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TRANSPORTATION RESEARCH AND DEVELOPMENT: APPLICATIONS AND OPPORTUNITIES IN THE DENVER REGION

FIELD HEARING

BEFORE THE

COMMITTEE ON SCIENCE
HOUSE OF REPRESENTATIVES

ONE HUNDRED EIGHTH CONGRESS

SECOND SESSION

JUNE 4, 2004

Serial No. 108–62

Printed for the use of the Committee on Science

Available via the World Wide Web: http://www.house.gov/science

U.S. GOVERNMENT PRINTING OFFICE

94–016PS WASHINGTON : 2004

For sale by the Superintendent of Documents, U.S. Government Printing Office
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TRANSPORTATION RESEARCH AND DEVELOPMENT: APPLICATIONS AND OPPORTUNITIES IN THE DENVER REGION

FRIDAY, JUNE 4, 2004

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE,
Washington, DC.

The Committee met, pursuant to call, at 9:30 a.m., in the Broomfield City Council Chambers, Broomfield Municipal Center, One Descombes Drive, Broomfield, Colorado. Hon. Ken Calvert presiding.

COMMITTEE ON SCIENCE
U.S. HOUSE OF REPRESENTATIVES

Transportation Research & Development: Applications & Opportunities in the Denver Region

Friday June 4, 2004
9:30 a.m. to 11:30 a.m.
Broomfield City Council Chambers

Witness List

Mr. Guillermo Vidal, Manager of Public Works for the City and County of Denver.

Mr. Jayson Luber, Helicopter News/Traffic Reporter for the Denver radio station KOA.

Mr. Carlos Hernandez, Transportation planner who has worked for Charlier Associates.

Dr. JoAnn Silverstein, Chair of the Department of Civil, Environmental & Architectural Engineering at the University of Colorado.

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HEARING CHARTER

COMMITTEE ON SCIENCE
U.S. HOUSE OF REPRESENTATIVES

Transportation Research and Development: Applications and Opportunities in the Denver Region

FRIDAY, JUNE 4, 2004
9:30 A.M.–11:30 A.M.
BROOMFIELD CITY COUNCIL CHAMBERS
BROOMFIELD MUNICIPAL CENTER
ONE DESCOMBES DRIVE
BROOMFIELD, CO 80020

Purpose

On Friday, June 4, 2004 at 9:30 a.m., the Subcommittee on Environment, Technology and Standards of the Committee on Science will hold a hearing on Transportation Issues in Colorado with a focus on the Region of Denver: Research Applications and Opportunities.

Every six years Congress authorizes expenditures for the Nation's surface transportation projects. While the Transportation and Infrastructure Committee has primary jurisdiction over most of the programs in this area, the Committee on Science has oversight and legislative jurisdiction over the research, development and demonstration programs.

The R&D programs are in Title V of the transportation bill. Most of the funds for these programs are authorized for appropriation out of the highway trust fund ($468 million in FY03). There are seven broad categories of transportation R&D: 1) Surface Transportation Research; 2) Technology Deployment; 3) Training and Education; 4) Bureau of Transportation Statistics; 5) Intelligent Transportation Systems (ITS) Standards, Research, Operational Tests, and Development; 6) ITS Deployment; and 7) University Transportation Research.

Table 1. Research Organizations and their general purpose and focus.

Research Organization	Time Horizon	Type of Work	Geographic Scope
Federal Highway Adm.	Medium to Long	Broad disciplinary focus on issues of national concern	Regional to National
National Cooperative Highway Research Program	Medium to Long	Broad disciplinary focus on regional and multi-state issues	Regional
State DOT	Short	Applied focus on state operational needs including focus on technology transfer	State
University Transportation Centers	Project dependent – could be short, medium or long	Independent and cooperative research; focus on training; mix of applied and basic research	Mixed
Strategic Highway Research Program (SHRP & F-SHRP)	Short to Medium	Focused on specific, well-defined list of applied research needs	Regional to National

Transportation Issues in the Denver Region

Between 1985 and 1995, traffic on Colorado's highways, particularly on the interstate highways, increased by 43 percent. By 2000, the Texas Transportation Institute ranked the Denver area the seventh most congested metropolitan area in the country. The interchange at I–25 and I–225 in the southeast corridor was ranked the 14th busiest in the Nation.

The area known as the southeast corridor connects two major centers of employment in Denver, the Denver Central Business District (downtown) and the Southeast Business District which includes the Denver Tech Center. The Denver Tech Center developed in the early 1980s continued to expand and to encourage other development in the area south of Denver. Over the past decade the southeast area of

Denver has been among the fastest growing areas in the country. Growth in the outlying communities surrounding Denver has also been substantial. While this has brought many benefits, traffic congestion and delays have increased and as in other areas, vehicle miles traveled has grown faster than population.

Communities in the mountains have expanded along with their tourism-based economies. Skiing, golfing, hiking and other outdoor recreational activities have drawn increased numbers of tourists and year-round residents to these communities. The major route connecting tourists to these resort areas is I–70 which has become increasingly congested over the past decade. In addition, when snowstorms, avalanches, rock slides or accidents occur along I–70—which happens frequently—this arterial shuts down for hours, dramatically impacting the economy of Colorado's western communities as well as the movement of interstate commerce.

The desire to maintain the environmental amenities that draw people to the region and the need to maintain mobility of people, goods and services is placing an increasing strain on the current transportation system. This is leading communities in these areas to look at multi-modal solutions to their transportation problems. These include expansion of existing interstate capacity, expansion of mass transit, and increased bicycle and pedestrian networks.

Current transportation projects in the Denver area include the Transportation Expansion Project (TREX) and the Downtown Multi-modal Access Plan (DMAP).

The TREX project began construction in 2001 and will be completed in 2006. The project is located in the southeast corridor. TREX is a multi-modal project that includes widening of Interstate 25, the major north-south route through Denver, and a light rail line. The project requires cooperation between CDOT which is responsible for the highway widening portion of the project, DCOG the metropolitan planning organization for Denver, and the Regional Transportation District (RTD) which is responsible for the light rail portion of the project. The TREX project is funded through several sources including federal transportation funds provided to Colorado.

The Downtown Multi-modal Access Plan is a new project of the Department of Public Works. The 25-year plan will include proposals for vehicular, pedestrian, bicycle and rail access into and throughout Downtown Denver. It will also include long-term land-use planning, infrastructure and other elements that will connect downtown Denver to the adjacent communities. DRCOG, CDOT, and RTD are all involved in this planning exercise with the city and county of Denver.

Witnesses: Their Backgrounds and Institutions

Mr. Guillermo Vidal, Manager of Public Works—Denver:

Mr. Vidal is the current Manager of the Department of Public Works for the City and County of Denver. Prior to his current position he served as Executive Director for the Denver Regional Council of Governments. Mr. Vidal also served as the Director of the Colorado Department of Transportation (CDOT) under Governor Roy Romer.

The Department of Public Works is responsible for all road maintenance and repair and for waste management and storm drainage systems in the city and county of Denver. The Department manages design and construction of streets, bridges, and public buildings. Transportation services include parking management, transportation planning, and engineering.

The Denver Council of Regional Governments (DRCOG) is the metropolitan planning organization for the Denver region. It is a voluntary association of 50 county and municipal governments in the Denver area. Member counties include Adams, Arapahoe, Jefferson, Gilpin, Clear Creek, Broomfield, Boulder, Douglas, and Denver. DRCOG address issues including growth and development, transportation, services for senior citizens, environmental issues, and performs analyses of economic and development trends.

The Colorado Department of Transportation is responsible for the 9,142 miles of highway throughout the State of Colorado. Ten percent of these highway miles are part of the Interstate highway system, but they account for forty percent of the highway travel in Colorado. CDOT also supports aviation throughout the state with grants to local airports through the Division of Aeronautics. CDOT's Transit unit assists the transit systems throughout the state.

Mr. Vidal will provide an overview of transportation issues in Colorado with a focus on challenges in the Denver region. He will discuss the linkage between the state and federal transportation research and development enterprises and the application of transportation research to conditions in Colorado.

Mr. Jayson Luber, 850 KOA Helicopter News/Traffic Reporter:

Mr. Luber has served as the Helicopter News/Traffic Reporter for the Denver radio station, 850 KOA since May of 2001. Mr. Luber reports on traffic conditions in the Denver area to commuters during the morning and afternoon. Mr. Luber also reports for 9NEWS, the National Broadcasting Corporation affiliate in the Denver area.

Mr. Luber will discuss the areas with recurring traffic problems in the Denver region and the factors that contribute to traffic delays during commuting times.

Mr. Carlos Hernandez, Charlier Associates:

Mr. Hernandez is a transportation planner who has worked for Charlier Associates since 1998. Mr. Hernandez has experience in local and regional multi-modal transportation planning projects with expertise in transportation plan development, multi-modal transportation integration, trail design, and GIS development.

Mr. Hernandez has worked on a variety of projects in Colorado including: mapping of existing bicycle facilities in the U.S. 36 corridor to identify gaps in the existing trail system and conducting a peer study for the Colorado Department of Transportation to evaluate the relationship between land use patterns and passenger rail systems.

Charlier Associates, Inc. is a multi-modal transportation planning firm that has been based in Boulder, CO since 1993. Charlier specializes in the use of innovative approaches to improving mobility. Their clients include states, towns, cities, counties, regional agencies and transit service providers. Charlier has worked extensively with medium-sized cities to develop transportation programs that address the specialized needs of mountain communities with tourism-based economies.

Mr. Hernandez will discuss the transportation issues Charlier Associates' clients have hired them to address. He will also identify areas of research needed to better enable his firm to address the transportation challenges identified by his clients.

Dr. JoAnn Silverstein:

Dr. Silverstein is the Chair of the Department of Civil, Environmental & Architectural Engineering at the University of Colorado. Dr. Silverstein is a civil engineer with expertise in environmental engineering. The Department has considerable experience doing research on transportation systems. Over the past five years, the Department has done over 50 independent projects. They have been funded at approximately $1.5 million per year over this time period.

Currently the University is developing a proposal for a Center for Applied Integrative Research in Transportation. The Center would bring together resident researchers, professors, and special outside experts to work on surface transportation issues in partnership with local government and industry. The broad themes the Center would address include: Transportation Security, Infrastructure Safety and Maintenance, and People, Energy, and Environmental Sustainability.

Dr. Silverstein will discuss the past and present transportation research and development at the University of Colorado and the proposal for the new transportation research center.

Mr. CALVERT. Good morning. Welcome to today's hearing, "Transportation Research and Development: Applications & Opportunities in the Denver Region." My name is Ken Calvert. I'm a senior Member of the House Science Committee. I used to chair the Energy and Environment Subcommittee. I represent the 44th District of California, including Riverside and Orange Counties. I am pleased to be here in the Denver area with my friend, Mark, and I am looking forward to hearing from today's distinguished panel.

I am flying to Los Angeles this afternoon, so I know first hand about congestion. As a matter of fact, I was talking to Mr. Luber. He was saying that you were number 4, number 5.

Mr. LUBER. Three.

Mr. CALVERT. Number 3. Well, I'm from the number 1 area in the country, you know so I know what traffic congestion is all about, so I understand the frustration of traffic congestion. And according to the Texas Transportation Institute, L.A. Is ranked number 1 in total delay and in delay per person caused by congestion, and many other areas, of course, in Southern California are on top of that list. So it will probably take me longer to get from LAX to West L.A. Than it would for me to get halfway across Colorado. So I appreciate though that traffic is a tremendous problem.

Congestion is crippling many metropolitan areas across the country, causing people to waste time that could be spent with families; and businesses to lose money in delays and at times making our roads more dangerous. Addressing congestion is crucial to improving the quality of life, driving economic growth, and creating safer roads. Research and development is crucial to understanding how to alleviate congestion, and the Science Committee authored legislation to fund surface transportation research and development. We are now working with our colleagues in the Congress to make sure that research and development is appropriately funded in the final transportation bill.

I am looking forward to hearing from our witnesses today about how research and development can help address congestion in our transportation system, and how the state, county, and local governments are able to use federally funded research to reduce congestion here in the Denver area.

I certainly welcome this distinguished panel, and I'm looking forward to your testimony. But before we do that, I'm going to turn to Mr. Udall for his opening statement and introduce some special guests. And I want to thank him for inviting me here and for the hospitality of this region. And with that, Mr. Udall, you may have your opening statement.

[The prepared statement of Mr. Calvert follows:]

PREPARED STATEMENT OF REPRESENTATIVE KEN CALVERT

Good morning. Welcome to today's hearing, "Transportation Research and Development: Applications & Opportunities in the Denver Region." I am Ken Calvert, a senior member of the House Science Committee, and I represent the 44th district of California, including Riverside and Orange Counties. I am pleased to be here in the Denver area, and am looking forward to hearing from today's distinguished panel.

