that the best way of reducing traffic congestion in our communities is to reduce density. If a community has only six or eight dwelling units per acre, it obviously will produce fewer trips per acre than one that has 20 or 30 dwelling units per acre, so to improve the quality of community life, we should build at lower densities. They would argue that people don't want to live at New York densities, and we should build many more Walnut Creeks in order to allow larger numbers of people to live in less traffic-impacted communities, even though the consequence of this is to cover a larger proportion of the land area with lower-density communities and thus to undoubtedly encourage more travel in total though less per unit of area.

Which approach is better? While the neotraditionalists argue for higher density and transit-oriented development, and their critics insist that most people like less-congested communities and prefer low-density suburbs, and very spirited debates take place over these issues, I stand back and ask whether it's worth debating about at all in the abstract. I see a future with more variety more of each choice as both inevitable and desirable. I have seen several efforts to downzone the allowable densities in communities in order to reduce traffic congestion, while other communities are constructing urban limit lines in order to force higher densities within certain boundaries in order to reduce traffic congestion, and critics of each approach rage and rail against one another. Yet, transportation planning is largely debated at the regional level, and land use is largely regulated at the municipal level, and though the two are functionally interdependent, for the most part, we find it difficult to orchestrate them so that they are determined in concert with one another.

While these debates take place, we have created a society in which we have more registered cars per licensed driver than any other in the world, and we spend more public money on transit per rider served than any country in the world, and while we are probably the most mobile society that has ever existed, despite this we have people who lack health care or employment or educational opportunities for lack of access. To me, the inability of some elderly people to get to health care, the inability of many people to search for work beyond their neighborhoods because of the cost of time and travel, and the frustration that parents face because they have to drive their kids everywhere are more important social issues than the physical form or our cities. While these issues are not completely independent of urban form, they are also not entirely the result of urban form either, and their solutions can be found in many approaches and strategies that reach beyond urban form.

Suppose it is now 2050, and we are looking back from that vantage point on the year 1998, and we are asking what changes have occurred between 1998 and 2050 in the relationship between travel and urban form. I believe that in the year 2050 our society and our transportation planners will simply not consider the issue of density and travel to be as significant as we do today. Those issues will have become uncoupled from one another. The debates we are having now might be an interesting footnote in a history book, but looking back on these current debates and on the communities that we are creating from the perspective of 50 years in the future, I believe that we will hardly remember that this

debate ever took place.

Because the population will have continued to grow between 1998 and 2050, cities will be much larger than they are today. Much of California will be urban, but the differentiation between urban, suburban, and rural will be far less pronounced than it is today. We will have in general larger urban regions but they will be less intensely developed than they are today – except for nodes of dense development that exist for cultural reasons to satisfy the demands of people who choose to live at and work at higher densities. But the quality of life, the nature of daily living and the travel patterns of families will be more varied from household to household than they are today, and less associated with population density or land use density. Because we will communicate with one another in so many ways over so many parts of the world, we will find ourselves working at different hours from one another, and work will be fundamentally different in time and location; we will work at home and in offices and in factories, and we will work in the morning or afternoon or evening. We will travel at different times, and our travel will be more broadly distributed in space and time, and that dispersion of travel in both space and time will be one of the **major factors** that will allow us to manage an enormous increase in travel volumes without an enormous increase in congestion.

People who in 1998 believed that we could not sustain increased motorization without choking ourselves on congestion and air pollution will have been proven wrong because we will travel at a wider variety of times and places and, even though we will travel more, we will not all be competing for limited transportation capacity at the same hours of the day. Greater transportation capacity through automation and the use of communications technology will also contribute to broader ranges of choices in how we communicate with one another and travel to and interact with one another. Less air pollution and greater energy efficiency will be the result of changes in technology rather than of urban form, and people won't even associate those issues with urban form; nor will they remember that anyone ever did. Urban form will be less of a determinant of travel and human interaction than ever, and that greater independence will allow for a greater variety of urban forms as a reflection more of tastes and historical accidents and climate and so forth rather than of transportation technologies.

At the 100th anniversary of the Institute of Transportation Studies at UC Berkeley, we will honor and fondly remember the contributions of the recently retired director of ITS who graduated with her Ph.D. in 1999, and had returned to head the healthy and growing institute from 2020 to 2050, after she rose to prominence as an academic at a different, eastern university. She will have become famous for developing a general theory of the unity of telecommunications and transportation, and will have finally presided over the seismic upgrading and aesthetic redecoration of McLaughlin Hall, which had originally been scheduled for the late nineties, but which, in accordance with the traditions of Berkeley, had actually been started in 2040 and completed in 2050.

REFH|INKING THE ROLE OF ELIBLIC TRANSPORTATION

Institute of Transportation Studies Symposium
THE TRANSPORTATION ENTERPRISE: CHALLENGES OF THE 21st CENTURY

Berkeley, California
April 24, 1998

Sharon D. Banks
General Manager

NOTES

Rethinking the Role of Public Transportation

- **Other Transit Roles "HATS"**

Rethinking the Role of Public Transportation

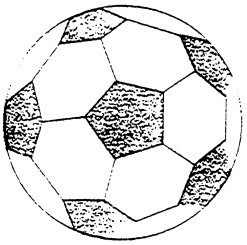
Mobile Child Care Specialists and Partners with Parents who entrust their school-age children to us each school day.

Rethinking the Role of Public Transportation

Transportation Departments for libraries, museums, county administrative offices, training programs for single parents, football stadiums, movies, concert balls, welfare to work programs

NOThS

Rethinking the Role of Public Transportation



Dependable "soccer mom" Drivers of non-drivers (teens. adults and seniors) to and from school. college, work and extracurricular activities.

Rethinking the Role of Public Transportation

Ambassadors for Reliable and Safe Travel for seniors and persons with disabilities.

- Fixed route
- Curb to curb paratransit

Rethinking the Role of Public Transportation

Authentic and original van pool operators.

NOThS

Rethinking the Role of Public Transportation

Emergency and Routine Medical Trip Providers for all who need rides to doctors, clinics and hospitals.

Rethinking the Role of Public Transportation

7

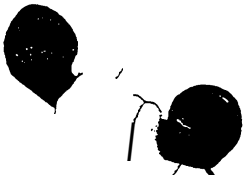
Disaster Transporters of Victims and Emergency Workers (police. fire. other volunteer rescuers) during earthquakes. fires. floods and toxic spills.

Rethinking the Role of Public Transportation

Warm, Safe, Dry Mobile Homes for homeless women, children and men.

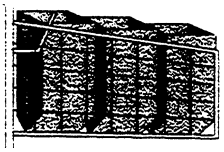
NOTES

Rethinking the Role of Public Transportation



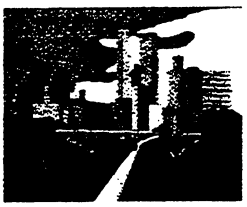
Telephone
Lifeline seven days a week to thousands who have no one else to call.

Rethinking the Role of Public **Transportation**



"Nordstrom" Like Customer Advocates for
- **Internal Customers**
- **External Customers**

Rethinking the Role of Public Transportation



Protectors of the environment.
- clean fuel
- alternative fuel
- clean waste water
- hazardous waste disposal

NOTES

Rethinking the Role of Public Transportation

- **Partners with Workforce.**
  - –participatory management
  - —sharing gains and risks

Rethinking the Role of Public Transportation

Experts in Leadership Development and Managing people, change, and dwindling resources.

Rethinking the Role of Public Transportation

Entrepreneurs.

- – "Contracting-in" work
- – Creating Cost-Saving Ventures

NOTES

Rethinking the Role of Public Transportation

Contractors

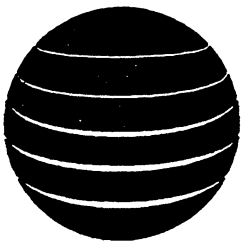
- **for millions of dollars in goods and services.**
- **expanding** definition of "vendors" to business partners.

Rethinking the Role of Public Transportation

Contributors to the

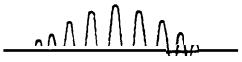
- boom in a robust economy or
- revival of the sagng economy.

Rethinking the Role of Public Transportation



- **Partners with Retailers who** need customers delivered to stores, business services, retail shops and centers.

Rethinking the Role of Public Transportation



Communicators and Experts in applying new technology for:

- efficient operations
- customer information
- "out of the box" mobility strategies

Rethinking the Role of Public Transportation

Connectors for People making intermodal travel trips via **buses**, bikes, planes, trains and ferries.

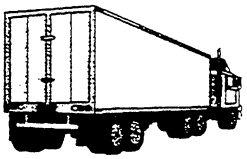
Rethinking the Role of Public Transportation

Dreamers, Planners and Designers of local tours and recreational travel to historic sites, parks and other sites.

NOTES

NOThS

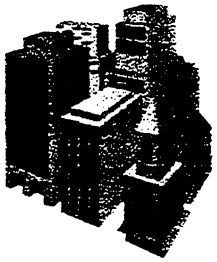
Rethinking the Role of Public Transportation



Partners with Highway Professionals to:

- maximize highway use and reduce congestion.
- facilitate freight movement

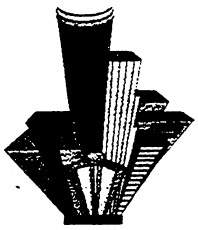
Rethinking the Role of Public Transportation



Trend Benders

- Create travel options for the cocoon generation.
- Maximize transit people friendly developments.
- Design travel for telecommuters

Rethinking the Role of Public Transportation



Trend Benders:

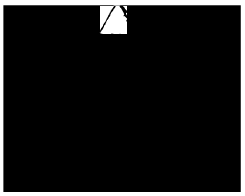
- accommodate Saturday and year-round K-12 schools
- create new efficient suburb-to-suburb travel options

NOTES

Rethinking the Role of Public Transportation

- Partners with
  - Communities
  - Businesses
  - Agencies
  - Customers

Rethinking the Role of Public Transportation



- Perpetual Rethinkers of
  - Old roles that should be discarded
  - New Paradigms for Public Transit. e.g. TCRP J8 Project Outcomes
  - Transit's mission/role
    New options for moving people

Providing New Infrastructure

Mary Moehring,
Special Assistant to the Regional Administrator, Region 9, Federal Highway Administration

I am very pleased to speak to you today on behalf of Julie Anna Cirillo, the Regional Federal Highway Administrator for Region Nine. As part of this session I've been asked to address issues surrounding providing new infrastructure in the future. Obviously, this is an extremely broad and many faceted public policy topic. In the short time I have today, I've decided to concentrate on the near term issue of funding the surface transportation program for the next several years and end by sharing some thoughts on how I think the federal transportation program, and in particular, the federal highway program will be delivered in the longer term.