I am flying to Los Angeles this afternoon, so I know first hand about congestion. According to the Texas Transportation Institute, the Los Angeles area was ranked 1st in 2001 in total delay and in delay per person caused by congestion. Many other areas in California also fall near the top of this list. It will probably take me longer

to get from LAX to West L.A. this afternoon than it would take to drive half way across the State of Colorado.

Congestion is crippling many metropolitan areas across the country, causing people to waste time that could be spent with families, businesses to lose money in delays, and at times making our roads more dangerous. Addressing congestion is critical to improving quality of life, driving economic growth, and creating safer roads.

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I am looking forward to hearing from our witnesses today about how research and development can help address congestion in our transportation system, and how State, county and local governments are able to use federally-funded research to reduce congestion here in the Denver area.

I welcome the distinguished panel before us, and I look forward to your testimony. Now I will turn to Mr. Udall for his opening statement.

Mr. UDALL. Thank you, Chairman Calvert. I did want to begin by acknowledging the time you've taken out of your busy schedule to join us here for this important field hearing. And I do understand the challenges the Los Angeles region faces but hopefully we're not too far behind you that we cannot learn from what you've been able to put in place and what opportunities we have here.

I did want to also thank the City of Broomfield and my good friend, Mayor Karen Stuart, who's here on behalf of the City of Broomfield, and it's my great privilege to represent the City and County of Broomfield and we know and we'll hear later about the good work you've done here, Mayor, when it comes to the 36th corridor and your traffic and transportation needs within your wonderful county and city.

Let me turn to my statement, if I could, at this point. When I return to Colorado every week, I normally hear from people about problems with traffic congestion. I experience them firsthand as I travel to events and meetings along I–70 in the mountains and throughout the Northern Denver-metro area which is my congressional district. I mentioned the Denver-Boulder turnpike, which is my most frequently traveled route, and it is especially congested at times, as all of you here, and all of you watching on the television know. And that is why communities along the corridor have been working together to plan for a mix of much needed transportation improvements including bus-rapid-transit, commuter rail and bike paths.

However, our area is not unique in experiencing problems with congestion. It is widespread throughout, as Mr. Calvert mentioned, metropolitan areas of the country. Despite increased investments in highway infrastructure, we are not making, in my opinion, sufficient progress in easing the problems.

We need to continue to invest in improving our transportation system and we will need to expand the capacity of our highways. But we are not going to be able to simply "build" our way out of this problem. We need to use our current highway system more efficiently, improve our transportation planning, and develop highway materials that last longer and require less maintenance. Research is the only way that we are going to develop the solutions to these types of problems.

In 1991 with the passage of ISTEA, we began to devote a significant amount of transportation monies to research. These research programs have yielded a number of successes, but we've also had some misses. From what I understand, many of the misses are due to the lack of a holistic approach to our transportation systems and not giving human factors and socioeconomic issues sufficient consideration.

I believe that the public needs a greater role in transportation planning in the early stages. We need to creatively utilize and link all modes of transportation including bicycle and pedestrian modes, and to focus on expanding mobility, not just infrastructure. We also need to develop new technologies that might allow us to use our highway system more efficiently. I'm concerned that human factor and socioeconomic considerations are not given adequate consideration and are not integrated sufficiently into our more traditional transportation R&D efforts.

We need more investment in the transportation system. However, we all recognize the list of desirable projects exceeds our current ability to pay for them. We need to ensure that the investments we make will provide us the greatest mobility for the money. We want to maintain the beautiful scenic landscapes that make Colorado famous and to ensure that we have the ability to access them efficiently and safely.

We are privileged to have a panel of witnesses with a broad range of experience with transportation issues in Colorado. Again, I want to thank you all for taking time from your busy schedules to appear before the Committee this morning. And I look forward to your testimony and to hearing your perspectives on how best to keep the citizens of Colorado moving. Again, I want to thank Mr. Calvert for joining us today.

[The prepared statement of Mr. Udall follows:]

PREPARED STATEMENT OF REPRESENTATIVE MARK UDALL

Thank you all for being here this morning. I would like to welcome my colleague from southern California, Representative Ken Calvert to Colorado, who is chairing the hearing this morning. Thank you very much for being here today. I hope you did not encounter any transportation problems we will be hearing about on your way to the hearing this morning.

Each week when I return to Colorado, I not only hear from people about problems with traffic congestion, I also experience them firsthand as I travel to events and meetings along I–70 to the mountains and throughout the Denver-metro area's northern communities. The Denver-Boulder turnpike, which is my most frequently traveled route, is especially congested at times. That is why communities along this corridor have been working together to plan for a mix of much needed transportation improvements, including bus-rapid-transit, commuter rail and bike paths.

However, our area is not unique in experiencing problems with congestion—it is widespread throughout the metropolitan areas of the country. Despite increased investments in highway infrastructure, we are not making sufficient progress in easing the problems.

We need to continue to invest in improving our transportation system and we will need to expand the capacity of our highways. But we are not going to be able to simply "build" our way out of this problem. We need to use our current highway system more efficiently, improve our transportation planning, and develop highway materials that last longer and require less maintenance. Research is the only way that we are going to develop the solutions to these types of problems.

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We are privileged to have a panel of witnesses with a broad range of experience with transportation issues in Colorado. I thank you all for taking time from your hectic schedules to appear before the Committee this morning. I look forward to your testimony and to hearing your perspectives on how best to keep the citizens of Colorado moving.

Mr. CALVERT. I thank the gentleman.

We'll now introduce our witnesses for today's hearing. Before I introduce the witnesses, we have a clock here, the five-minute clock. We try to keep the testimony to five minutes. That way, it gives us plenty of time for questions and answers. Also, a yellow light will come on and give you some indication. So with that, I'll introduce our witnesses for today's hearing: Mr. Guillermo Vidal is the Manager of the Public Works of the City and the County of Denver; Mr. Jayson Luber is a helicopter news and traffic reporter for the Denver radio station, KOA; Mr. Carlos Hernandez is a transportation planner who works for Charlier Associates; and Dr. JoAnn Silverstein is Chair of the Department of Civil, Environmental, and Architectural Engineering at the University of Colorado. I certainly thank you for coming today.

Mr. CALVERT.And we'll start off with Mr. Vidal. You're recognized for your opening statement.

STATEMENT OF GUILLERMO V. VIDAL, MANAGER, PUBLIC WORKS OF THE CITY AND COUNTY OF DENVER

Mr. VIDAL. Good morning Mr. Chairman. Congressman Udall, it's nice to see you again. My name is Guillermo V. Vidal, I serve as a member of the Cabinet of Mayor John Hickenlooper in the role of Manager of Denver Public Works for the City and County of Denver. I am extremely honored and privileged to be in front of you today to give this testimony and I appreciate you taking the time to hear it.

I present somewhat of a unique perspective because of the various roles that I've served throughout my career. I've seen these issues from being—I've worked for the Colorado Department of Transportation for 23 years, serving as Director my last five years there. I spent five years then as Executive Director of the Denver Regional Council of Governments for the Metropolitan Planning Organization, and now as a Manager of Public Works for the city.

I think it gave me a unique perspective—perhaps it shows that I can't hold a job for very long—but it does give me the perspective that I see this from all sides. And I thought what I would talk about is that part of the issue in trying to talk about research is, maybe try and understand why, in spite of all the money that we

have been spending on trying to deal with congestion, we're still not resolving that. And I think part of it is because in most metropolitan areas, you usually have three or four separate agendas going on.

One is the DOT who focuses on maintaining the existing highway structure and deals with congestion with the focus on the motorists' ability to go from point A to point B on a particular corridor as fast as they can. And although this is great for traffic operations, it doesn't balance well with land use decisions or the use of transit that is so important in metropolitan areas.

Then next to the DOT is the agenda of the transit agencies who, of course, are advocates for transit. And although transit tends to be a little bit friendlier to land use, we usually end up having competing agendas between transit and highways.

Following that is the agenda of the MPOs who normally try to view transportation for the region for consistent connectivity as well as multi-modality. However, they tend to look at things in the 20-year vision. I mean, I spent five years of my career with Dr. Cox so I think this is a good way to look at it. However, the MPOs have very little authority in implementing plans, and they leave any certainty of implementing long range plans up to the voluntary efforts of each individual jurisdiction.

And so even though they look at things regionally and multimodally, it doesn't necessarily guarantee that that will happen.

Last but not least is the agenda of the cities and counties. And although they value mobility and congestion relief, they don't feel that the motorists on the corridors have a greater right than the citizens who live alongside the corridors. So this means they will support transportation decisions that don't sacrifice the quality of life of their neighborhoods or destroy their businesses. And they also tend to favor the solutions that help economic development.

Where this breaks down, I think, here in Colorado is that we're really left to the agenda of the implementing agencies because normally, since they have the money to implement, their agenda is going to rule. And even though we have things like the need for a process to determine alternative selection, the implementing agency can even influence this decision by limiting the budget tied to projects. So I think what's happening is that we have an imbalance in transportation planning.

I think we have the unfortunate situation right now in the Denver region. It's that our economy is not doing well, the state economy is not doing well, and we find that CDOT gives a priority to maintenance of the entire state system over relieving congestion in the urbanized areas. So that means that most of the dollars are going to the rural areas where the largest inventory of miles is, and we're left in the urbanized areas to solve our congestion problems by either taxing ourselves regionally or tolling. And both of these just add a greater burden to the transportation costs of urban citizens.

Anyway, this leads me to points about what to research. I think we should establish congestion performance measures that can help articulate goals to be achieved in congestion relief, just like we do for maintenance of our bridges where we have maintenance performance measures.

Number 2, we should establish transportation measures that reflect the movement of people and goods as opposed to only the movement of cars and trucks. Cars and trucks have to move but that's "a" way of moving people and goods, not "the" only way.

Number 3 is to develop methods to integrate transit and highway planning. We got to stop competing between these two modes.

Number 4, establish methods that integrate transportation planning and land use. This can't be done in the vacuum.

And then 5 is, we really need to look at how do we establish true joint resource allocation as articulated in TEA–21 so that there's truly a partnership that takes into account things such as contribution to the funding pot and measures people as—it takes into consideration people as well as miles.

Six, I would say, not all miles of the highway system should be considered equal. Different maintenance standards should be investigated to be established on different kinds of roads, and again you have more detail on that.

I'm going to just get to my last suggestions on research. It seems that I got the red light. I think we also should look at establishing best practices and send us those strategies and encourage people to use alternative modes of transportation during the peak traffic period.

Number 2, we should establish an incentive for businesses that have encouraged their employees to change their traveling patterns during peak periods. In other words, what can be done to encourage business to implement tele-commuting, flexible work hours, car pooling and so on.

Three, establish measures and standards for traffic demand management strategies. So how do we measure these strategies? How do we incorporate them into the regional transportation plan? Right now it's a marketing process. It's not really a strategy to use for transportation solutions. Establishing determined best practices for dealing with freight movement in metropolitan areas: Should we take them out during peak periods? Should we provide special lanes for truck movement and so on?

And then, last but not least, serious evaluation should be done to determine the success of toll roads and hot lanes that have been established since the passage of ISTEA. And I just conclude with them when they say, "That's what's being proposed for us in the metropolitan area as our solution for congestion." And frankly it's not like there's a great track record for these facilities around the country in the last decade or so. You know, toll roads that were established back east 30, 40 years ago are working well but new ones and hot lanes aren't necessarily even paying their own way.

So let me stop with that. I'm certain you have a lot more detail on that. I realize I went a minute or two over my time, but I appreciate your listening to my testimony.

Mr. CALVERT. I thank the gentleman.

[The prepared statement of Mr. Vidal follows:]

PREPARED STATEMENT OF GUILLERMO V. VIDAL

Good morning Mr. Chairman and Members of the Committee. My name is Guillermo V. Vidal, I serve as a member of the Cabinet of Mayor John Hickenlooper in the role of Manager of Denver Public Works for the City and County of Denver. I

am extremely honored and privileged to be invited to testify in front of you today regarding this very relevant topic.