Before, I think it is important to give you some context for my remarks, particularly for those of you who are not familiar with the federal agencies involved in transportation. The federal Department of Transportation, U.S. DOT, as it is known, is made up of eight major operating administrations -- or modal administrations as we call them: the Federal Aviation Administration (FAA), Federal Highway Administration (FHWA), Federal Transit Administration (FTA), Federal Railroad Administration (FRA), National Highway Traffic Safety Administration (NHTSA), Research and Special Programs Administration (RSPA), and the U. S. Coast Guard. Each of these administrations have different functional and programmatic responsibilities. However, the intermodal nature of transportation today has fostered a more collaborative atmosphere among the modes. Secretary Slater, in particular, has fostered the concept of One DOT.

With that, let me turn to one piece of transportation surface transportation. The most important piece of domestic legislation now before Congress is the surface transportation reauthorization bill. The surface transportation reauthorization legislation is the most important piece of domestic legislation now before the Congress (and not only because it will include the funds to continue to pay my salary) and it is vitally important to the traveling public, and both the public and private sectors of the transportation community.

As I am sure you are aware, the most recent federal-aid highway and transit legislation was the Intermodal Surface Transportation Efficiency Act of 1991, known as ISTEA. ISTEA was a multi-year bill which expired on September 30, 1997. The Administration submitted its proposal to reauthorize the federal-aid highway and transit programs in February of 1997 and proposed $175 billion in total funding for a 6-year period beginning in fiscal year 1998. That proposal was known as "NEXTEA" for short.

However, Congress was unable to agree upon a new, long term bill to extend highway and transit programs prior to September 30 of last year and instead passed a seven month extension of ISTEA, which expires on April 30, only six days from today. After that date,

no new federal transportation funds will be available for projects until a permanent extension is passed.

I had hoped that I would be able to tell you that a bill to reauthorize the highway, transit, and highway safety programs had been enacted and that I would be able to discuss its features, programs, and funding provisions. Unfortunately, I can't. The enactment of a bill is still a few weeks and perhaps a few months off. The good news, however, is that both the Senate and the House of Representatives have passed versions of a reauthorization bill which will carry forward the highway, transit, and safety programs for another six years.

The Senate Bill, S. 1173, is called the Intermodal Surface Transportation Efficiency Act of 1998. It is generally known as ISTEA II. The House Bill, H.R. 2400, is called the Building Efficient Surface Transportation and Equity Act of 1998. This bill is more commonly known as BESThA.

However, as is usually the case in major pieces of legislation, the two bills differ significantly in their specific provisions. As many of you probably know, the mechanism used to resolve the differences between the two bills is known as a conference committee, composed of selected members from both the majority and minority parties in the Senate and the House who are charged with drafting a bill which resolves the differences between the two bills. Once the committee agrees upon a conference bill, it is submitted to both houses of Congress for approval. No amendments are permitted -- it is either up or down. So you can see how important the conference committee deliberations are to the ultimate outcome of the legislation. Both the Senate and the House have chosen their respective conferees and they began their deliberations this week

The original goal -- which was for the completion and passage of the conference agreement for the President to sign by May 1, thus avoiding the lapse in spending authority which I mentioned earlier, is no longer realistic.

It appears that once the complexities of both bills were examined by Conferees and their staffs (a process that has been underway for several weeks) and, most particularly, when the budget issues that stand in the way of funding at the levels approved by the House and Senate were reviewed, the target date for enactment was pushed back.

The new target date for completion is before Congress recesses for the Memorial Day holiday. If that is not met, the next logical target date is before the July Fourth recess. Hopefully, Congressional action will be completed sooner rather than later.

Although both bills are very large pieces of legislation, with thousands of provisions, the debate is really about just three things --- money, money, and money how much, who gets to spend it, and what it gets spent for.

Let me cut right to the chase -- the real sticking point to the passage of this legislation is the overall annual funding level and how that level relates to the Budget agreement. Both

Senate and House bills provide for a very substantial increase in transportation spending for highways and transit over the level provided in ISTEA. The total funding provided for all highway and transit programs in the Senate version of the bill over 6 years is about $214 billion. The House version is somewhat higher at about $218 billion over 6 years. In other words, the overall levels are very close. In Washington terms, a billion here or there for a massive, multi-year pubic works program is a relatively minor matter.

However, the real problem is that these funding levels significantly exceed the funding levels of the current balanced budget agreement. The House bill at $218 billion exceeds the balanced budget agreement by some $26 billion.

While we obviously don't know what the final numbers will be, it may be of interest to review the magnitude of the increase. Let me use the House bill for purposes of illustration. The House bill would increase highway funding by about 50 percent over the totals under ISTEA to an average level of about $30 billion annually. Highway safety programs would be funded at an average annual level of about $350 million. Transit programs would be funded at an annual level of about $6 billion.

So as you can see, the biggest issue facing Congress, and the one which will ultimately decide the fate of the reauthorization bill, is how the increased transportation spending found in both the Senate and the House bills can be accommodated within the confines of the bipartisan balanced budget agreement. Until the budget issues are resolved, the conferees will not know how much money that will be available for surface transportation -- and we will not have a bill.

The Administration has indicated that while it is committed to increasing transportation spending over the levels of ISTEA, it believes the proposed spending in both the House and Senate bills **goes too far,** and could threaten both fiscal discipline and commitments to education, child care and other investments.

The House bill contains a provision stating that the Secretary of Transportation shall not **apportion,** allocate, or obligate any funds unless the additional spending for transportation is offset by savings elsewhere. However, the bill doesn't contain any specific savings. Therefore, these savings will have to be found by the Conference Committee. The House leaders have expressed a commitment to find savings (or offsets as they are called inside the beltway) in other areas to maintain the caps of the balanced budget agreement.

Those funding shifts must be part of the FY 1999 budget resolution that Congress is supposed to finish by each April 15, but rarely does -- and this year is no exception. The House Budget Committee has yet to complete its version of a new budget plan.

The Senate budget plan approved just before the Spring recess assumes $10.5 billion in savings on veterans' health benefits and $1.7 billion in projected savings in food stamp administrative costs to help fund the transportation reauthorization bill. These projected savings were also assumed in the President's budget submitted earlier this year. However,

the Administration is counting on these savings to fund education programs and other initiatives rather than increased transportation funding. In addition, the food stamp administrative savings are also being claimed as offsets for an agricultural research bill now in conference and as way to fund the restoration of benefits to legal immigrants which were eliminated in the 1997 welfare reform legislation. So, you can see, there are many claimants on these potential savings.

You have all probably read recent news reports that indicate that there is far more money coming into the Treasury than was forecast perhaps as much as a $50 billion surplus in FY 1998. If this is true, doesn't that solve the problem of finding additional transportation dollars? Not necessarily. There are also proposed uses for these funds -- the most prominent of which is a plan to use any windfall surpluses from a booming economy to help solve the looming crisis in Social Security funding.

Therefore, it is still the case, at least at the moment, that any increased spending for surface transportation (or any other government programs for that matter) must be offset with matching spending cuts elsewhere in the federal budget, and these decisions have yet to be made.

The long and short of it is that unless an alternate budget solution can be agreed on, the final transportation reauthorization level could be well below either the current House or Senate version. However, expectations are that the eventual agreed-upon funding level will still show a substantial increase over ISTEA funding levels -- and that is good news for all of us who have been concerned that we have been falling short in the funding of our transportation infrastructure needs.

Realistically, I think the final figures will probably be somewhat less than the current House and Senate levels -- but remember that the Administration's own proposal for the 6-year program was $175 Billion -- about $20 Billion more than ISTEA, so even a final figure closer to the Administration's original proposal would still represent a substantial increase in overall transportation spending.

Another dilemma which the conferees will face and one which is directly related to the balanced budget issue about which I have been speaking -- is whether the final bill will include the House-passed provision to remove the highway fund from the unified federal budget --or as they say in Washington take the highway fund "off-budget."

The "off-budget" proposal has been floating around for a number of years and has been suggested by those members of Congress who feel that including Highway Trust Fund revenues (which are primarily fuel taxes) to balance the overall federal budget situation, does a disservice to the user fee concept -- in which gas taxes are supposed to be used only for transportation purposes.

If the Highway Trust Fund is taken off-budget, then the reauthorization bill would not be subject to the discretionary spending caps of the annual budget. Since there is a substantial

balance in the Trust Fund, this would force substantial cuts in the programs which remain under the unified budget. My own view, and that is all it is, is that it is unlikely that the final bill will include the off-budget provision. While there is strong support for removal among some House members, the Administration is strongly opposed to it, and the Senate has not been particularly supportive in the past. One idea which has been recently floated is to require that all trust fund receipts of one year be spent the following year. There are sure to be other proposals which would accomplish the objective of making sure that all **transportation user fees are spent on transportation,** without removing the Trust Fund from the unified budget.