I believe I present a very unique perspective because of the various roles I have served in throughout my career. I have seen these issues from the State level as the Executive Director of the Colorado Department of Transportation, as the Executive Director of the Denver Regional Council of Governments (the local Metropolitan Planning Organization), and now under my current role with the City of Denver. Although there has been substantial investment in highway infrastructure and traffic management technologies, we are still having troubles recognizing the unique problems of the urbanized areas and therefore congestion and traffic delays continue to worsen. I believe the reason for this has to do with the differing agendas and goals of the various organizations that are involved in planning and funding transportation projects. The DOT is usually focused on maintaining the existing highway infrastructure. However, in dealing with congestion, they focus on the motorists' ability to go from point "A" to point "B" on the particular corridor as fast as they legally can. Although this vision may be an excellent one for traffic operations, it does not balance well with the land use decisions or the use of transit that is so imperative for healthy metropolitan areas.

Next to the DOTs are the transit agencies whose agenda is focused around the operations and development of transit. Although this agenda is more supportive of the regional and local land use plans, it is often viewed as a competing agenda to that of highways. This agency in Denver is the Regional Transit District (RTD).

Following is the agenda of the MPOs who normally try to view transportation for the region for consistent connectivity as well as multi-modal. In Denver, DRCOG, in partnership with their member governments, created Metro Vision. This is a twenty year vision for the region that tries to incorporate and integrate transportation and land use planning. I believe this is the right way to look at transportation planning, unfortunately the MPOs have little authority in implementing these plans, leaving any certainty of implementing long range plans strictly up the voluntary efforts of each individual jurisdiction or State agency.

Last but not least is the agenda of the cities and counties. Although they value mobility and congestion relief, they do not feel the motorist on the corridor have a greater right than their citizens who live along side of those corridors. This means they will support transportation decisions that do not sacrifice the quality of life of their neighborhoods or destroy their businesses. They also tend to favor those solutions that help economic development. This translates into support for decisions that will allow people to easily get and stay in their communities rather than just drive through them.

Where all this breaks down is that little exists in the process that allows either the MPOs or the communities themselves to truly influence the selection of projects or alternatives on their various corridors or communities. Although there is the NEPA process to determine alternative selection, the implementing agency can influence the decision of the selected alternative by limiting the budget tied to the project. Additionally, on the project selection process, the MPOs and the local governments only provide input to the process, leaving the decision making process entirely in the hands of the implementing agency. The final result is that the agenda of the implementing agency ends up ruling the day since they have unilateral control of most of the funds.

In Colorado, the unfortunate situation the Denver Region finds itself in is that the CDOT has given priority to maintenance of the entire state system over relieving congestion in the urban areas. This means that most of the dollars end up fixing the large inventory of miles which tend to be in the rural areas, while the urban areas are left to solve their congestion problems by either taxing themselves regionally or tolling. Both of these add a greater burden of the transportation costs to urban area citizens.

The areas that I would recommend be investigated to improve planning and evaluation tools are the following:

1) Establish congestion performance measures that can help articulate goals to be achieved by the DOTs as well as to define the problem. This would be similar to a pavement or bridge management system that are being used to establish maintenance goals as well as funding levels by the DOTs. We need similar goals and funding levels to be established for congestion relief.

2) Establish transportation measures that reflect the movement of people and goods as opposed to only the movement of cars and trucks. Although the movement of cars and trucks is important, we need to remember that this is only one method of moving people and goods. Unfortunately, we are stuck with using traffic measures such as Average Daily Traffic (ADT) as the only

congestion measure therefore, our solutions tend to be highway oriented in order to address this car congestion.

3) Develop methods to integrate transit and highway planning. We need to stop making these modes compete with each other and begin to treat them as necessary solutions to urban area problems.
4) Establish methods that integrate transportation planning and land use planning. In order to do this we need to first of all understand what kind of land use is promoted by each kind of transportation solution so that we can determine the pros and cons of each one. Ultimately, neither planning can be done in a vacuum.
5) Develop methods that truly enable joint resource allocation between the DOTs and MPOs/local governments. Although everyone recognizes that maintenance of the system is important, good balance needs to be maintained between maintenance, safety and congestion relief. In order to assure this balance, contribution to the funding needs to be considered as part of the resource allocation factors. This is similar to the "Minimum Guarantee" that is established in the Federal Transportation Legislation TEA–21. In other words, in order to be more directly responsive to the people who contribute to the funding as opposed to being only responsive to the number of lane miles, resource allocation processes should be established to weigh into any formula the contribution to the funding stream by the citizens of an identified planning region.
6) Not all miles of the state highway system should be considered equal. Different maintenance standards should be investigated to be established on different kind of roads. Heavily congested roads should have different priority and maintenance standards than lower congested roads. Farm to market roads should have a different standard than low volume rural roads. Truck routes a different standard than non truck routes. The bottom line is that even if maintenance is considered more important than congestion relief, perhaps this decision can be limited to only the maintenance of key roads as opposed to the maintenance of all roads.

Unfortunately, the cities, counties and MPO have very little role in the research agenda for the Colorado DOT or even at the federal level. Although we may be provided input, the ultimate choice is the DOTs. Additionally, both the Federal Highway Administration (FHWA) and the Federal Transit Administration (FTA) cater to their main clients, the DOTs and the transit agencies thereby ignoring the needs of the MPO and the local governments. I can relate that while working for DRCOG, I got little response or attention from the federal agencies to those issues we wanted investigated or researched. In fact most of our requests were usually run by the CDOT and RTD for their support or approval. If these implementing agencies did not agree, usually our requests were denied. Where MPOs and local governments have been effective in research and development needs is in the application for specific grants. These tend to be very specific to a particular project or method to be explored and may not necessarily have broad policy implications.

I believe the investment made on research for improved materials and in traffic management tools has been a good investment and should continue. It is important however, to expand the thinking into researching strategies that would encourage people to change their travel patterns and choices at least during the peak hours. I also believe it is important to evaluate the effectiveness of strategies that are being used and/or proposed as congestion relief measures to ensure whether or not they are truly being effective. I offer the following areas for consideration for further research.

1) Establishing best practices, incentives or strategies that encourage people to use alternative modes of transportation during the peak traffic periods.
2) Establishing incentives for businesses to encourage their employees to change their traveling patterns during peak periods. In other words, what needs to be done to encourage businesses to implement tele-working, flexible work hours, carpooling, providing transit passes, etc.
3) Establishing measurable standards for Traffic Demand Management (TDM) strategies and incorporating them into the Regional Transportation Plan.
4) Establishing and determining best practices for dealing with freight movement in the metropolitan areas. Actions such as not allowing trucks during peak periods, exclusive truck lanes, truck bypasses should be evaluated for effectiveness.

5) Serious evaluation should be done to determine the success of toll roads and hot lanes that have been established since the passage of ISTEA. These are being proposed as the main strategies to deal with congestion in the Denver metro area and it is impossible to determine if these would be successful strategies. Investigation should be made to determine are the facilities successful. Questions such as, are they generating enough revenue to make them worthwhile? Are they even breaking even financially? Are they relieving congestion on the corridors they were meant to address?

I hope I have provided useful and helpful suggestions for your consideration. I appreciate the opportunity to address the Subcommittee and I thank you for your time.

Mr. CALVERT. Mr. Luber.

STATEMENT OF JAYSON LUBER, HELICOPTER NEWS AND TRAFFIC REPORTER, 850 KOA RADIO AND CHANNEL 9 NEWS

Mr. LUBER. Good morning, Congressman Calvert, Congressman Udall. It's a sincere honor to appear before you this morning. Thank you again for asking me to be a part of this. I am Jayson Luber, helicopter news and traffic reporter for 850 KOA Radio and Channel 9 News here in Denver.

The transportation issues we will talk about today are close to my heart. On one hand, the constant congestion construction, accident stalls and other road hazards I report on a daily basis keeps me employed. On the other hand, delays can be some of the most frustrating time and waste of money spent in a person's day. Countless dollars are wasted in stop-and-go traffic while commuters, truckers, delivery drivers sit and idle their gas away, have to repair and maintain their vehicles' brakes and engines more frequently, lose productivity in their job, and miss out on quality time they could otherwise spend with their families.

Understanding the congestion problem is easy. Traffic congestion occurs when the number of vehicles exceeds the capacity of a highway or road. Metro-Denver is one of the worst. According to a 2003 study by the Texas Transportation Institute, Denver is the most congested city of its size and the third most congested of all cities nationally. I can vouch for that as I fly above the congestion on a daily basis.

Solving the issue is a tough one since the two major ingredients in congestion, traffic volume and road capacity, are never a constant. Sure we can reasonably predict there will be an increase of traffic volume in the morning and afternoon rush hours—to and from work—but how much volume is never really known until it actually happens.

The second ingredient, road capacity, can change with weather, construction, auto accident stalls. The Federal Highway Administration estimates that 50 percent of traffic delays are caused by those factors. Now you might think a good solution to the problem, as we've talked about, is just to build more roads. Well, that can be effective in some areas but in major metropolitan cities like Denver, that's not always possible.

Denver has that problem along I–25 through what we call the "Narrows," the section of highway between Broadway and University Boulevard. The T–REX I–25 Highway Expansion and Light Rail Project can only widen the interstate from three lanes to four lanes in each direction there because of that limited space avail-

ability. Additionally, road construction is expensive, time consuming and may create additional traffic hazards adding to the congestion.

I personally believe Colorado had been slow in building and expanding our highways at the rate that kept pace with our growth. But in recent years that has improved except for one major interstate. Yes, there have been significant improvements in the Metro Denver area like the T–REX Project along I–25, the expansion of E–470 and the Northwest Parkway toll roads. There are improvements of the I–25 along the North through Greeley, Longmont, Loveland called "The North Forty," and to the South through Casera, Colorado Springs, Pueblo and Trinidad, and up in to the mountains over Berthoud and Wolf Creek Passes. But one major problem remains. Ask any skier or snow boarder what it is, I assume it would be I–70 from Denver to Vail.

I've heard solutions to that problem that range from trains to monorail to buses or HOV lanes or just general widening of the highways. All solutions come with a huge cost. Ask any highway construction contractor about the challenges and the huge price tag attached to building a road up in the mountains. I believe a monorail is the wrong solution in predictive bill. The majority of passengers would be tourists to our ski areas. They are not the ones that are clogging up I–70 on Saturdays and Sundays. The best solution, in my opinion, is to expand I–70 to at least three lanes at each direction, and possibly four, and also look at expanding Highway 285 between Bailey and Fairplay, and Highway 9 between Fairplay and Crisco.

I also believe we should study the possibility of getting traffic through the Moffat tunnel, linking Boulder County to Grand County without traffic having to go over I–70 in Berthoud Pass to get up to Winter Park and the Fraser Valley.

I don't know the estimated cost to the state from a project like this but I do know the cost to the ski resorts if we do nothing to combat the congestion on I–70. Once, this past winter, my wife and I turned around and came back home from a ski trip because the hour long delay it took us just to get from the Evergreen area to Idaho Springs. And we were still looking at another 45 minutes to an hour just to get to Winter Park and then we had the prospect of driving back home in all that traffic and congestion. It didn't make us want to go skiing any longer. How many other front-range recreation skiers have done that same thing?

I'm not a legislator nor do I play one on the radio or TV, but I do know what I see hovering over Denver roadways every day. And I do know the frustration of weekend and daily commuters that drive at our highways. They email me about it all the time.

Thank you for inviting me to testify before your committee, and I look forward to ways that I could help control Colorado's continuing congestion problems and look forward to any questions you may have.

Mr. CALVERT. I thank the gentleman.

[The prepared statement of Mr. Luber follows:]

PREPARED STATEMENT OF JAYSON LUBER

To the distinguished Members of the panel,

Hi, I am Jayson Luber, Helicopter news and traffic reporter for 850 KOA Radio and Channel 9 news here in Denver. The transportation issues we will talk about today are close to my heart. On one hand the constant congestion, construction, accidents, stalls and other road hazards I report on a daily basis keeps me employed, on the other hand traffic delays can be some of the most frustrating time and waste of money spent in a person's day. Countless dollars are wasted in stop and go traffic while commuters, truckers, delivery drivers sit and idle their gas away, have to repair and maintain their vehicles brakes and engines more frequently, lose productivity in their job and miss out on quality time they could otherwise spend with their families.

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Solving the issue is a tough one since the two major ingredients in congestion, traffic volume and road capacity, are never constant. Sure we can reasonably predict there will be an increase of traffic volume in the morning and afternoon rush to and from work but how much volume is never know until it happens. The second ingredient, road capacity changes with weather, construction, or accidents and stalls. The Federal Highway Administration estimates that 50 percent of traffic delays are caused by these factors.

Now you might think a good solution to the problem is just to build more roads. That can be effective in some areas but in major metropolitan cities, like Denver, that is not always possible. Denver has that problem along I–25 through what we call the narrows, the section of highway between Broadway and University Blvd. The T–Rex I–25 highway expansion and light rail project can only widen the interstate from three lanes to four lanes in each direction there because of the limited space available. Additionally, road construction is expensive, time-consuming and may create additional traffic hazards adding to the congestion.