Another item which is sure to be a subject of debate in the conference committee is the **issue of demonstration projects.** The use of demonstration projects has been contentious for some years. In **many ways, demonstration projects are a reflection of** the tension between the authorizing committees and the **appropriations committees** in **Congress.**

The authorizing committees are responsible for establishing the program and the overall **funding** level of the **program. However,** under pressure to control spending, the **appropriating committees won** the **right to cap total highway spending** with annual **obligation ceilings which may** be (and almost always are) lower than the level approved by the **authorizing committees. There** are only a few exceptions to the obligation ceilings and one of the most notable is demonstration projects **another is emergency relief** funding, **of which we have made ample use here** in California during this El Nino year.

The House likes demonstration projects, while the Senate generally disapproves of them. The House bill contains some 1,400-plus specifically listed demonstration projects (called high priority projects in the bill) totaling some $9 billion -- about 5% of the bill's total highway funds. They are spread throughout the country, and were allocated on a 55-45 split between Republican and Democratic representatives.

In a recent press conference, Chairman Schuster of the House Transportation and Infrastructure Committee said that while some groups and individuals may **criticize** the inclusion of these projects, it was his view that it was not inappropriate to give 5% of the **decision-making on highway projects to Congress because state** and local officials will still decide where 88% of the funding is used (with **discretionary programs under** the direction of DOT comprising the remaining 7%.)

The Senate, true to **its opposition to demonstration projects, inserted a provision** in its bill which would **require** that **demonstration projects** be included **under** the obligation ceiling. This would eliminate much of the appeal of demonstration projects because it would have the effect of reducing the funding available for the projects proposed by state and local agencies.

The Administration has expressed its strong opposition to demonstration projects by whatever name. So **you can see, this** will be a contentious discussion by the Conference Committee, to be sure. My personal opinion is that the result of the Conference Committee

negotiations will likely be a bill which includes demonstration projects, albeit fewer in both number and dollars than currently appear in BESTEA. In other words, there will be a compromise, which is how most of the differences between the House, the Senate, and the Administration will be settled.

There are other key issues that could hinder the quick passage of a bill, such as the Senate proposal to lower the national threshold for drunken driving to .08% blood alcohol content. Under the Senate bill, the failure of a state to enact the .08 standard by October 1, 2001 would result in the withholding of 5% of apportions. As of October 1, 2002 it would be 10%.

The House version contains provisions which would provide incentive grants to states to encourage the lowering of the drunken driving limit rather than imposing sanctions for failure to do so. Most state leaders are on record as supporting the use of incentives rather than sanctions for the implementation of impaired driving laws.

Another issue is the extension of the reduced tax rate on gasohol. Under current law the reduced tax rate on gasohol would expire on October 1, 1999, and thereafter gasohol would be subject to same tax as gasoline. The Senate has voted to extend the reduced tax rate to the year 2007. The House bill would let the reduced rate expire on schedule.

There are hundreds of other differences between the two bills which also must be resolved some of which will be easier than others. I have only tried to highlight some of the major issues which the conference committee will be debating over the next several weeks.

I think it is important to remember however, that in large part, the main program provisions in both bills continue the direction set by ISTEA in 1991. Programs to fund improvements to the highway system; to repair and replace deteriorating bridges; to mitigate congestion and improve air quality; to implement transportation enhancements; to continue research on new products and ideas; and **to provide expanded opportunities for disadvantaged** individuals and businesses to compete for transportation work are all continued. New programs, including one which would help those making the transition from welfare rolls to payrolls get to where jobs are located, will likely be enacted. And whenever things are finally worked out, we fully expect a long term surface transportation program which includes a substantial increase in transportation spending, most all of which will flow to state and local governments to support sound transportation investments for America's future.

For those of you who wish to keep up to date on the happenings in the Conference Committee deliberations, I would urge you to log on to the FHWA Internet home page at www.fhwa.dot.gov. The home page contains a special section on reauthorization and it is regularly updated as events transpire. It includes the text of both current bills, as well as a side by side comparison of the bills, and a state by state chart of apportionments contained in both the Senate and House bills. One note of caution, the FHWA side by side comparison only addresses the highway provisions. The transit provisions are not included.

Let me now offer some brief speculations about the longer term. For the last 40 years FHWA has focused on building the interstate system, and in the process, it took on a compliance-focused business strategy. Under this strategy FHWA enforced standards, and if states didn't comply, they didn't get reimbursed. We (FHWA) approved states' plans, we inspected their projects, and we dutifully and methodically checked off their progress mile after mile, project after project. And what was the result of our efforts -- only the best and largest public works project the world has ever seen. What FHWA did was absolutely right for the time -- but times have changed.

I think it is important to remember that compliance was an acquired role for FHWA. Long before the Interstate Highway System was a gleam in any president's or engineer's eye, FHWA, and its predecessor agencies, had a long history of delivering a quality highway product.

And how did these predecessor agencies accomplish this? They were experts in "how to." It is important to recall that the original mission of the Office of Road Inquiry (as FHWA was called in 1891) was to construct short sections of "object-lesson" roads throughout the country to demonstrate how good roads should be built. While motoring was still in its infancy, the Office of Road Inquiry set up the first laboratory for testing new materials to build hard surface roads. This hands-on activity continued over the next 30 years until the interstate era. It is my view that in the future, FHWA, and the federal highway program in general, will in some ways return to its roots. It will switch from a compliance focused business strategy, to one of the development and delivery of technology products.

In fact, this change has already begun. Currently, FHWA has a three-tier structure of a headquarters office in Washington, D.C., nine region offices and division offices in each state which report to the region office. The Administrator and the Secretary have under consideration a plan which would eliminate the FHWA region offices, delegate all program responsibility to the FHWA division offices, and establish four resource centers staffed with technical specialists who would function much like consultants to the Divisions and state highway agencies.

I view this proposal as a harbinger of a much more collaborative approach to transportation policy among federal, state, and local agencies. I expect to see much more of it in the future.

Thank you very much for inviting me. I would be pleased to answer any questions you might have concerning reauthorization and I want to assure you that even though these bills are each about 800 pages long and contain thousands of provisions, I have memorized each and every item, no matter how obscure! Seriously, whatever questions you may have, I'll do my best to answer.

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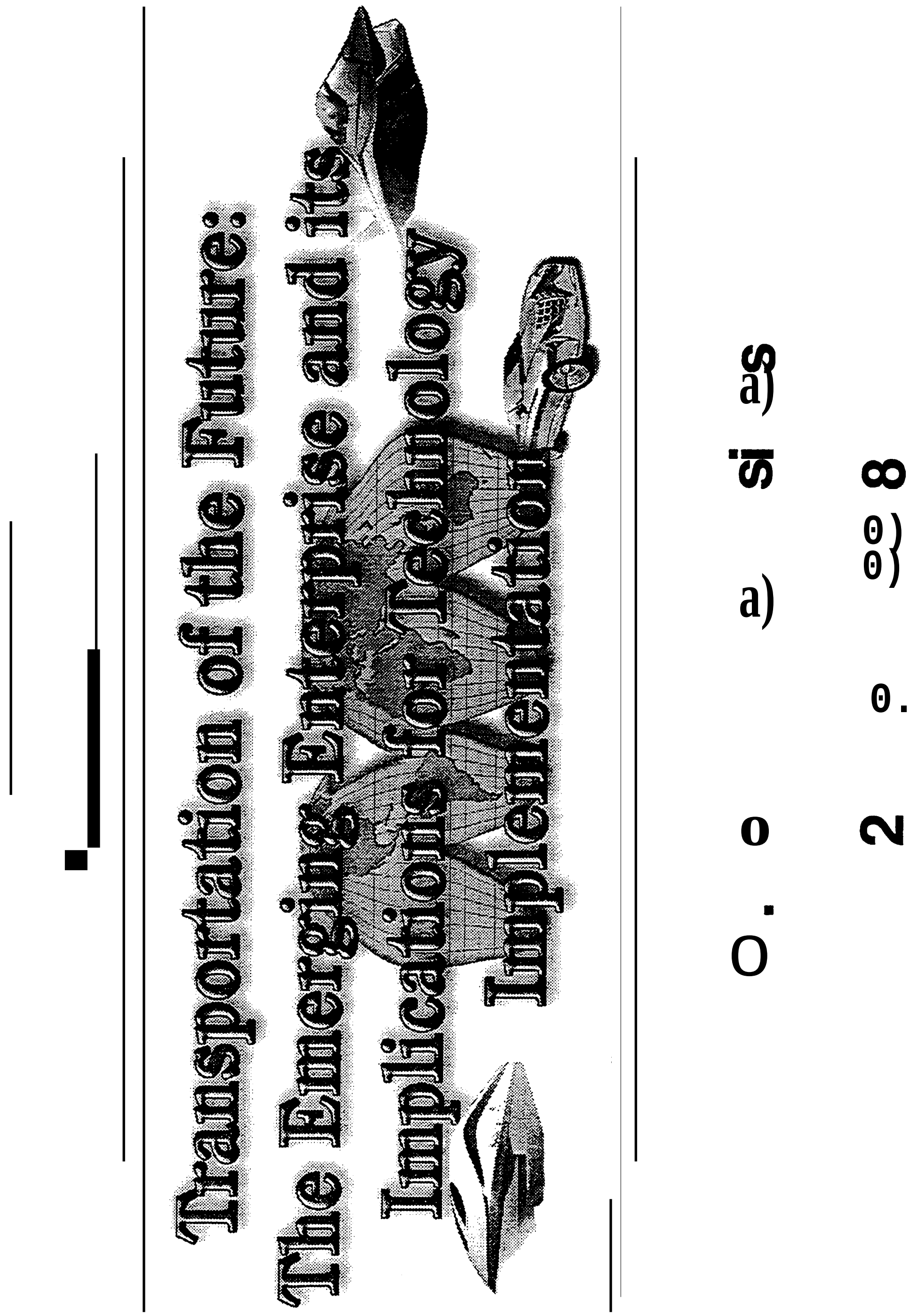
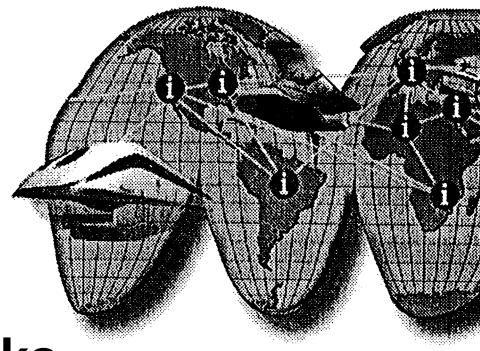
Deployment of New Technology

John Feamsides,
Vice President, The MITRE Corp.(Overheads/Narrative)



Overview



The Emerging Transportation Enterprise

- Information Sharing Networks
- Two examples
  - The Air Traffic Management (ATM) system
  - The Intelligent Transportation System (ITS)

- What Kind of Technology is needed to support this enterprise?