I personally believe Colorado had been slow in building and expanding our highways at the rate that kept pace with our growth. But in recent years that has improved except for one major interstate. Yes there have been significant improvements in metro Denver like the T–Rex project along I–25; the expansion of E–470 and the Northwest Parkway toll roads; the improvements to I–25 along the north though Erie, Longmont, Loveland and Fort Collins and to the south through Castle Rock, Colorado Springs, Pueblo and Trinidad; and into the mountains over Berthoud and Wolf Creek passes but one major problem remains. Ask any skier or snowboarder what it is. I–70 from Denver to Vail.

I've heard of solutions to that problem that range from trains, to a monorail, to bus only or HOV lanes, or just a general widening of the interstate. All solutions come with a huge cost. Ask any highway construction contractor about the challenges and the huge price tag attached to building a road in the mountains. I believe a monorail is the wrong solution and predict if built the majority of passengers would be tourists to our ski resorts. They are not the ones clogging up I–70 on Saturdays and Sundays. The best solution in my opinion is to expand I–70 to at least three lanes in each direction and possibly four and also look at expanding Highway 285 from Bailey to Fairplay and Highway 9 from Fairplay to Frisco. I also believe we should study the possibility of getting traffic though the Moffett Tunnel linking Boulder County to Grand County without traffic going over Berthoud Pass and along I–70.

I don't know the estimated costs to the state from a project like this but I do know the costs to the ski resorts if we do nothing to combat the congestion on I–70. Once this past winter my wife and I turned around and came back home from a ski trip because of the hour-long delay it took us just to get from Evergreen to Idaho Springs. And we were looking at another 45 minutes to and hour to get to Winter Park from there and then the prospect of driving home in that traffic made us not want to go skiing any longer. How many other front range recreation seekers have done the same thing?

I am not a legislator nor do I play one on the radio or TV but I do know what I see hovering over Denver roadways every day. And I know the frustration of weekend and daily commuters that drive on our highways, they e-mail me all the time. Thank you for inviting me to testify before your committee and for looking at ways to help control Colorado's continuing congestion problems. I look forward to any question you may have.

Reference:

1. Texas Transportation Institute study: *http://mobility.tamu.edu/ums/*

2. Federal Highway Administration study on congestion: *http://www.fhwa.dot.gov/congestion/*

Mr. CALVERT. Mr. Hernandez.

STATEMENT OF CARLOS HERNANDEZ, TRANSPORTATION PLANNER, CHARLIER ASSOCIATES, INC.

Mr. HERNANDEZ. Thank you, Congressman Calvert. Congressman Udall, thank you very much for my ability to testify today. Can we put up my presentation? Okay. I turned down the lights a little bit. That's not the cue to fall asleep.

I'm Carlos Hernandez and I'm a transportation planner and our firm is based in Boulder, Colorado. And what we do is we develop transportation solutions that don't actually take a lot of road capacity. We look at alternative modes as options for mobility. We work all on the front-range, we work in the Denver area, we've worked in our hometown here in Broomfield, we've worked on an interesting project called "The Zip" which kept ties transit and land use together. In interchange projects, it helped build pedestrians' support between land uses and residential areas.

We're a part of a really exciting team on EPA right now. EPA is starting to look at how we've actually developed communities since World War II. And they are going in to these key cities and looking at how growth patterns have met the transportation systems and we're part of this larger team.

So I'm going to use one term throughout and I want to make sure it's really clear. And this term is multi-modal. When I talk about multi-modal, I mean a pedestrian who's trying to access transit. I mean a transit rider who just got off the bus with their bicycle. I mean someone who just got off light rail and went to the parking lot and is getting in their automobile. Multimodal means a combination of different modes.

The reason why we're really excited about being here is because we work on the leading edge of this type of transportation. And the way that we convince our clients, when we talk to the public and we work with people, is with research. We've been involved in various other research opportunities especially in this state. We did a big rail-oriented development study for Colorado Department of Transportation that looked at how various forms of passenger rail were affecting land uses. We went to Northern California, we went to Washington, we went to Seattle and we looked at how these development patterns are actually affected by other modes of transportation. So research is a very important vehicle for what we do.

There are three areas that are really lacking research on. One is pedestrians and traffic. We built huge roadways that carry a lot of volumes of traffic and we forgot about pedestrians.

The second part is there's a large body of research that has just been published by the Center for Disease Control on obesity. And they're starting to talk about how our communities are becoming larger and larger. And we think that there might be a tie to the built environment. And then the last point is actually looking at that built environment. So what do we know?

Well, from a pedestrian traffic standpoint, we're really good at planning for these. We know how to do road capacity. We know how to move vehicles around pretty darned good. We've been study-

ing it for fifty years. But what we don't know so well is what mobility options there are for other users in our roadways. Because other users besides vehicles use our roadways: Buses, transit, kids walking to school are all part of that equation.

There are many successful examples of integrating bicycle, pedestrian and transit in the communities but there's not a clearinghouse, there's not a document, there's not a place where communities can go to find out what's actually working. And there are plenty of great examples around the country. More specifically in Colorado, our mountain towns are dealing with this problem. This is a picture of Breckenridge. This is what everyone thinks of Breckenridge when they think of the Breckenridge experience, its Main Street, it's beautiful, it's February. Well, here's 4 o'clock on Park Avenue: There's traffic. So we need to develop some kind of clearinghouse or method of planning for engineers and planning departments to balance both of these needs.

The other part is the Center for Disease Control's research on obesity. And it's alarming. It's really alarming. If you haven't seen the research and if you only have scratched the surface on it, it's pretty amazing to get into depth on what they actually know. And we tend to think—and there's a little bit of research out there—that this obesity rate is tied to our ability to only have automobile access, to not have sidewalks and bike paths in our neighborhoods. We need studies for us to know if that's right or wrong.

And there is one body of research that's out there and it's in the private sector; Robert Wood Johnson Foundation is doing a lot of work on this topic.

The City of Broomfield, with our help and a few other consultants' help, put together this excellent trails plan on how we are going to link and trails and put them all together. And we presented an opportunity for research to this panel to look at how these trail improvements were going to actually affect people's ability to get out and move and circulate. Well, they have 4,000 applicants for 150 grant applications. It's virtually impossible—nearly impossible to get one unless you know the right person.

The last part of it is the grid. And if you look to the far left, that's a grid of how we built suburbs since World War II. This grid is more of a traditional grid. And we tend to think—and there's some research out there but none of it really extensive—that this grid pattern can have a big effect on how people access transit, how people get from point A to B, and also alleviating traffic congestion in terms of automobile circulation in the front-range and in many of our communities who are trying to adapt this multi-modal solutions to our neighborhoods. And they're just not working. They're not getting to the point where you can get accessible neighborhoods.

We also have these new type of developments that are coming along and they're called "The Walkable Communities," and they're going to be a big impact on the exurbs, the suburbs, and in downtowns all over the country. And we're not sure how they work yet. We let the suburbs develop without doing much research and now we're going to have these walkable communities come about and we're just not sure yet how they're going to function. So research is really important. Transportation planners in the future are going

to need it even more so. And I appreciate the opportunity to testify. Thank you.

Mr. CALVERT. I thank the gentleman.

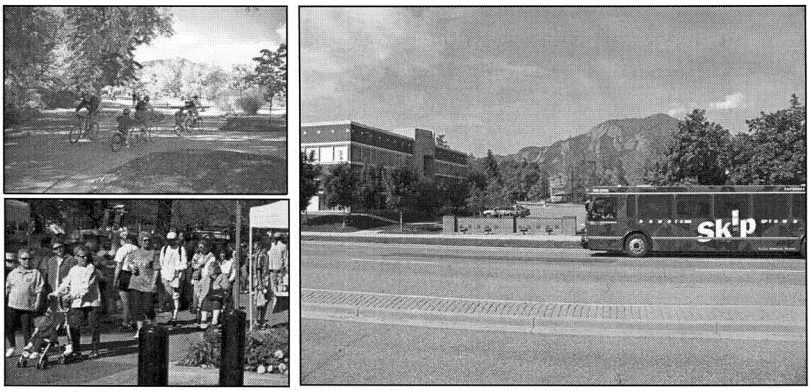
[The prepared statement of Mr. Hernandez follows:]

PREPARED STATEMENT OF CARLOS HERNANDEZ

Who is Charlier Associates, Inc.?

Charlier Associates, Inc. (CAI) is a multi-modal transportation planning firm, specializing in innovative approaches to improving mobility for states, towns, cities, counties, regional agencies and transit service providers interested in moving beyond traditional solutions and approaches. The firm is thirteen years old and has been based in Boulder since 1993. With five professionals, representing the disciplines of transportation planning, landscape architecture, urban design and transportation engineering, CAI has expertise in a wide array of transportation applications, including pedestrian and bicycle system planning. Perhaps those projects most demonstrative of CAI's expertise include application of the firm's research and experience in pairing transportation planning and land use patterns to improve mobility while preserving and enhancing livability. We focus on:

- Multi-modal transportation corridor planning;
- Transportation master-planning;
- Transit-oriented community design;
- Growth management and strategic land use planning;
- Innovative transit system development concepts and transit development plans;
- Urban design for pedestrian environments;
- Safe pedestrian circulation systems and pedestrian-friendly streets;
- Circulation and access issues;
- Parking management strategies for downtowns and activity centers;
- Bicycle and pedestrian system planning and facility design, including ADA requirements;
- Federal, State and local transportation policy and funding.



Charlier Associates, Inc. is located in Boulder, Colorado and developed the City of Boulder Transportation Master Plan that set the stage for their nationally recognized pedestrian, bicycle, and transit system.

How does our firm use innovative approaches to solve transportation problems?

CAI works on the leading edge of multi-modal transportation planning. We work with our clients to develop solutions that go well beyond traditional methods. Such innovations include:

Planning for the future: We write Transportation Master Plans with strategic implementation steps.

Maximizing capital dollars: We incorporate transit, bicycle, and pedestrian facilities into roadway capital projects to minimize costs of high quality facilities.

Developing reasonable solutions: We design community-based solutions that offer competitive travel time to personal automobiles.

Creating options: We work with our clients to integrate land uses with transit stops, bicycle facilities, and sidewalks to increase trips by alternative modes.

Create with the community: We develop alternatives and strategies with the community during all phases of a project to ensure their support during plan adoption and funding.

How does research play a role in our innovation?

CAI exposes our clients to leading edge research when relevant studies exist. Research plays a role in educating communities on decisions before new projects are constructed. Likewise, case studies from built facilities, present communities with relevant solutions in an organized manner. CAI examines research from many cutting-edge organizations who are working on transportation and land use topics. We focus on research that studies alternative modes of transportation and creating communities with mobility options. The organization listed below periodically offer guidance on such topics:

- Congress on New Urbanism
- University of California at Berkeley—Institute of Transportation Studies
- Urban Transportation Monitor
- America Bikes

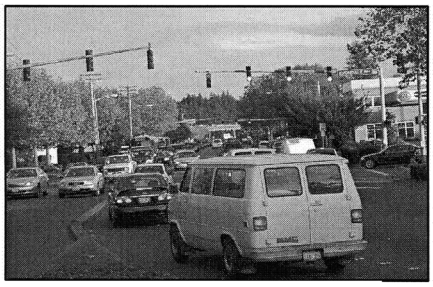
What research should be undertaken to promote communities to build transportation facilities that support alternative modes of travel?

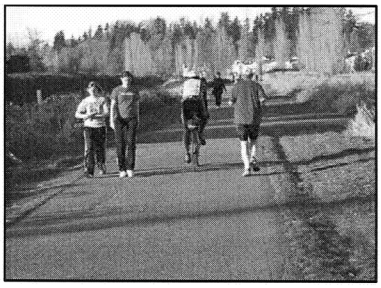
1. Pedestrian and Traffic Safety Research

Problem: One of the major barriers to safe pedestrian connections is motor vehicle traffic. We have designed our communities with roadways to accommodate large volumes of traffic for the benefit of high-speed travel. Such roadways require pedestrians to travel across long distances near fast moving traffic with little refuge or protection. Likewise, most of the roadways designed for high-speed travel are near capacity at peak hours and offer fewer opportunities for persons to navigate a crossing.

Available Research: The research available to planners and engineers today is limited. Most of the research in this field tends to focus on taking the pedestrians out of the area with removed sidewalks and overpasses. The available research does not consider land use or transit access, which is critical to creating safe pedestrian environments. Although, many communities have successfully addressed large volumes of traffic and pedestrians, they have not been given the opportunity to document their stories for other communities to use.