- How should this technology be implemented?

The Emerging Transportation Enterprise

- How is the Internet reshaping the relationsh between suppliers of productsIserVices and customers?

- How are the ATM system and ITS becoming the Internet?

- What are the implications for the enterprise supporting technologies?

How *is* the Internet Changing Supplier/Customer Interaction?

Increased customer access to information

- Chat rooms to compare actual performance of products/services
- Facilitation of bulk buying
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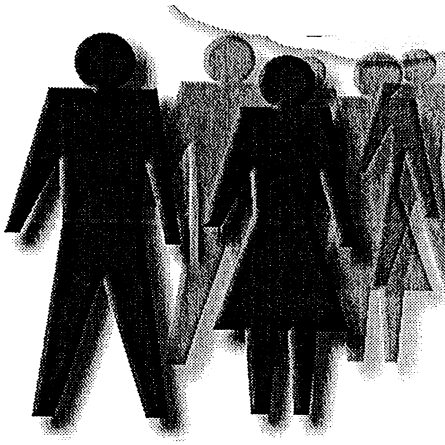
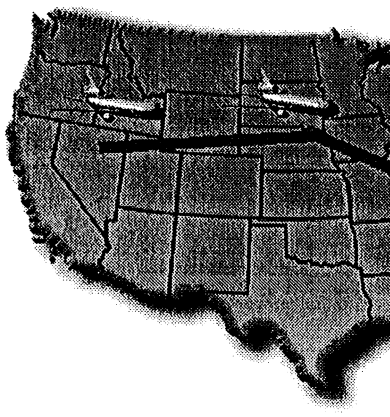


Traffic Flow Management (TFM)

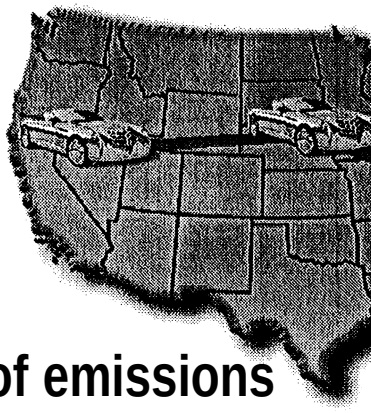
- What is Traffic Flow Management?



- TFM adds a new dimension
  - Air Traffic Control (ATC)–Safety Decisions
  - TFM–Economic decisions
- TFM demonstrates new needs
  - Collaborative decision making (CDM)
  - A network to facilitate the transfer of information

Note: CDM is a component of "Free Flight"

Intelligent Transportation System



- **What is ITS?**
  - Four goals
    - Decrease traffic congestion
      Improve safety
      Reduce the environmental impact of emissions
      Expand the use of public transportation
  - Advanced computer and communications techno
- **Challenges of ITS**
  - Collaboration between federal and state governm
  - Use of existing infrastructure complemented by commercial providers for some services
  - New operational concepts

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Dynamics of User/Provider Interac -TFM

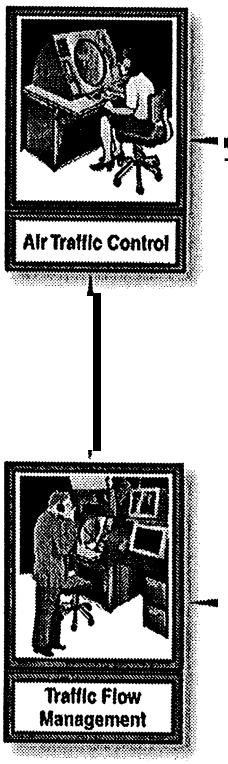
Today

- Decision-making is centralized in FAA
- Economic needs of users not fully understood
- Result: Inefficiency

Dynamics of User/Provider Interac
TFM (Concluded)

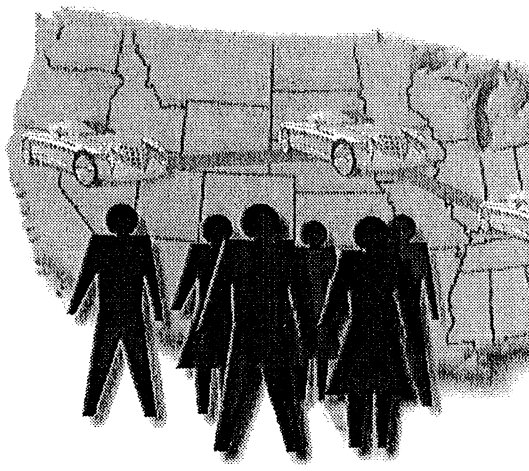
The Future

- More collaborative decision-making
- More information sharing
- FAA will ensure safety
- Users will address efficiencies
- New behaviors will *emerge*



Dynamics of User/Provider Interactions – ITS

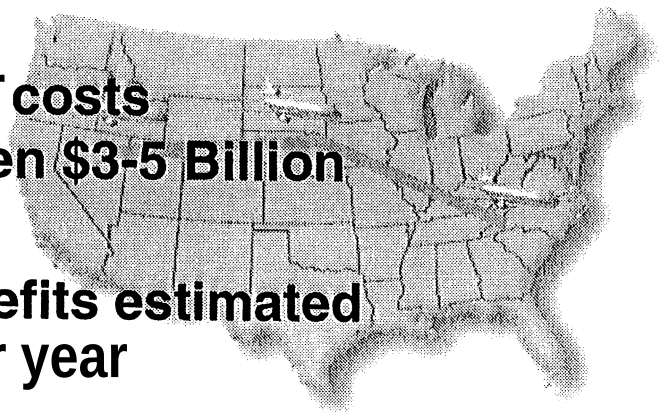
- A unique deployment experience
  - Interacts with the general public
  - Previously, these types of systems interacted only with specially-trained populations



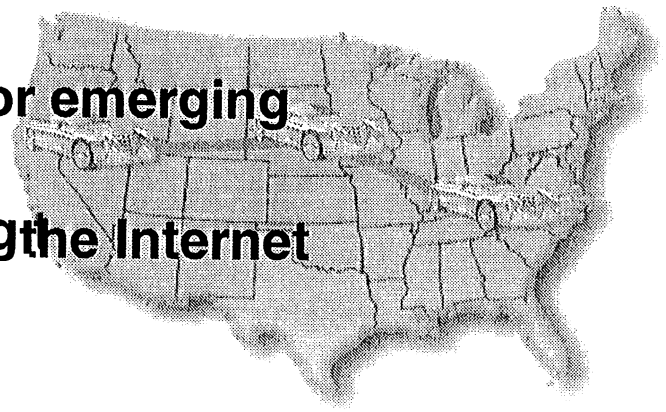
- Human Factors
  - "Lessons-learned"
  -

User Benefits of Collaboration

- **TFM**
  - Excess ATM user costs estimated between $3-5 Billion per year
  - "Free Flight" benefits estimated at $1.5 Billion per year



- **ITS**
  - Reduced costs for emerging technologies
  - Value of bringing the Internet into vehicles



User Dynamics

- **TFM**
  - **"Slot swapping"**
  - **Electronic whiteboard**
  - **Airlines/FAA collaboration**
  - **New roles for dispatchers and controllers**

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- **ITS**
  - **Collaborative decision making**
  - **New roles for drivers, law enforcement, maintenance authorities, emergency services**

Implications for Implementing Technology

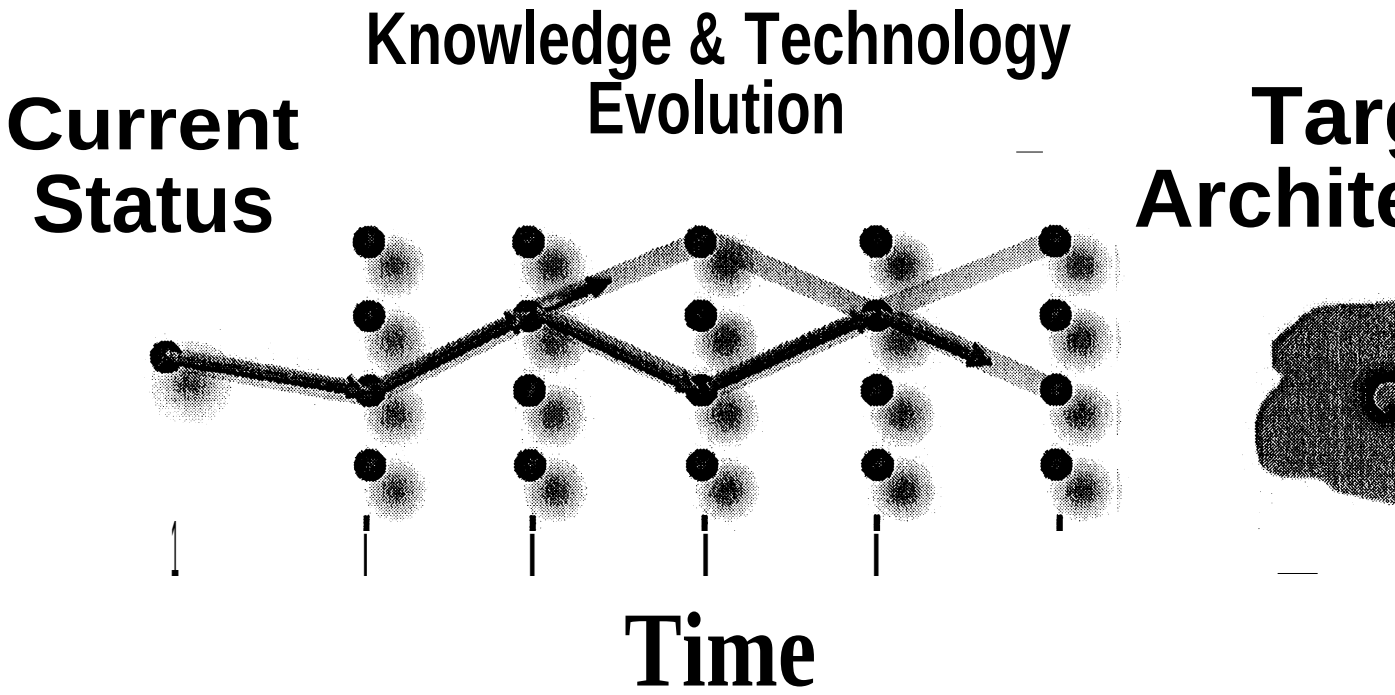
Information technology to support evol
user roles

New applications to support new uses

Complementary evolution of applicatio

- nfrastructure

Implementing New Technology



Example: Free Flight Phase 1

- Early, evolutionary deployment of capabilit
  - Conflict Probe in limited daily use
  - Sequencing and Spacing Tools in demonstratio
  - CDM-enhanced ground delay programs in use

- The impact:
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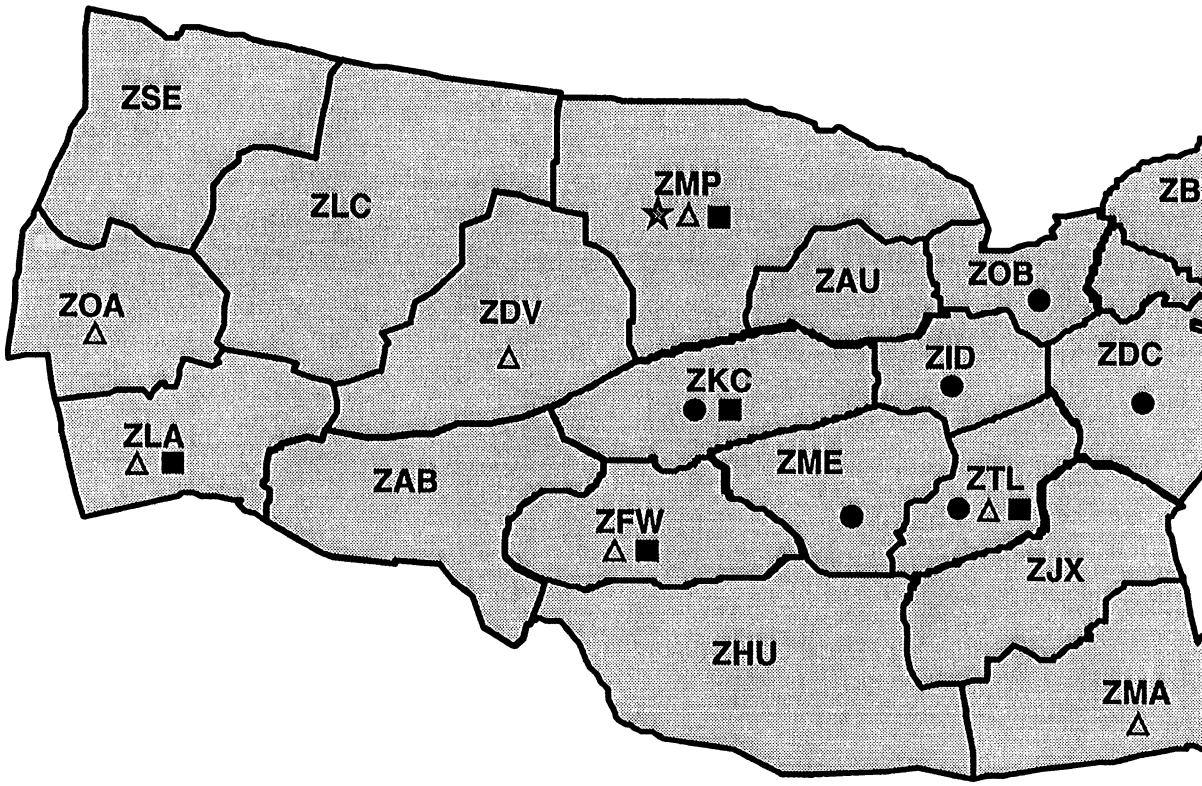
Deployment



- **URET**

ATMA

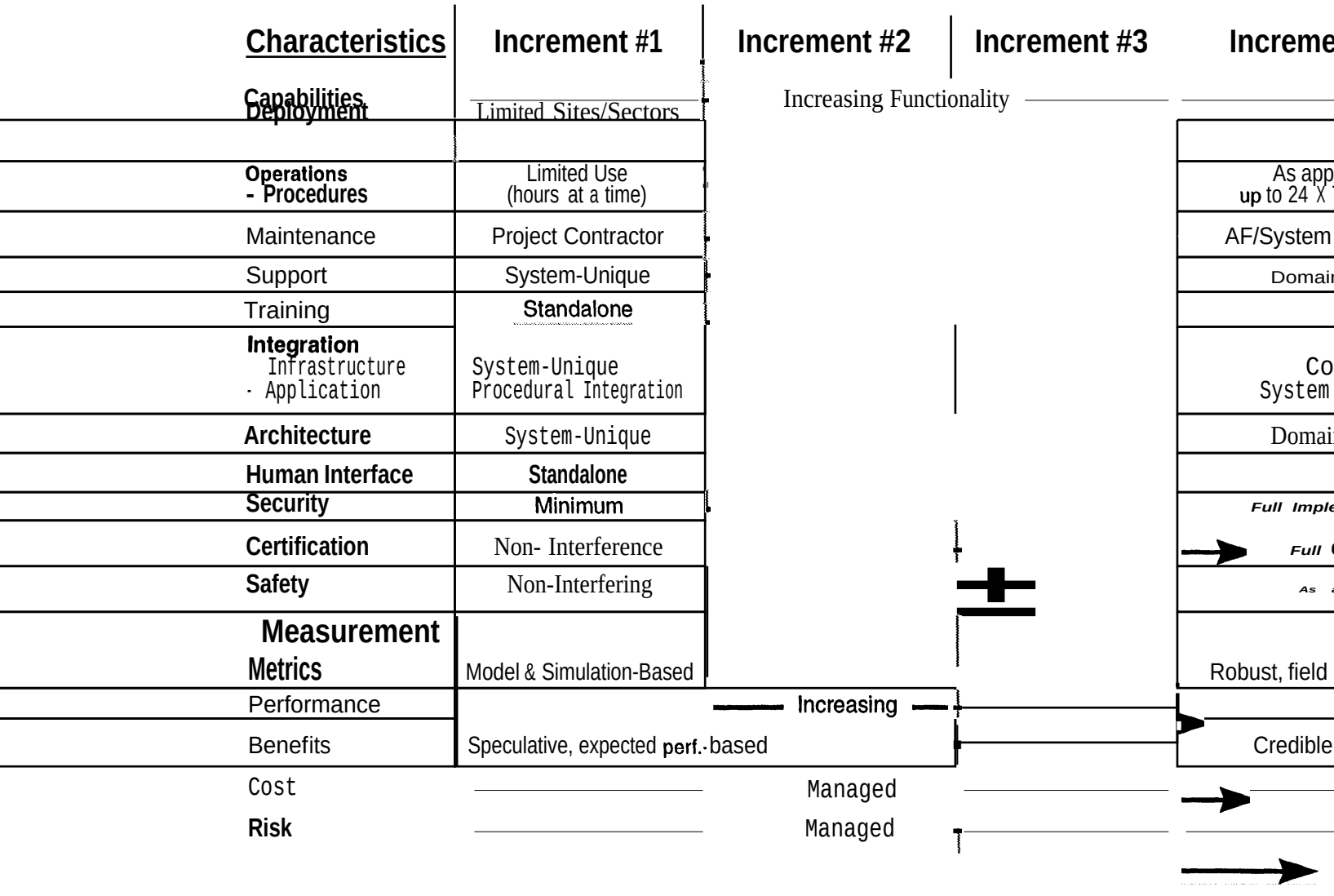
- p-FAST

*

◈ CDM

Note: CDM-S is deployed at ATCSCC

Evolutionary Development



Development of New Technology

- **Free Flight Phase 1 should be different**
  - **Not a classic government procurement**
  - **Not built from abstract specifications**
  - **Meets/matches user expectations**

- **New technology should EVOLVE**
  - **"Harden" what has already been tested**
  - **Think in parallel about next steps**
  - **Work collaboratively with all system users**
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Role of Research in Shaping the Future Transportation System

Robert Skinner,
Executive Director, Transportation Research Board

Research can play a big role in shaping transportation systems and technology, and in fact many of our systems are fruits of such research. But we all know the difficulty of measuring the benefits of research. There are many ways in which transportation improvements change our lives, only some of which can be measured. Examples of areas for which we can demonstrate measurable benefits, attributable in part to research, include air quality, highway safety, and commercial air travel service.

Looking to the future, research - and the innovation process more generally - will not be uniform across the transportation sector because transportation is a collection of autonomous and semi-autonomous, often overlapping systems. The role of research in the future will be shaped by the needs and opportunities presented by these component systems.

No breakthroughs are likely that would fundamentally change the way we use transportation systems or the way they shape our lives. Certainly not like the advent of motor vehicles and airplanes, and the impact they had in the past century.