Future Research: One of the major opportunities in this field of research is documenting what other communities have learned by trail and error. Because the science of planning for pedestrians is not roadway planning, the same rules of research cannot be applied. We need a document, updated on a consistent basis, or a clearinghouse of research that communities can consult for guidance.





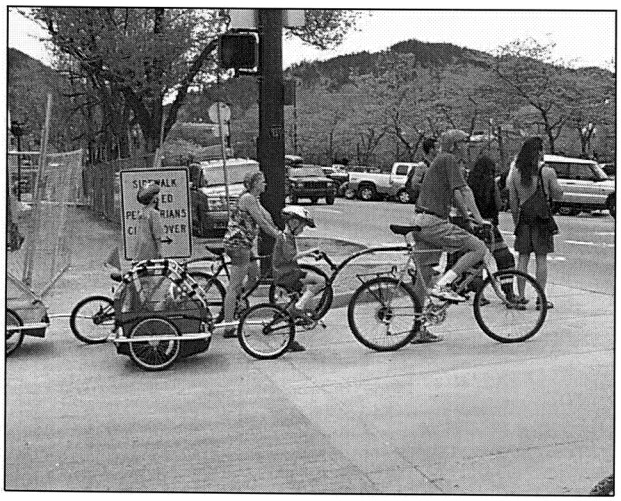
Communities need additional research on creating safe pedestrian facilities along our congested roadways.

2. Community Health and the Urban/Suburban Form

Problem: The Center of Disease Control (CDC) has recently published a large set of data that shows our country is becoming more obese. Much of this research has focused on the medical side affects of this growing disease. The research suggests that obesity is accelerated in children and adults with sedentary lifestyles, but the research does not explore a possible connection between transportation alternatives and obesity. Factors such as safe streets, access to local trails, and availability of transit service should receive additional consideration by researchers.

Available Research: The limited amount of research that ties obesity to the urban/suburban form is being conducted in the private sector. Organizations such as the Robert Wood Johnston Foundation are just beginning to investigate this topic, but the program cannot meet the large volume of research requests.

Future Research: Further research on this topic would help develop more livable communities and increase mobility in neighborhoods. Planners could build on the data from the CDC, to develop case studies that tie obesity rates to transportation options in neighborhoods. By tracking physical activity in neighborhoods with different types of sidewalks, bicycle facilities and transit access, the studies could be used to validate or invalidate possible urban form solutions.



Communities need additional research that explores obesity rates and the built environment. Research focused on this topic could present the relevance of multimodal transportation facilities.

3. Efficiency of the street network and the grid

Problem: Most suburban communities have adopted one form of street pattern for new residential development. That pattern uses cul-de-sac and limited access streets to prevent pass-thru traffic. This has made it very difficult for communities to develop a multi-modal transportation system that connects homes to destinations by modes other than the automobile. The alternative to the suburban model is a grid of interconnected streets. Such grids are typically found in traditional neighborhoods near urban centers.

Available Research: The connection between street patterns and pedestrian mobility, bicycle usage, and transit patronage has been studied on a limited basis and only under special circumstances. Most of the findings point to the need for additional research.

Future Research: Additional research focusing on how street patterns distribute automobiles, transit, bicycles, and pedestrians is needed. Communities need a guidebook that highlights the successes and failures of both types of street patterns. The research should continue to document patterns in traditional and suburban neighborhoods.

Denver Post- Friday, May 21, 2004

If spending your time in bumper to bumper traffic isn't your idea of fun, try the urban alternative.

Stapleton is a classic urban community, meaning it's built for people, not just cars. So you'll find ample trails and sidewalks that lead from your home to just about anywhere...including local shops and restaurants, schools, offices and countless neighborhood parks and open spaces. So lace up your tennies and discover Denver's new "walkable" neighborhood...just 10 minutes from downtown. Leave those long commutes behind and start enjoying an urban neighborhood. **Stapleton. The art of urban living.**

Communities need additional research to show the advantages and disadvantages of street patterns to developing pedestrian, bicycle and transit connections.

BIOGRAPHY FOR CARLOS HERNANDEZ

EXPERIENCE

Mr. Hernandez is a transportation planner with experience in local and regional multi-modal transportation planning projects. He has particular expertise in transportation plan development, multi-modal transportation integration, trail design, and GIS development.

In the spring of 2002 Mr. Hernandez completed a project sponsored by the U.S. 36 Transportation Mobility Organization (U.S. 36 TMO) that involved the cities of Boulder, Broomfield, Lafayette, Louisville and Westminster; the Town of Superior; and Boulder County. The project was a regional effort to map existing bicycle facilities in the U.S. 36 corridor and identify missing links in the overall system.

Mr. Hernandez recently completed a Comprehensive Trails Plan for the City and County of Broomfield, Colorado. As project manager, his primary responsibilities included mapping existing trail facilities, coordinating planned facilities, identifying missing links in the overall system, re-evaluating trails design standards, integrating a major trail along a new toll road (Northwest Parkway), creating a trail network that links key recreation and open space areas, and working with neighboring cities and counties on regional trail connections. He was also a key facilitator at the three public workshops that were conducted at various stages in the project. In a similar project for the City of Thornton he developed a trail facility classification, a detailed inventory of existing trails, plans for future trail facilities along ditch corridors, and capital plans for trail improvements.

Mr. Hernandez recently completed a multi-modal transit plan for the La Crosse Area Planning Committee (Wisconsin). This plan developed a strategic approach to improving fixed route bus operations and enhancing pedestrian and bicycle facilities to major transit hubs. Mr. Hernandez also developed a series of guidelines and policies for the region that address land use and transportation integration.

In the spring of 2001 Mr. Hernandez conducted a peer study for CDOT that evaluated land use response to various forms of passenger rail systems. Mr. Hernandez visited and documented rail systems in the San Francisco Bay Area, Victoria and Vancouver British Columbia to gauge land use response to various passenger rail systems. Mr. Hernandez also completed a multi-modal transportation plan for the City of Breckenridge, Colorado that same year. As part of the project he worked directly with the Town of Breckenridge, Vail Resorts, Colorado Department of Transportation (CDOT), Summit Stage, and Summit County evaluating the local transit system, potential new gondola alignments, pedestrian movements and parking policy.

Mr. Hernandez has also worked on rail corridor realignments for the City of Flagstaff, Arizona, including an initial assessment of environmental impacts; parking studies in Steamboat Springs, CO, Santa Fe, NM, and Jackson, WY; and site plans for transit orientated tourism in Palembang, Indonesia.

Education
Bachelor of Environmental Design, University of Colorado at Boulder, 1999

Work Experience
Charlier Associates, Inc., 1998–Present

Affiliations
American Planning Association
America Bikes
Congress for the New Urbanism

Mr. CALVERT. Next, Dr. JoAnn Silverstein. Doctor.

STATEMENT OF DR. JOANN SILVERSTEIN, PROFESSOR AND CHAIR, DEPARTMENT OF CIVIL, ENVIRONMENTAL, AND ARCHITECTURAL ENGINEERING, UNIVERSITY OF COLORADO

Dr. SILVERSTEIN. Good morning, Congressman Calvert and Udall and fellow witnesses and ladies and gentlemen in the audience. My name is JoAnn Silverstein. I am a professor and chair of the Department of Civil, Environmental, and Architectural Engineering at the University of Colorado at Boulder. And I very much appreciate the opportunity to present developments in transportation research at the University of Colorado, which I think address emerging issues on transportation systems in Colorado and throughout the western United States.

First, I would like to acknowledge my colleagues who have developed the University's Center for Applied Integrated Research in Transportation at the University of Colorado, the Administration of the University of Colorado for their support, and particularly the government relations staff, Tanya Kelly-Bovary and Lynne Lyons have been invaluable all along the way.

Almost a year ago, a group of CU Faculty began planning to advance existing research in transportation by integrating individual expertise and applying our collective knowledge to the technical, economic, and societal challenges for planning, design, and maintenance of sustainable transportation systems. Transportation in the western United States is influenced by conditions like highly varied terrain, changing weather, long travel distances, air quality, and land development concerns. Transportation systems must serve rapidly urbanizing, rural and mountain regions. Interstate highways support significant commercial and domestic travel and major freight railroad lines across the region. Innovative solutions have been developed to alleviate growing automobile traffic, such as the Denver Light Rail System, which is one of the most extensive in the country, and the Integrated Light Rail Bus System, developed by the Denver Transit District, which is an exemplary inter-mobile transportation system.

For these reasons, Colorado provides unique opportunities for productive research on emerging transportation issues. It is our premise that both maintenance of existing transportation infrastructure, much of which is in need of renovation, and design of new facilities must satisfy concerns for security, safety, risk and cost management, environmental protection, and sustainability. Merging these themes with the technology of transportation systems is the goal of the CU Transportation Research Center. To implement this broader vision, the CU Center will partner with local

government agencies and industry to ensure that research will be both practical and applicable.

Since 9/11, the U.S. Department of Transportation has recognized that mass transit systems are a prime target for terrorist attack. However, secure travel entails more than anti-terrorism. In a broader sense, security includes measures to ensure the personal safety of travelers during normal use as well as emergencies, and the integrity of the physical structures in transportation systems subjected to wear and weathering, or during an extreme event, whether a natural hazard such as an earthquake or fire or manmade hazards. Investigators at CU have developed a systems approach to address the risk, safety, and life-cycle cost of transportation facilities using analytical models that allow prediction of the security of transportation systems by simulating deterioration processes and structures, such as bridges, or quantifying the vulnerability of structures to natural and manmade disasters. In addition, events such as evacuation or human responses can be incorporated into these analytical models.

Cost and Project Delivery. A recent study of 258 infrastructure projects built over 70 years found that project costs were underestimated 90 percent of the time, with average cost overruns of 28 percent. Furthermore, costs tend to be underestimated as much today as 70 years ago. The impact of cost estimation errors can be high, projects are cut and scoped, or even cancelled, and public trust in engineers and planners is undermined. Causes of inaccurate cost estimation are numerous, including the complexity of human organizational, technical, and natural resources involved, unforeseen requirements for environmental litigation, societal and political challenges such as right of way determination.

Faculty and students at the University of Colorado investigate the success of alternative approaches for project delivery, project procurement procedures, and contract payment in reducing uncertainty in cost estimates by documenting actual projects which have been authorized as demonstrations of various contract management approaches.

Environmental Protection. Environmental impacts to air, water, and land occur at all stages in the life cycle transportation systems. Air pollutants and greenhouse gases are emitted during vehicle manufacture, manufacture of steel, concrete, and asphalt roadway construction, and vehicle use. Among all of these impacts, air pollution is considered to be the most significant impact of transportation systems and is the subject of significant research at the University of Colorado. Litigation efforts in place over the last 25 years have resulted in improved air quality in many regions, with reduced emissions of carbon monoxide, but also organic compounds and nitrogen oxides. However, an expected 70 percent increase in passenger miles and 30 percent increase in freight transportation over the next 20 years may wipe out these gains. Furthermore, new contaminants increase the urgency for improving monitoring and control strategies for air pollutants, and inevitably, this will involve transportation systems.

I just want to summarize, in terms of the University's contribution to transportation research, the themes of the University of Colorado's Transportation Research Center that I have described

speak to the need for research beyond traditional technology which fosters interdisciplinary approaches combining engineering, economics, and social science. Universities can play an important role in developing long-term solutions to transportation needs. They provide a neutral forum for examination of diverse and occasionally conflicting interests. For example, the life cycle of transportation systems is measured in decades, whereas the financing of transportation projects is subject to shorter-term election and budget cycles. Since short-term financing typically drives project selection, long-term impacts of transportation facilities may not be adequately considered.

The primary activity of the University of Colorado's Transportation Research Center will be decision support for public agencies and industries involved in transportation planning and system design. In addition, University students constitute a highly educated, enthusiastic, and inexpensive intellectual workforce for study of transportation systems. Finally, the University will provide opportunities for professionals with public and private institutions to study transportation issues without the constraints imposed by individual projects.

I'll stop there and thank you very much for the opportunity to talk to you.

Mr. CALVERT. Thank you.

[The prepared statement of Dr. Silverstein follows:]

PREPARED STATEMENT OF JOANN SILVERSTEIN

THE UNIVERSITY CENTER FOR APPLIED INTEGRATIVE RESEARCH IN TRANSPORTATION

(SECURITY, SAFETY, RISK, COST, ENVIRONMENT AND SUSTAINABILITY)

INTRODUCTION

Critical Transportation Issues

This country faces critical transportation issues that will have major impacts on the economy, the security, the environment and the standard of living for millions of Americans. The ability to grow the U.S. economy, face global competition and provide secure movement of products and people will be crucial over the next 10 to 20 years. Providing safe, secured and efficient transportation with high reliability must be accomplished, while preserving long-term sustainability of the communities and regions. An integrated university transportation research center shall be established to take the lead in finding solutions of these issues.