Information and communication technology will change where and how we live and work. This is the revolution we expect. It could have a profound impact on the demand for transportation. Also, it will change the ways researchers work and interact with each other.

Before us are a rich set of technologies and technological possibilities--new materials, intelligent systems, and so on

A formidable set of problems and issues confront transportation. Issues related to the environment will be of greater importance--how transportation fits into a world of sustainable systems. And decision-making about transportation will be all the more complex as we try to balance a complex set of social, environmental, economic, and community objectives and concerns.

On the public side, we will never have the resources that we think we need based on past standards of performance and upkeep. "Better, faster, cheaper" will continue to be our mantra.

Many of the barriers to innovation that have constrained us in the past will persist (e.g., decentralization and fragmentation)

The private sector role will be more important in the future--as the public sector outsources more and the private sector is given greater incentives to innovate

- As we use up excess capacity, make our systems more efficient with respect to everyday demand, and integrate transportation into the entire production process for manufacturing and business, the systems will become more vulnerable, and the
- consequences of disruptions could be far more severe in the future than they have been in the past

- Finally, the unexpected. We've been taught to expect the unexpected. What will it be: unimagined breakthroughs in smart materials, energy, ways to deal with global warming? Or could the surprise be that we seriously underestimated the impact of information technology? Overestimated?

What do these future challenges mean for research, and what should we change and do differently? I believe that research will be more important than ever, given our increasing concerns related to congestion, safety, and environment. There will be a need for more "soft side" research, reflecting the human and social dimensions of transportation. Hopefully, there will be a growing private-sector role in research. And finally, the process of organizing and undertaking research will become more complex for three reasons.

- It will be more intertwined with implementation issues and public decision-making.
- It must be integrated across more disciplines and more areas of technology.

  It will still be essentially a decentralized enterprise.

Perhaps by focusing on a specific research program, I can illustrate the growing complexity of transportation research and the challenges ahead. The example is close to home - the National Automated Highway System (AHS) Research Program and the consortium established to be its major element. This is a research program authorized in ISTEA, which specified an automated roadway demonstration to be implemented by 1997. The DOT made this requirement part of the work program for the consortium, which was led by General Motors and included PATH and Caltrans. The AHS program was budgeted at roughly $20 million per year, with half of the cost to be borne by the private partners. A special TRB committee began a seven-month review of the AHS program in August 1997. In December 1997, before the TRB committee's report was complete, the DOT withdrew all funding effective September 1998.

The program was designed to address congestion and safety, and it was a bold initiative looking for long-term breakthroughs. However, as conceived and executed, the program faced insurmountable hurdles in the view of the TRB committee. The committee's report contained three main findings.

First, the development, evaluation, and selection of a preferred specification for an AHS in only seven years was unlikely due to daunting technical, social, and institutional issues. It is not enough to recognize and study the myriad barriers to implementation; realistic approaches to overcoming these barriers are needed.

Second, the consortium was given dual, conflicting responsibilities to promote a vision of AHS and to evaluate the prospects of addressing and overcoming the many complicated challenges to AHS. We need grand plans and visions and high-risk research with potentially high payoffs. Such programs are difficult to sell, and it is difficult to transition from selling and building consensus to the business of scientific pragmatism in which

discovering a loser is just as big a "success" as discovering a big winner. We would like a culture where research does not have to be oversold and/or resold. But in the meantime, we especially need mechanisms for independent review of research how it is framed, conceived, and organized.

And finally, the consensus-based management and decision-making structure of the consortium, required by DOT, made it difficult for the consortium to shift in response to either changes in government funding levels and priorities or its own research findings.

Such a structure can be overly cumbersome; and no consortium, no matter how it is organized, can be a substitute for making what will ultimately amount to a political decision. In a sense, choosing a preferred AHS is much more complicated than picking a system to put a man on the moon.

The AHS experience again demonstrated how difficult it is to maintain a sustained commitment to a risky program with payoffs many years in the future. The DOT changed its mind, seeking shorter-term payoffs. We should not stop being creative, and we should apply the lessons leamed so that we can make programs better in the future.

From the Institute of Transportation Studies Extension to the Institute of Transportation Studies Technology Transfer Program: So What?

Linda Howe,
Director, Technology Transfer Program; Institute of Transportation Studies

GOOD MORNING. I AM HUMBLED TO BE IN THIS ILLUSTRIOUS COMPANY, HAVING ARRIVED IN CALIFORNIA SLIGHTLY LESS THAN TWO YEARS AGO, I AM BEGINNING TO FEEL PART OF THE ITS FAMILY. AND, I MUST SAY, IT'S A NICE PLACE TO BE.

IT IS CERTAINLY AN HONOR TO BE HERE AND TO HAVE AN OPPORTUNITY TO TELL YOU A LITTLE BIT ABOUT THE PROGRAM THAT I INHERITED AND AM REINVENTING AS THE INSTITUTE'S FIRST MANAGER OF TECHNOLOGY TRANSFER.

HARD ON THE HEELS OF THE CREATION OF THE INSTITUTE OF TRANSPORTATION STUDIES BY FIAT OF THE CALIFORNIA LEGISLATURE FIFTY YEARS AGO, CAME THE CREATION OF THE INSTITUTE'S STATEWIDE TRANSPORTATION EXTENSION PROGRAM.

ITS EXTENSION, AS IT WAS KNOWN, WAS CHARGED TO PROVIDE TRAINING AND TECHNICAL ASSISTANCE, "EXTENDING" THE RESOURCES OF THE INSTITUTE TO THE STATE'S TRANSPORTATION COMMUNITY AND "TRANSFERRING" THE RESULTS OF RESEARCH DONE HERE.

ITS EXTENSION PLAYED A SIGNIFICANT ROLE IN THE DESIGN, CONSTRUCTION, AND MAINTENANCE OF CALIFORNIA'S WORLD-CLASS HIGHWAY SYSTEM IN THE FIFTIES AND SIXTIES AND SEVENTIES.

WHEN I ARRIVED AT THE INSTITUTE JUST UNDER TWO YEARS AGO, ITS EXTENSION HAD A SOLID AND VENERABLE REPUTATION IN CALIFORNIA AS A SOURCE FOR SHORT COURSES AND WORKSHOPS ON-AS ONE MIGHT GUESS-HIGHWAY CONSTRUCTION AND MAINTENANCE AND TRAFFIC ENGINEERING, TOPICS PRIMARILY DIRECTED TOWARDS PERSONNEL IN CITY AND COUNTY DEPARTMENTS OF PUBLIC WORKS-THOSE FOLKS ON THE FRONT LINE, AS IT WERE-FOR PROFESSIONAL EXCHANGES, INFORMATION, TRAINING, AND TECHNICAL ASSISTANCE IN THE APPLICATION OF INNOVATIVE TRANSPORTATION TECHNOLOGIES.

A MARKETING STUDY PERFORMED IN THE SPRING OF 1996, HOWEVER, INDICATED THAT THE IMAGE OF ITS EXTENSION WAS JUST A LITTLE BIT BORING AND OLD-FASHIONED. ITS EXTENSION WAS THE PLACE YOU CAME TO LEARN THE BASICS OF TRAFFIC ENGINEERING OR HIGHWAY MAINTENANCE, BUT IT WAS NOT WHERE YOU CAME TO LEARN ABOUT ADVANCED APPLICATIONS OF INFORMATION OR SENSING DEVICES OR ABOUT THE LATEST TRANSPORTATION MODELS OR WHAT'S AT THE CUTTING EDGE OF ANYTHING, EXCEPT PERHAPS ASPHALT PAVEMENT MAINTENANCE.

THE MARKETING STUDY LEANT SUPPORT TO A GROWING SENSE IN THE INSTITUTE THAT THE TRANSPORTATION EXTENSION PROGRAM HAD BECOME A LITTLE DISCONNECTED FROM THE RESEARCH GOING ON-PARTICULARLY THE PATH RESEARCH PROGRAM-AS WELL AS FROM NEW IDEAS GENERALLY BUBBLING IN THE INTERCONNECTED, INFORMATION-RICH WORLD OF TRANSPORTATION.

THE PROCESS OF REINVENTION ACTUALLY BEGAN, MAYBE HALF A DOZEN YEARS AGO, LED BY SOME FAMILIAR PEOPLE-ADIB, MARTY, BETTY DEAKIN, DAN SPERLING, MEL WEBBER, AMONG OTHERS. ONE OF THE FIRST ACTIONS TAKEN WAS TO BRING THE ITS EXTENSION PROGRAM BACK UNDER THE DIRECT ADMINISTRATIVE WING OF THE INSTITUTE ITSELF.

FOR THOSE OF YOU FAMILIAR WITH THE INNER WORKINGS OF ACADEME, THIS PROCESS HAS BEEN FULLY AS TIME-CONSUMING AND BYZANTINE AS ONE MIGHT EXPECT. THE NAME CHANGE FROM "ITS EXTENSION" TO "ITS TECHNOLOGY TRANSFER"-LIKE WHAT USED TO HAPPEN WHEN A WOMAN GOT MARRIED-IS A SIGNAL OF CHANGED INSTITUTIONAL RESPONSIBILITY, AS WELL AS DIRECTION.

THE REORGANIZATION IS NOW NEARLY COMPLETE AND HAS RESULTED IN A REINVIGORATION OF OUR SUBSTANTIVE PROGRAM AND PRODUCED A MORE COMFORTABLE "FIT" WITH THE KIND OF PROGRAM WE ACTUALLY ARE. LIKE UNIVERSITY RESEARCH, TECHNOLOGY TRANSFER DEPENDS HEAVILY ON SPONSORED PROJECTS-OR SOFT MONEY. FROM A BUDGETARY STANDPOINT, THIS PROGRAM HAS APPROXIMATELY DOUBLED IN SIZE OVER THE PAST DECADE. TODAY OUR ANNUAL BUDGET IS WELL OVER A MILLION DOLLARS, WITH MAJOR GRANTS AND CONTRACTS FROM CALTRANS, THE FEDERAL HIGHWAY ADMINISTRATION, AND THE CALIFORNIA OFFICE OF TRAFFIC SAFETY.