The Vision of the Center

The Transportation Center of the University of Colorado will be an internationally enabled, U.S.-centered technology and educational institute whereby multidisciplinary expertise can be applied to provide solutions for the Nation's surface transportation issues. It will be based on its innovative research capability but with the goal of solving problems. The center will include resident researchers, teaching professors and special external experts to provide both the core competencies and the knowledge to be the national resource for surface transportation issues. The center will partner with local government and industry to ensure that its research will be practical and adoptable. We envision it will become the center of the university centers with its national and international outreach for exchange of expertise to be a major resource center for the U.S. Department of Transportation (U.S. DOT).

Location and Geographic Resources of the Center

Located in Boulder, Colorado, it is at the center of national surface transportation activities. On the railroad front, Fort Collins-Denver-Colorado Spring forms the

major crossing areas of the Nation's freight railroads. There are ample experience and knowledge of railroad safety and route management nearby and connected to the university as a knowledge base. Further south to Boulder in Pueblo is the Transportation Technology Center (TTC), home of national and international rail car test ground. TTC has tested transit rail cars from New York City to Hong Kong since it became independent from U.S. DOT in 1988. Because of its large layout and modern facility, it has become the preferred center of rail car dynamic testing in the world. For urban transportation, Denver has the most extensive modern light rail network in the country. Furthermore, it represents an extensively integrated rail and bus operation. Utilizing recent research results in ITS, the Denver RTD has developed a regional bus management system coordinated with the Denver Light Rail System in a real time fashion, leading the country in bus/rail service coordination. These are parts of the setting of the Transportation Center for the University of Colorado and certain formal endorsements and association will be completed at the establishment of the center.

The Denver-Boulder area is also the hub of highway design and construction activities. For example, the major U.S. east-west Highway 70 intersects several north-south highways with numerous elevated over-pass and clover leaves to accommodate the heavy travel demands of one of the busiest wide spread metropolitan area in the USA. In addition, the 70 West Corridor poses the difficult challenges for providing easy access to the Rocky Mountain Range that requires innovation in tunneling or new material elevated structures, the subject of new planning and research. The University of Colorado plans to complete an infrastructure reliability prediction model for optimizing the highway maintenance, using a network of four interconnecting highways and 14 bridges around Boulder-Denver area (see Figure 1).

National and International Orientation

The proposed Center will take advantage of the International Association for Bridge Maintenance, Safety and Management (IABMAS). This association of more than 300 members from 37 countries and over 30 supporting organizations, deals with transportation infrastructures. The IABMAS is led by a faculty member in the University and was active in the official investigation of the Kobe Earthquake and surrounding highway damages. Another faculty member is actively involved in a post-September 11 analysis of the collapse of the World Trade Towers in New York on request by the National Institute of Standards and Technology (NIST). There is ample structure expertise's with the university to apply to the surface transportation research.

CENTER THEMES

The proposed themes for the Transportation Center of the University of Colorado are:

Transportation Security

Personal Security

Since the 9/11, the U.S. Department of Transportation has funded many security-oriented research projects. The fact that mass transit always carries a large number of passengers makes it a vulnerable target of a terrorist attack. Both the Paris bombing incident (1998) and the Tokyo sarin gas attack (1996) serve as a grim reminder of what could happen to any major metropolitan city in the U.S. or worldwide. The Federal Transit Administration has undertaken a number of critical areas of passenger security research ranging from emergency communication requirements to hardening of civil facilities. Universities have the additional role to fill in looking further into the broader impacts and requirements of prevention of attacks and post crisis management of an incident. The Federal Highway Administration has also undertaken security research. The major areas for research concerning passenger security for the proposed center are:

— Establishing emergency procedures for passengers/travelers to follow if an incident has occurred, communicate the procedure to them before hand and learn how to implement them.

— Training the management or police personnel for transit system or highway of crisis management and crowd control.

— Minimizing casualties by orderly evacuation and disperse of passengers/travelers from the scene of the incident.

— Pre-established medical and care centers around most probable location of incidence.

System Security

In terms of physical structure the vulnerability of transportation structures to natural and man-made disasters, usually results in the collapse of a structure in a crowded urban area. This not only causes considerable human casualties but also has a severe impact on the socio-economic stability of the area. A recent report by the American Society of Civil Engineers found that 27.5 percent of highway bridges in the U.S. have deteriorated to an extent that they are considered structurally deficient or functionally obsolete (ASCE, 2003), becoming more vulnerable to a terrorist attack. Research of the future security of the physical transportation systems will include:

— Hardening of the bridges and tunnel in critical security areas. In transit systems for example, underwater tunnels in New York City NYCT or San Francisco BART are clearly necessary; the question is how to accomplish that in minimal time and low cost.

— Protection schemes and devices for the electrical power grid and communication control systems for rail transit is another necessity. How to accomplish these with proper design of software and hardware.

To address these above issues, the center will take the approach in the following sequence:

— Refine and select critical security vulnerability areas in highway and transit

— Outline innovative and practical counter-measures

— Define solution options with the center's industry partners.

In addition to the vulnerability of transportation structures with regard to earthquakes, roadside fires are of great concern if we recall the recent tunnel disasters in Europe (Channel fire and the Montblanc tunnel fire). Furthermore, accident conditions include vehicular collisions and crashes with roadside safety devices, such as guard rails and support structures for luminaire devices and sign posts. These different accident conditions are in the forefront of homeland security aspects in search of better protection of our transportation infrastructure.

A system approach to address the risk, safety, and life cycle costs of transportation facilities requires good analytical models that can predict and simulate the deterioration process of transportation structures and the vulnerability of these structures to natural and man-made disasters. Such models can be used for risk assessment and system reliability analysis of large-scale transportation systems and networks, life cycle analysis of transportation structures, and the development of health-monitoring and intervention strategies. Computational simulations of dynamic events form the core of safety assessments for extreme events. Computational mechanics and nonlinear dynamic finite element analysis provide the theoretical and analytical tools to perform crash, earthquake, and fire simulations of structural components and systems in support of forensic engineering and the development of new design concepts for extreme events. These computational models rely upon basic materials and deterioration science, material constitutive laws, facture mechanics, and finite element techniques.

Infrastructure Safety and Maintenance

Risk Analysis

Risk and safety assessments of the transportation facilities and systems are continuations of the discussion from the above section. Traditional risks of accident and equipment malfunction are now augmented by the possibility of deliberate acts of terrorism.

The public has traditionally accepted risk of mortality and morbidity from highway travel of two to three orders of magnitude greater than from other transportation modes. Chief in the minds of the public are three factors, each highly correlated with observed decision traits. One of these is *dread* of the event, for which study groups have associated the feelings of catastrophe, inequitable, difficult to prevent, threatening to the future, and involuntary. Each of these is associated with events of transportation of the mass, such as airplanes and trains, and much less so with automobile travel. A second factor is *technological stigma,* which is associated with the unknown, uncertainty, a lack of observability, lack of immediacy, and the lack of trust in the source of the information. Finally, the *number of people exposed* is a critical factor. Studies have shown this is very highly influenced by the number of people affected by single incidents.

We propose to conduct risk analysis of physical systems by focusing on:

— Its characteristics of induce fear of "dread" to the public even if its infrastructure value is not high.

— Increasing the observability to any vulnerability of the surface transportation facilities/infrastructure, so that the transparency helps to make it safe and secure.

— Investigate designs to reduce the over-exposure of the number of traveling public in a given public transportation facility—future design of facility that reduces security and safety blind spots.

— The hardness of the facility.

A recent study team of the National Academy of Engineering (National Research Council, 2002) has investigated in depth the ability to increase safety and security of facilities with various technological solutions. It concludes that there are essential elements for making facilities, especially public ones, safe and less vulnerable to attack. Many of their recommendations, including those on lifelines and networks, will need to be evaluated. In addition, a small NAE study group concluded that isolating systems and preventing acts of terrorism would both be essential ingredients in the security of large-scale systems. Lessons from a classic NAE study in increasing the security of physical facilities at U.S. embassies worldwide can also provide valuable guidance with respect to transportation systems.

Significant research over the past two decades on natural hazards and disasters has produced valuable lessons for protection of the built environment (Mileti, 1998). While much of this information is not directly suitable for terrorist-instigated security issues of facilities, many results in mitigation, preparedness, response and recovery do bear directly on the transportation facility security issue (Levinson and Granot, 2002).

With regard of the hardness of a facility, usually experimental research provides the essential means to validate and calibrate analytical models and evaluate the performance of structures under extreme load conditions. Without adequate test data to calibrate, most analytical models are not reliable as predictive tools and are unable to capture the fine details of a failure process. A hybrid test method that combines physical testing with model-based simulation provides a cost-effective means to assess the behavior of large transportation structures without ignoring the detailed behavior of its critical components. In such a test, a large-scale structural system can be modeled analytically in a computer, while a critical component of the system is tested either statically or dynamically to assess its performance under extreme loads.

The University of Colorado at Boulder has a state-of-the-art fast hybrid test facility in the Structures Laboratory. The facility is also well connected to other large-scale structural testing facilities in the U.S., Europe, and Asia both physically via a high-performance information network and through personal contacts. It is thus well positioned to serve as a resource center to address the most challenging problems related to transportation facilities.

The University of Colorado at Boulder has had a world-class geotechnical centrifuge in operation since 1988. This 400 g-ton, 6-m radius machine can accommodate a two-ton payload and test it at an acceleration level as high as 200 g. It has been used in research in many static and dynamic applications. For instance, by activating a shake table carried on the centrifuge test platform, effects of earthquakes on the stability of earth dams can be studied. On the other hand, by using scaled quantities of explosives embedded in the soil sample, effects of blasting on buried structures can be readily identified.

System Safety and Life Cycle Assessment

The prioritization of scarce funds among the multitude of urgently needed transportation maintenance activities is a major problem that transportation agencies everywhere are facing. Despite all the difficulties in using the minimum expected whole life costing as the optimization criterion for the prioritization of funds, transportation authorities are committed to it. Thus far, however, the implementation of this criterion in management of transportation systems has been very limited.

Current transportation management systems, including the two most advanced bridge management systems in use in the United States, Pontis and BRIDGIT, are based on very restrictive assumptions. Due to these assumptions, these systems are not able to: (a) capture the propagation of uncertainties during the service life of transportation structures; (b) integrate reliability and life cycle cost; and (c) cost-effectively manage networks of aging and deteriorating structures. Therefore, further research is immediately needed to overcome these difficulties by optimizing management decisions for transportation networks based on simulated time-dependent performance and life cycle cost.

One of the objectives of the proposed center is to further develop system safety and lifetime assessment and cost models for transportation structure networks based on the minimum expected lifetime cost criterion. The background on these topics is already in place. However, further developments are urgently needed for advancing the states of the art and practice in management of the transportation infrastructure. Experience in incorporating health monitoring and inspections on the assessment of structural safety of bridge systems has been acquired over the last decade at the University of Colorado, resulting in novel time-dependent safety and maintenance models.

The proposed center will investigate a new long-term transportation infrastructure model for predicting life-cycle cost considering multiple-objective optimization for management. This model will provide a decision tool that optimizes actions (inspection, repair, maintenance, replacement) on transportation infrastructures for multiple user-specified performance criteria.

Safety and Security of Infrastructure and Network

A primary objective is to develop a model-based simulator for optimizing management decisions for transportation networks based on simulated time-dependent performance and life cycle cost. Uncertainties in loading, environment, resistances, deterioration processes, and maintenance costs will be included. An objective and yet practical definition of an optimum lifetime management process for transportation networks based on minimum expected lifetime cost of maintenance interventions is proposed. The goal is to determine and implement the best possible management strategy that ensures an adequate level of transportation infrastructure network reliability and serviceability at the lowest possible life cycle cost. The proposed simulation model will also capture the system effect due to loss of functionality of an individual structures or a group of structures in the network. Therefore, this novel approach will be able to solve problems characterized by abrupt discontinuities including such phenomena as loss of connectivity of individual structures in the network.