THE SHORT COURSES, CONFERENCES, NEWSLETTERS, BRIEFINGS, TECHNICAL ASSISTANCE, AND LIBRARY INFORMATION SERVICES THAT WE SPONSOR- "TOUCH" SOME 4000 PEOPLE ANNUALLY. THAT'S A BIG REACH. THE NAME CHANGE HAS ALSO HELPED STAFF BEGIN TO RE FOCUS ON NEW PROGRAM DEVELOPMENT, INNOVATION, AND WAYS TO SUPPORT THE INTERACTION OF RESEARCH AND PRACTICE DURING THE SOMETIMES FRUSTRATING PROCESS OF ADOPTING AND IMPLEMENTING NEW TECHNOLOGIES.

AS WE MOVE AHEAD, WE WILL KEEP THE BASIC TRAINING PROGRAMS FOR WHICH WE HAVE BECOME KNOWN, BUT WATCH FOR SOME MAJOR EXPANSIONS INTO AREAS SUCH AS ADVANCED TRANSPORTATION SYSTEMS, SIMULATION MODELS, COLLABORATIVE PLANNING, AND AIRPORT OPERATIONS.

FOR THOSE OF YOU WHO MAY BE A BIT HESITANT ABOUT THE LINGO, "TECHNOLOGY TRANSFER" GENERALLY REFERS TO THE PROCESS OF MOVING A TECHNOLOGY FROM ONE VENUE TO ANOTHER. A TECHNOLOGY IS BROADLY THE PRACTICAL APPLICATION OF AN ORGANIZED BODY OF THEORY AND KNOWLEDGE-WE THINK IN TERMS OF TOOLS, METHODS, COMPLEX PHYSICAL SYSTEMS.

WE COMMONLY TALK ABOUT TECHNOLOGY TRANSFERS FROM COUNTRY TO COUNTRY, FROM ONE INDUSTRY TO ANOTHER INDUSTRY, AND FROM THE RESEARCH LAB TO WORKPLACE. RECENTLY, IN SOME CIRCLES, TECHNOLOGY TRANSFER HAS COME TO MEAN THE PROCESS OF COMMERCIALIZING PRODUCTS THAT COME OUT OF THE RESEARCH LAB. INDEED THERE ARE SPECIAL OFFICES OF THE UNIVERSITY THAT DO THIS-FOCUSING ON PRODUCTION OF VENTURE CAPITAL, PATENTS, AND SO ON.

THIS IS NOT THE CHARGE OF THE ITS TECHNOLOGY TRANSFER PROGRAM. INSTEAD, OUR CHARGE STILL LOOKS A LOT LIKE THE OLD AGRICULTURE COOPERATIVE EXTENSION, BUT WITH A MORE CONTEMPORARY, 21ST-CENTURY TWIST AS IT WERE, DESIGNED TO LINK US BACK CLOSER TO THE

INSTITUTE'S RESEARCH PROGRAM, DISSOCIATE OUR PROCESSES AND INTERESTS FROM THE SELF-SUPPORTING, CONTINUING EDUCATION PROGRAM OF UNIVERSITY EXTENSION, AND MAINTAIN A MORE PRO-ACTIVE APPROACH TO SUPPORTING ADOPTION AND IMPLEMENTATION OF APPLICATIONS BASED ON ACADEMIC RESEARCH RESULTS.

THIS TRANSFER PROCESS IS SOMETHING TO PAY ATTENTION TO IN THE UNIVERSITY BECAUSE SUCCESSFUL TECHNOLOGY TRANSFERS HELP JUSTIFY TO PUBLIC FUNDERS THE USEFULNESS OF RESEARCH PROJECTS.

BECAUSE A LOT OF LEARNING ON BOTH SIDES GOES ON DURING A TECHNOLOGY TRANSFER, SUPPORTING THIS PROCESS FITS WITH THE UNIVERSITY'S BROAD EDUCATION MISSION-NOT TO MENTION THE INSTITUTE'S OWN SPECIFIC CHARGE. -AND BECAUSE TECHNOLOGY TRANSFER ITSELF IDENTIFIES IF NOT CREATES NEW RESEARCH OPPORTUNITIES.

NEW TECHNOLOGY APPLICATIONS HAVE A STRONG TENDENCY TO UNDERGO CHANGE AS THEY MOVE FROM ONE ARENA TO ANOTHER: PEOPLE NOT ONLY NEED TO LEARN NEW CONCEPTS AND HOW TO USE NEW TOOLS, BUT THERE IS ALSO A KIND OF ORGANIZATIONAL "NESTLING" PROCESS THAT GOES ON AS PEOPLE-THOSE ORNERY INTELLIGENCES THAT PERSIST IN TINKERING WITH THINGS-TAILOR IDEAS AND METHODS TO FIT DIFFERENT PURPOSES, DIFFERENT CULTURAL HABITS AND REQUIREMENTS, AND DIFFERENT PARAMETERS FOR HOW AN APPLICATION MUST FUNCTION.

AS THEY DO THIS, THEY MORE OFTEN THAN NOT ASK IMPERTINENT QUESTIONS, REVEAL NEW KINDS OF PROBLEMS THAT NEED SOLVING, AND EVOLVE NEW AREAS FOR RESEARCH-AT LEAST FOR THOSE WHO ARE LISTENING. WHICH IS WHAT MAKES TECHNOLOGY TRANSFER INTERESTING.

AS I SEE IT, THE PURPOSE OF OUR TECHNOLOGY TRANSFER PROGRAM IS TO HELP SPEED UP ADOPTION AND IMPLEMENTATION ADVANCES. WE NOT ONLY WANT TO DISSEMINATE INFORMATION ABOUT NEW IDEAS, BUT ALSO TO EASE THE TRAUMA AND RELIEVE THE UNCERTAINTIES ASSOCIATED WITH INNOVATION. OUR BASIC TOOLS FOR MAKING THIS HAPPEN ARE EDUCATION, TRAINING, INFORMATION, AND TECHNICAL ASSISTANCE EXPLICITLY DESIGNED TO ADDRESS SPECIFIC WORKPLACE APPLICATIONS.

AS WE ENTER THE NEXT FIFTY YEARS, OUR MISSION AT THE ITS TECHNOLOGY TRANSFER PROGRAM IS TO STRENGTHEN THE BRIDGE BETWEEN RESEARCH AT THE UNIVERSITY OF CALIFORNIA INSTITUTE OF TRANSPORTATION STUDIES AND TRANSPORTATION PRACTICE IN ORDER TO FACILITATE AND SUPPORT THE PLANNING, DESIGN, CONSTRUCTION,

OPERATION, AND MAINTENANCE OF EFFICIENT AND EFFECTIVE STATE-OF-THE-ART TRANSPORTATION SYSTEMS.

WE WILL DO THIS BY: NURTURING COLLABORATION BETWEEN RESEARCHERS AND PRACTITIONERS; PROVIDING TRAINING, TECHNICAL ASSISTANCE, AND INFORMATION THAT BUILD SKILLS AND KNOWLEDGE NEEDED TO DEPLOY MODEL SURFACE AND AIR TRANSPORTATION SYSTEMS; PARTICIPATING IN THE DESIGN OF IMPLEMENTATION AND EVALUATION STRATEGIES FOR FIELD OPERATIONAL TESTS; CONDUCTING RESEARCH ON TECHNOLOGY TRANSFER INTO TRANSPORTATION PRACTICE; USING ADVANCED TECHNOLOGY TO PROMOTE TECHNOLOGY TRANSFER; AND BUILDING AWARENESS OF AND INVOLVEMENT IN TECHNOLOGY TRANSFER PROGRAM ACTIVITIES.

OUR VISION IS THAT THE INSTITUTE'S TECHNOLOGY TRANSFER PROGRAM WILL BECOME A MAJOR INTERNATIONAL CENTER FOR ADVANCED PROFESSIONAL EDUCATION AND TECHNOLOGY SHARING IN TRANSPORTATION ENGINEERING, PLANNING, AND MANAGEMENT. WE ARE BUILDING A PROGRAM THAT PUBLIC AND PRIVATE AGENCIES WILL TURN TO FOR PROFESSIONAL EXCHANGES, INFORMATION, TRAINING, AND TECHNICAL ASSISTANCE ON THE APPLICATION OF INNOVATIVE TRANSPORTATION TECHNOLOGIES.

IN CALIFORNIA, THE ITS PROGRAM WILL BE THE HUB OF SUCH ACTIVITY AND PLAY A VISIBLE AND CRITICAL ROLE IN THE SUCCESSFUL CREATION AND DEPLOYMENT OF A 21ST CENTURY TRANSPORTATION SYSTEM THAT IS EFFICIENT, SUSTAINABLE, INTEGRATED, MULTI-MODAL, AND THAT IMPROVES THE QUALITY OF PEOPLE'S LIVES.

I EXTEND AN INVITATION TO WORK WITH US TO ACHIEVE THIS VISION. THANK YOU.

Institute of Transportation Studies Library: The Next Generation

Catherine Cortelyou,
Librarian; Institute of Transportation Studies

So many of you are people who have used the library for years, or people I have known as voices on the phone, or as authors listed in our catalog. It's been a great pleasure having a reunion with you or meeting you face-to-face for the first time during this 50th birthday celebration. So I feel as though I'm talking today to a group of friends. I am also very much aware of my position as the last speaker on the last panel just before lunch. I'm sure, as friends, you want me to get right to the point.