The framework for optimizing management decisions for transportation networks based on time-dependent performance and life cycle cost will be based on a multiple-objective formulation balancing the reliability of individual structures in the network, the overall reliability of the network, and the lifetime cost of maintenance interventions. Such an approach is in an initial stage of development at the University of Colorado using a real transportation network of 14 bridges connecting Boulder to Denver as indicated in the figure that follows:

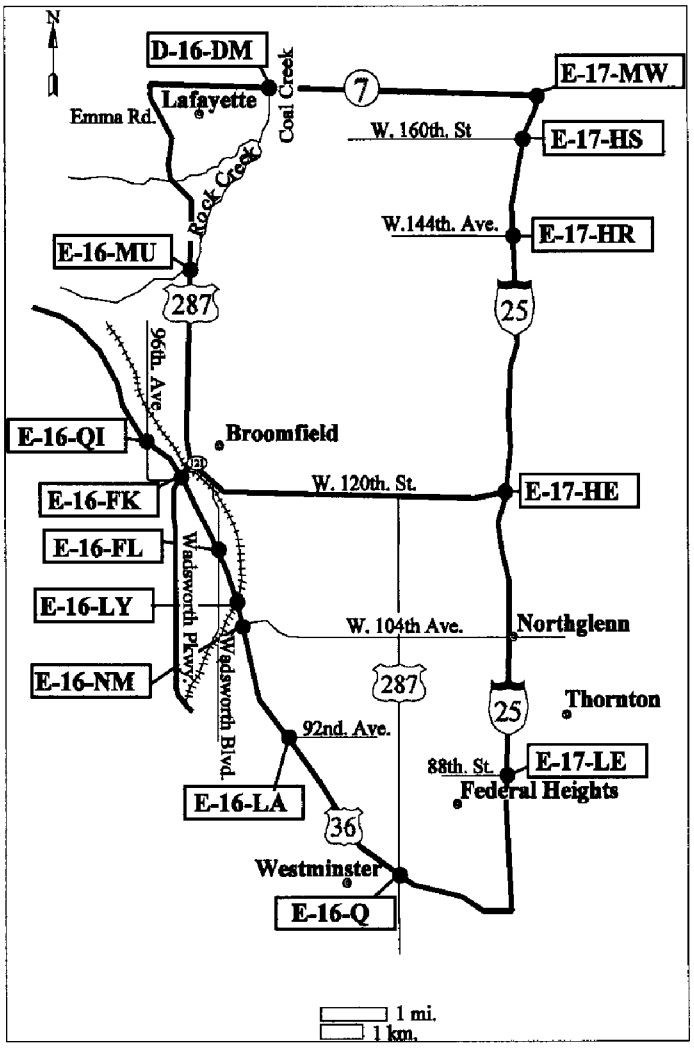


Figure 1. *A Simulator for Optimizing Highway and Bridge Management Decisions in Denver/Boulder*

The proposed activity will advance discovery and understanding of life cycle and network approaches to maintenance and management of transportation infrastructure and create the basis of a new generation of transportation infrastructures management systems where optimal management decisions in terms of life cycle cost are made at the network-level while explicitly taking into account the propagation of uncertainties during the entire service life of each structure in the network.

Infrastructure Investment and Maintenance

The subjects of *Life Cycle Cost and Project Delivery Alternatives* for transportation projects hold the key for proper future investments and returns. We have historically experienced significant cost overruns from the stage of conceptual planning estimates. A recent study of 258 infrastructure projects spanning a time period of more than 70 years found that project costs are under-estimated in approximately 90 percent of the projects, and the actual costs averaged 28 percent higher than estimated on this sample (Flyvbjerg et al., 2002). Although highway projects fared better than rail and fixed-linked projects, the sample still displays an increase in project costs of more than 20 percent. Recent high profile highway projects, such as Boston's Central Artery/Tunnel (the "Big Dig") and Virginia's Springfield Interchange have made engineers, contractors, and public taxpayers acutely aware of the problem. For example, the Big Dig was estimated at a cost of $2.6 billion (1982 dollars) and is expected to be completed at a cost of $14.6 billion (2002 dollars) with completion anticipated in 2005 (NAE, 2003). Additionally, it can be argued that construction cost estimating on major infrastructure projects has not been increasing in accuracy over the past 70 years. The under-estimation of cost today is in the same order of magnitude that it was then.

New ideas and techniques need to be developed to improve this area where no learning seems to have taken place. Cost estimation practices need to improve for many reasons. Projects are often cut in scope or canceled altogether due to other projects exceeding their budgets. This persistent cost underestimation reflects poorly on the industry in general, but more specifically on engineers.

The root cause of inaccurate cost estimating on mega-projects (projects over $100 million) can stem from a multitude of reasons. Managing the capital construction of mega-projects requires the coordination of a multitude of human, organizational, technical, and natural resources. Engineering and construction complexities can include a lack of information on the extent of utility impacts, required environmental mitigation, maintenance of traffic requirements, work hour restrictions, etc. Quite often however, the engineering and construction complexities of such projects are overshadowed by economic, societal, and political challenges. In addition to these challenges, a number of observers have suggested that project estimates have purposely been misrepresented in an effort to secure project approval.

Alternative project delivery strategies offer the opportunity for early cost knowledge and construction innovation. While alternative project delivery approaches are not yet commonplace in public transportation projects, there is a great potential for improved management of cost and schedule with the alternative delivery methods. For example, ISTEA authorized the FTA to select four transit projects to participate in the FTA Turnkey Demonstration Project Evaluation Oversight. The programs selected are: Baltimore Light Rail Extension; San Juan Tren Urbano Rail; El Segundo Del Norte (Green Line) Station; and the BART Airport Extension. Documented evaluations of these projects could potentially provide important input into this study. The figure below summarizes some of the delivery approaches that may result in more accurate cost estimation and management.

Project Delivery Approaches

- Indefinite Quantity/Indefinite Delivery
- Construction Manager at Risk
- Design-Build Contracts
- Design-Build Warranty
- Design-Build-Operate-Maintain (DBOM)
- Design-Build-Operate-Maintain-Finance (DBOM-F)
- Performance-Based Total Asset Management Contracts

Procurement Approaches

- Bid Averaging Method (BAM)
- Alternative Bids/Designs
- Request for Proposals
- Cost Plus Time (A+B)
- Multi-Parameter Bidding (A+B+Q)
- Best Value

Contract Payment Approaches

- Disincentive or Penalty Contracts
- Incentive Contracts
- Incentive/Disincentive Contracts
- Lane Rental Contracts
- Active Management Payment Mechanism
- No Excuse Bonus Contracts
- Lump Sum Contracts

By addressing these alternative delivery strategies with a focus on cost estimation and management, the center will provide engineers with better strategies, tools and techniques for cost management of our nation's infrastructure. Many lessons can be learned from an international exploration of these topics. Countries outside the

United States face the same problems with growing infrastructure needs, inadequate public funds and insufficient or diminishing staff. These countries have developed alternative delivery strategies that offer great promise in the U.S. Through an international research collaboration, there is great potential for us all to become better stewards of our public resources.

People, Energy and Environmental Sustainability

Modern transportation systems cause or contribute to a wide range of environmental problems, including local and regional air pollution, surface and groundwater contamination, habitat and ecosystem disruption and climate change. Significant impacts arise at all stages in the *life cycle* of both vehicles and road and railway infrastructure: emissions of air pollutants and greenhouse gases from vehicle manufacture and roadway construction and maintenance; emissions from vehicle use; deposition and resuspension or runoff of metals from brake and tire wear; surface and groundwater contamination from brake fluid, antifreeze, oil and grease; and emissions and solid waste from vehicle and battery scrappage and from pavement or railway demolition.

Among these environmental impacts, air pollution concerns have historically imposed the most significant constraints on transportation infrastructure and technology. Air pollution and climate change are likely to be the most important environmental drivers for alternative transportation modes and technology improvements in the future. Over the past three decades, significant progress has been made in reducing the rate of emissions of carbon monoxide, volatile organic compounds and nitrogen oxides from new vehicles. Nevertheless, as of 2000, 121 million people in the U.S. lived in communities that failed to meet National Ambient Air Quality Standards for ozone, carbon monoxide or PM10 (fine particulate matter less than 10 microns in aerodynamic diameter) (TRB, 2002). The transportation sector accounts for a major share of the emissions associated with each of these pollutants (EIA, 2002). Future growth in transportation demand threatens to outpace environmental mitigation efforts that have been carried out to date. By 2025, annual passenger-miles traveled is expected to increase to 8.4 trillion miles, from five trillion miles in 2000, and freight transportation to expand by almost 30 percent, to just over five billion ton-miles (TRB, 2002).

The Surface Transportation Environmental Cooperative Research Program Advisory Board, which was established pursuant to a congressional mandate in TEA–21, recently concluded that major new investments in environment research are needed "to support the Nation's growth and meet public expectations for improved transportation system performance" (TRB, 2002).

Among the local and regional scale air pollution problems associated with transportation, research on fine particulate matter and air toxics is particularly urgent. Current EPA standards are based on epidemiological evidence linking mortality and morbidity to PM2.5 mass concentrations, but significant uncertainties exist about how the size and composition of PM influence health risks (NRC, 2001).

EPA estimates that 100 million people live in areas of the U.S. where the combined upper-bound lifetime cancer risk from hazardous air pollutants emitted by mobile sources exceeds 10 in a million (EPA, 2002). Improved characterization of the composition and distribution of toxic air pollutants from mobile sources is thus needed to support comprehensive *risk assessments* and design cost-effective air pollution mitigation strategies (HEI, 2000). For both PM and air toxics, research is needed to quantify personal exposures to transportation-related air pollutants. Personal exposure data are especially critical for sensitive subgroups, including children, the elderly, those with cardiopulmonary disease and pregnant women.

In the past, environmental assessments of infrastructure plans and projects have often focused on local-scale air quality impacts of primary pollutants such as CO, with results aggregated over the transportation corridor. Environmental assessments for transportation systems need to be expanded to additional pollutants, such as fine particulate matter and air toxics, and to the full range of scales over which impacts occur. Ozone and fine particulate matter can form and be transported over distances of hundreds of kilometers, so the impacts of transportation systems on these pollutants are best examined on regional scales. Improved tools are needed to model the impacts of transportation systems on both finer scales and over larger regions, including, e.g., added air pollution from induced travel demand and land use changes.

Development of Energy Scenarios and Sustainability

The basic tenet of sustainability has been defined by the United Nations: "meet the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987). One of the major challenges of long-term sus-

tainable development is the balance of energy sources and uses. Oil, coal and natural gas account for the vast majority of the energy supply for transportation systems and electricity production, the latter being an important mass transportation energy source and a promising source for hybrid vehicles and hydrogen fuel cells. Transportation is the single largest sector of energy use in the United States, and therefore increased efficiencies will be vital as the supply of the resources mentioned begin to be depleted. Efficiencies of current modalities will be important, but so will new modes of transportation, altered behavioral patterns and new concepts of virtual presence.

The University of Colorado, Boulder, Center of the American West (CAW) provides an arena for regional transportation energy analysis. The settlement of the Trans-Mississippi West provides an extremely useful case study in a region in which changes in the technology of transportation underlie every step and stage of economic development, and the use of energy from fossil fuels has been the most consequential factor in the transformation of society and economy in the last century, with the free and unrestricted use of automobiles governing the shaping of the landscape. The Center has recently completed a comprehensive study and produced a report, *What Every Westerner Should Know About Energy,* written by Patricia Limerick, Claudia Puska, Andrew Hildner and Eric Skovsted. The study was made possible by the Hewlett Foundation.

In 2005, CAW will host, in collaboration with several federal agencies, a conference on "the Role of Engineers in the Shaping of the West," and transportation issues will be prominently featured in that conference and resulting publications. The life cycle analysis of transportation structures is fundamentally a historical enterprise. Combining the approaches and epistemologies of engineers and historians seems certain to produce fresh and innovative understandings.

There is no single, universally accepted definition of sustainable transportation, but the concept generally invokes a system that can meet mobility needs for all (including the elderly, disabled and economically disadvantaged) and be continued into the foreseeable future without harm to the environment and without depletion of the resources on which the system depends (Benfield and Replogle, 2002). Achieving sustainability in the face of the transportation sector's heavy reliance on fossil fuels will be a challenging task. Strategies that are generally viewed as promoting sustainability include increasing modal diversity, emphasizing transit, walking and biking; incentives to use efficient transportation modes; improved integration of transportation and land-use to minimize demand for single-occupant vehicle use; streamlining connections between modes; and pricing transportation so that it reflects full environmental and resource costs. The 1991 Intermodal Surface Transportation Efficient Act (ISTEA) and the 1998 Transportation Equity Act for the 21st Century (TEA–21) and the upcoming SAFTEA endeavor to promote these strategies. To improve their effectiveness, research is needed to better quantify the full life cycle costs and benefits of alternative transportation modes and infrastructure designs. As security issues receive increasing priority in transportation system design, both synergies and tradeoffs between enhanced security and sustainability need to be explored.