The point is generational change: changing technology, changing social and cultural

expectations. The temptation when speaking of libraries and information technology is to fall into glowing descriptions of the wonders that lie ahead, to paint a picture of what the next generation will be like. But in fact, this audience already has a pretty good idea. You know about databases and CD-ROMs and the Internet, and for many of you these are essential tools of your daily work. If you read the *Wall Street Journal* or business magazines or even United Airlines' latest in-flight magazine, you know that information management has become a critical issue for both the private and public sectors. You know that information technology is volatile, changing almost daily as new machinery and new software hits the market. You may be aware that 'Moore's Law' is holding true: computer chip speed and capacity are doubling about every 18 months.

My grandmother, who was a teenager when the Wright Brothers first flew, watched every NASA moon launch on TV. I hope I retain that same capacity for awe when I reach 90 and look back on the changes in the information world. We cannot predict exactly what form the new technologies will take, but they will be astonishing.

Although libraries are plagued with a public image as musty, conservative repositories sternly managed by a hopelessly out-of-touch librarian with glasses on a chain around her neck and a propensity to say "SSSSHHHH!", the truth is that libraries have always been at the forefront in seizing and exploiting **new technologies for information management.** Not all that long ago, library catalog cards were hand-written and library schools included a **class** in penmanship. Then came that **wonderful invention,** the typewriter! When I was in library school in the 1970's, catalog cards were still laboriously hand-typed, then duplicated by mimeo or that new machine, the photocopier. In library school they showed us a film about computer library catalogs— they didn't have a real computer to show us. Today on-line library catalogs, CD-ROMs, proprietary bibliographic databases, microforms, web sites and electronic communications are all everyday tools of the trade.

The library world is actively addressing both the opportunities and the implications of the **new technologies:**

The State of California and the University of California systemwide have launched an **initiative for a** "Digital Library" to put massive amounts of research literature, numerical data, and visual images of maps, artifacts and scientific specimens on the web in a format that is organized, indexed and systematic--quite an improvement over the results of the usual web search—and open to access by all. A library without walls.

The old Library School at UC Berkeley has re-constituted itself as the School of Information Management and Systems, with an interdisciplinary faculty expert in **technology, cognitive science, economics,** and law, in order to address the broader social, economic and ethical issues created by escalating efficiencies in **information management.**

We have the opportunity for growth in transportation, as well. The Bureau of Transportation statistics, with the support of the Secretary of Transportation, has included in the ISTEA renewal package language which would establish and fund a National

Transportation Library, bringing to transportation researchers and practitioners the benefits enjoyed for years by medicine, agriculture, and other fields through their federally-funded national libraries. Unlike those libraries, however, the National Transportation Library would not take form as a monolithic edifice in Washington, D.C. Instead, it would use the new information technologies to enhance and support existing transportation libraries in a national network of information collections and information sharing. At this point, the National Transportation Library is very broadly described, and its exact form has yet to be worked out.

I cannot come right out and use this podium to take a public position on pending legislation, *but...* I can tell you that this is an extraordinary opportunity for ITS Library, the Transportation Library at Northwestern, and the state DOT libraries. It will strengthen us all. The conference hearings on this part of the ISTEA legislation are scheduled for next week. If you'd like more information, including a list of committee members to contact, there's a handout on the registration table in the lobby.

So, change is happening in the library world in general and in transportation libraries in particular. As other speakers have discussed, the technological changes and the social/cultural changes are not happening at equal rates. In fact, as far as library users go, we are still very much in transition. Professor Newell proudly maintains his office as a "computer-free zone." Some library users approach the online catalog with great trepidation, hitting a computer key and then jumping back as though something awful, or something wonderful, is about to happen. A new book by Don Tapscott, *Growing Up Digital,* tells us that two-thirds of American children over age 6 know how to use computers. They will soon be our students, and before we know it they will be our next generation of faculty.

This generation is comfortable with the new technologies but perhaps not aware of its limitations. Some students today see the computer as the ultimate and only source of information and assume that if it's not in the computer it does not exist. I got a call from a student who had found our library web site and wanted me to help him with a paper because his own university had nothing on transportation. What he meant was, he had found nothing on transportation in his own university library's web site. "Have you spoken with your own university librarian, " I asked. "Well, no..." he said. "What university do you go to?" He replied, "Harvard." I gave him a telephonic kick in the initiative and sent him offto discover the extraordinary resources of his own university. He had to be educated in the realities of today's library world, a world in transition. Perhaps his notions of research were simply rooted in expedience, but it is also possible that he was influenced by a popular culture which idolizes the computer.

One image of the computer library is shown in *Star Trek.* You know *Star Trek.* Even if you don't watch it regularly you're familiar with the premise: through all its series and sequels there are new technologies, new aliens, new adventures in galaxies and worlds where "no man has gone before." Assisting the star ship crew is a know-it-all computer library containing all the accumulated knowledge of the known universe, which somehow has the

intuitive perception to give just the right answer.

The captain might ask it, as one student asked me, "Do you have anything on transportation?" and the computer would uncannily reply with the specific piece of data the captain needs, say a trip generation rate for supermarkets. On TV, the computer never spits out odd results or overwhelming quantities of information. We are a long, long way from *Star Trek: The Next Generation.* We may have doubts: *Star Trek* may not even be a desirable model of information management. What is unquestionable, though, is that we are on a fast track to a new paradigm in information management— both institutional and technological— and we somehow have to get from here to there.

At ITS we are extremely fortunate to be starting well ahead in the process. Beverly Hickok, our founding librarian, established a tradition of excellence in the scope and depth of the collection she started and set a model of personal, personable service which we work to continue today, and which cannot be replaced by all the whiz-bang technology in the world. Beverly is here, but the one thing she really hates is to be singled out in public, so Beverly, don't stand up, and the rest of you, don't applaud unless you really can't help it.

Thank you, Beverly.

Mike Kleiber, who succeeded Bev as head librarian, brought us into the computer age, occasionally kicking and screaming. To Mike we owe the conversion of the old card catalog into computer readable records and the inclusion of our records not only in the University's systemwide online library catalog, but also in the national TRIS database and now the TRANSPORT CD-ROM, an international bibliographic transportation database sponsored by OECD. Mike also developed the PATH database, creating the most comprehensive guide to literature concerning intelligent transportation systems. On the web it has thousands of users a month from all over the world.

Dan Krummes, who is my co-director in the library— we share the position of head librarian— has negotiated exchange agreements with numerous overseas transportation research organizations, greatly expanding the scope and coverage of our collection. Dan sets the standard for transportation library cataloging nationally.

We now have a global collection and users from all over the world. The Harmer E. Davis Transportation Library now consists of nearly 300,000 volumes and is recognized worldwide as an outstanding resource for transportation research. Dan and I are constantly conscious that we are responsible for an extraordinary heritage, made possible by the directors and faculty of ITS. It is the strength of this heritage that makes it imperative for us to move into the next generation of information management, to exploit the possibilities and enhance services to our users.

What are the first steps? My highest priority is addressing issues of inter-campus service to Davis and Irvine, our sister units of ITS, as well as expediting service to our constituencies at Berkeley, Caltrans, and remote sites— the telecommuting library users. At

the very least, we could be scanning requested articles and transmitting them electronically to speed delivery time. This is already standard library procedure in larger institutions. All branches of our Institute could be publishing our reports on the web. At Berkeley we should take our archives of Institute publications from 1948 on and make them accessible full-text on the web. These are simple and not terribly imaginative uses of available technologies, but they are our next steps.

With long-range inter-campus planning and coordination of our Institute computing facilities with our library facilities, I am confident that the Institute in the next generation will provide a state-of-the-art information resource which meets the human and intellectual needs of its users.

Through the web and electronic communications we are now serving a global community. This week I've had requests for information from Germany and Korea, private companies and other universities in the U.S., and continuations of ongoing email reference dialogues with doctoral students at other UC campuses. Through the Technology Transfer Program I've also had inquiries from several California cities. With the exception of Technology Transfer the library is funded by the Institute for the Institute.

We refer some private-sector clients to private-sector information brokers, and we generate revenue from fees for loans and copies. Still our library public services often resemble a triage operation. Demand exceeds capacity. We need to broaden our base of support from outside the Institute, from state and federal levels as well as the private sector, if the library is to maintain its excellence and continue to provide service to all sectors of the transportation community.

So far, I've spoken of the library in glowing terms and I am very, very proud of it. But I'm here among friends, so let me get real for a moment and tell it like it is. Our hopes for the future, for the next generation of the library, stem from the pursuit of excellence. But they also stem from dire necessity.

Let me tell you frankly about two things:

First, most of the collection is included in the on-line catalog, but not all. A critical gap is the articles which were indexed in the old card catalog prior to 1984, which is the year we were given the means to create online records for joumal and proceedings articles. As you well know, there is no comprehensive published or online index for articles in transportation, and as you well know, the transportation community began publishing articles well before 1984. Retrospective conversion of these catalog records is essential to us today and critical to continuing scholarship which will rely increasingly on the new information technologies. In the library we are making do with a microfiche copy of the old catalog, but this information is not accessible outside our walls.

Second, our facilities. There is no room in the library to add more desks, personnel, or computers for users. There is no room to add more books— our collection is growing at a

rate of about 3,000 a year— and for each item that comes in, one has to be put in storage or discarded. This is labor-intensive for library staff and costly in terms of time for library users who need items in storage, but we are making do.

It rained last night— no news to those of you who were at the barbecue. The first thing we had to do this morning was check for leaks. It's not the roof, which has been patched many times, it's the walls of McLaughiin Hall which now are admitting water. Until seismic rehabilitation in about 2003, we have to live with it and the toll it takes on our books as physical artifacts. The University has offered us unlimited quantities of plastic sheeting, and we are making do.

As Prof. Kanafani said in the opening session of this Symposium, we at the Institute have many years of practice at making the best of limited resources. We are very good at making do. But we have reached a point in the growth of our collection, the accessibility of our collection, the level of service we can provide in the library where making do is getting in the way of just doing it

Franldy, among friends, we have go to do better. And we have got to do it together. The next generation of the library depends on all of us.