Financial Incentives for Sustainable Transportation

Public funding for the development of transportation infrastructure made an enormous difference in the history of the American West. It will surely be of equal importance (either by its absence or its presence) in the national and international future, and that situation makes a reckoning with the word "public" in the phrase "public transportation" an urgent priority. There are two elements for sustainable transportation: the desirability of having such a system and the financial incentives for doing so. While much research has been conducted on the first, relatively little have been done to explore the financial incentives for constructing sustainable transportation systems.

One financial innovation is to negotiate a comprehensive partnership, rather than award construction to the lowest cost bidder. This has been practiced in many parts of the world, including to a limited extent in the United States. The paragraph below describes an example of an owner-contractor partnership agreement in The Netherlands, giving preference to bidders of public works projects who will construct an environmentally sustainable system. Similar methods were used in the building of West Rail of Hong Kong and elsewhere where environmental standards are stringent and consequently higher construction cost may require. We hope future research can be conducted to extend this practice to building sustainable transportation systems.

- The High Speed Rail (HSR) system in The Netherlands is being constructed in to connect the French TGV and German ICE to the Dutch cities of Rot-

terdam and Amsterdam. The environmental requirements of such large scale project are among the most restrictive in Europe. An American firm, Fluor, has led a consortium that has proposed environmentally friendly construction and taken responsibility for subsequent operation that will satisfy the stringent environmental and noise requirements in The Netherlands. This contract was negotiated with optimal construction and environmental performance, rather than lowest bid construction.

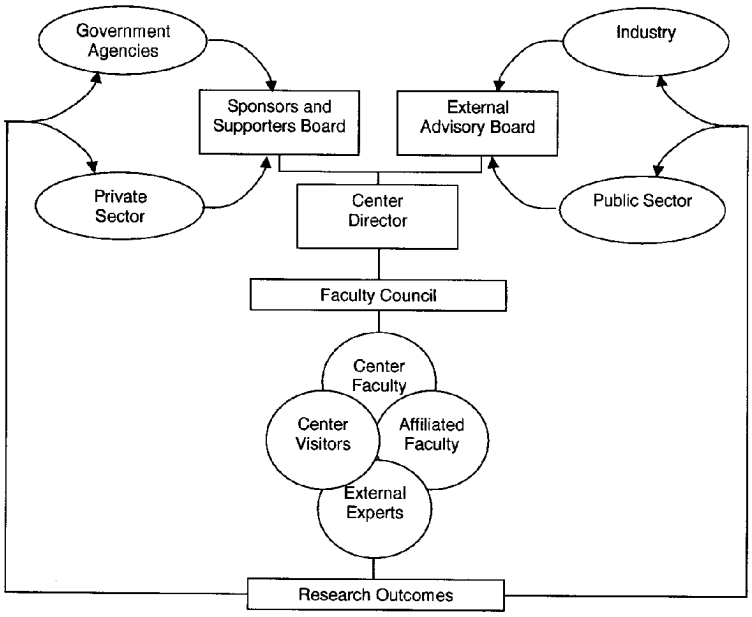
- A second example of innovative funding relates to the large picture of how to reduce carbon waste produced by industrial products. European investment banks and the World Bank are using Carbon Credits as an investment tool to compensate enterprises that are introducing new technologies to reduce the Green House effect. According to figures in the Financial Times in October 2003, a $0.98 credit may be traded on the open market for each tonnage of carbon that would otherwise be produced using old technologies. This scheme is benefiting oil and energy firms who are collecting such credits before projected future pollution penalties set by EU and other international bodies. Carbon credit is being traded as a real financial instrument; however, the credit goes to the manufacturer, not the end user. It is hoped that future research can draw together all the players involved with public transportation as incentives are sought for financing a sustainable system.

The two above examples demonstrate how one can encourage public investment in building sustainable transportation systems. However, much research effort needs to be devoted to this area of innovative financing for transportation systems. A sound financial incentive will secure a base for long-term sustainable development.

The allocation of public funding, and to a large extent private funding, in a free and democratic society based on the principles of capitalistic entrepreneurship present demanding challenges with respect to both transportation security and sustainability. Security and risk perception and trade-offs across societal choices will have enormous impact on our country's financial resources in the transportation sector. A broad comprehensive approach that has its roots in sound technological principles is urgently needed to guide future investment. Our country must have the knowledge to provide this guidance, and the wisdom derived from this knowledge to encourage free enterprise incentives concomitant with the goals of service, efficiency, security and sustainability. We must never forget the Native American saying, "The Earth was not given to us by our ancestors, it is borrowed from our children."

ORGANIZATION AND MANAGEMENT STRUCTURE OF THE CENTER

While a detailed description of the management structure of the Center is premature at this time, key attributes are conveyed in the figure below.



To ensure vision as well as focus for the Center, input from government agencies, industry and the public and private sectors must be formalized. These will be infused directly into the *Sponsors and Supporters Board* and the *External Advisory Board,* both through solicitation of views and through members of those constituencies serving as members of the boards. These boards will meet regularly with the *Center Director* as well as the *Faculty Council* in order to determine what projects should be initiated and how they will be staffed. The *Council,* in turn, will directly interface with the four principal resources of the Center, the Center Faculty, the Affiliated Faculty, the Center Visitors, and the External Experts, which form the core resource for conducting exploratory studies and research. Outcomes of the research and policy studies will then be directly transferred to government agencies, industry and private and public sectors.

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APPENDIX A

Physical System Performance

The University of Colorado at Boulder has renowned faculty in the area of performance of structural and geotechnical systems. Three aspects of physical system performance are of special interest for transportation systems, and are among the most active and acclaimed areas of expertise among the faculty. These are described briefly below.

Fracture and Fatigue

Fracture mechanics plays a most important role in the service life assessment of transportation facilities. Steel structures are prone to subcritical fatigue crack growth originating at poor welds, and aggravated by repeated loads, weathering (corrosion), and over-stressing. In particular, steel bridges built in the early 1960's are likely to have a high strength steel, but low fracture toughness, which may result in potential collapse.

Structural Deterioration

The deterioration of concrete structures manifests itself primarily through the formation of cracks. Whereas one would expect any reinforced concrete structures to develop cracks, shear failure (through cracking) is still poorly understood and in some cases critical, and nonlinear fracture mechanics concepts must then be used. Furthermore, chloride diffusion or carbonation can lead to a drop in the concrete Ph, which depassivates the steel, thus removing its inherent protection against corrosion. Once steel corrosion starts, there is a swelling of the steel resulting in cracking and eventually spalling (potholes) of the concrete. This can only be effectively addressed by fracture mechanics. Finally, modern bridge rehabilitation with fiber-reinforced polymers (FRP) has to rely on fracture mechanics to properly understand the various failure modes of these hybrid structures.

Foundation Failure

The performance of a transportation structure under extreme loads depends very much on the behavior of its foundations. For example, liquefaction and soil-structure interactions have a critical impact on structural performance under a major earthquake event. The deterioration of a transportation structure can also be caused by foundation settlements and scouring. Centrifuge testing is an important tool to characterize the constitutive behavior of soils and predict their behavior under different loading conditions. The concept of centrifuge modeling is quite simple. By testing an nth scale model under an acceleration equal to n times Earth's gravity, the important effects of gravity loading on earth structures and the control of soil's strength and stiffness properties can be faithfully simulated. Centrifuge testing can be used to study the safety of prototype designs and to validate analytical and numerical models. Thus, it can play a key role in the transportation research center because of its versatility in simulating various events that impact on the security of the transportation infrastructure. The issues of cost effectiveness in novel designs of critical protective structures and strengthening of existing structures can be conveniently addressed.

APPENDIX B

Summary of Activities

1. "An Established and Organized Program"

THE INTERNATIONAL CENTER FOR APPLIED INTEGRATIVE RESEARCH IN TRANSPORTATION

Over the next two decades, transportation issues will have major impacts on the economy, the security, the environment and the standard of living for millions of Americans. In particular, global economic competition and the assurance of secure movement of products and people will become crucial within the next 10 years. Concomitantly, transportation systems must sustain our communities and society as a whole. An integrated transportation research activity has been established at the University of Colorado to take the lead in addressing these issues, and a formal Center is being planned.

The Vision of the Center

The Transportation Research Center at the University of Colorado will include resident faculty researchers, special external experts, and students to provide the core competencies and the knowledge to be a national and international resource for planning and implementation of surface transportation systems. In addition, the Center will partner with local and regional government agencies and transportation enterprises to ensure that its research will be practical and adoptable. The Western mountain states are a very appropriate region for a national transportation center. The region has highly varied terrain, significant climate variability, long travel distances, as well as unique air quality and land development concerns. The need for integration of transportation systems to serve rapidly urbanizing, rural, and isolated mountain areas along with inter-regional travel provides opportunities for novel research and development. Furthermore, the Center will draw upon transportation expertise from around the world in bringing the greatest possible knowledge to bear on the transportation challenges of our country; while at the same time Center outreach will be directed to adapting the Center's integrated approach to transportation problems throughout the country and in other parts of the world.

Location and Geographic Resources of the Center

Colorado is the center of significant national surface transportation activities. The Fort Collins-Denver-Colorado Springs corridor has major crossing areas for the Nation's freight railroads, and there are ample experience and knowledge of railroad safety and route management nearby. The Transportation Technology Center (TTC), home of national and international rail car test ground, is located south of the Denver Metro area in Pueblo, Colorado. Because of its large site and modern facilities, it has become the preferred center of rail car dynamic testing in the world. With respect to urban mass transportation, Denver has the most extensive modern light rail network in the country, and leads the country in bus/rail service coordination. The Inter-mountain region is also the hub of highway design and construction activities, supporting a network of major north-south and east-west interstate highways. The I–70 West Corridor poses especially difficult challenges for providing easy access to the Rocky Mountains and points west that require innovation in tunneling, right-of-way, and new materials for elevated structures.

Faculty at the University of Colorado have been engaged in significant research on transportation infrastructure for many years, and over the past five years there have been almost 50 independent projects supported at the level of approximately $1.5 million per year, as described below. By bringing these individual researchers together, the Center will be able to make a significant contribution to emerging needs for transportation systems in the West, the entire country and worldwide.

2. "$1m/yr Transportation Research Activities for the Past Five Years"

RECENT TRANSPORTATION RESEARCH ACTIVITY (1999 – 2003)

Agency and topics	Number of projects	Funds Awarded
Colorado Department of Transportation (CDOT). Highway safety, highway infrastructure design and maintenance	15	$494,000
Colorado Local Technical Assistance Program for Roadway Infrastructure (LTAP). Roadway materials and testing	1	$750,000 (Total $1,500,000)
Federal Highway Administration (FHWA). Transportation infrastructure design, construction, and operation	9	$868,000
FHWA and CDOT. Highway/bridge safety and design	4	$2,400,000
National Cooperative Highway Research Program (NCHRP). Cost estimation and management, and best-value procurement for highway construction	2	$178,000
Washington State Dept. of Transportation. Design-build project evaluation	1	$120,000
Insurance Institute for Highway Safety. Methods to reduce crashes at rural high-speed intersections	1	$35,000
National Center for Excellence in Railway Mechanics, Sweden. Dynamics of train/rail/tie/ballast/sub ballast system under cyclic conditions	1	$95,000
National Science Foundation. Reliability and life-cycle analysis applied to design and maintenance of highways and bridges, durability of concrete.	9	$2,128,000
US Environmental Protection Agency. Air quality monitoring, estimation of exposure to volatile organic chemicals.	2	$236,000
California Air Resources Board. Modeling ozone episodes	1	$92,000
Federal Aviation Administration. Soil swelling and airport structure movement	1	$85,000
American Society of Civil Engineers. Optimal management of civil infrastructure	1	$5,000
Design-Build Education and Research Foundation. Lifecycle of transportation design-build projects	1	$45,000
TOTAL	**48**	**$7,486,000**

3. "Five Graduate Degrees (MS) Given in the Past Five Years in Transportation Related Field"

Only Master's degrees are listed here. Doctoral degrees are given in Appendix II.

1999

Miyake, Masaru, "Cost-Based Maintenance Strategies for Structures"
Frank, Dean, "Nondestructive Evaluation and Inspection of Structures"

2000

Ge, Yu-Ning, "Finite element analysis of staged construction"

2001

Noh, Jinil, "Reliability Analysis of Fiber-Reinforced Polymeric Bridge Deck"
Anderson, Melissa, "Source Apportionment of Toxic Volatile Organic Compounds"

2002

Omachi, Yoshiaki, "Lifetime Bridge Reliability Analysis under Fatigue"
Kawakami, Yoriko, "Life Prediction of Damaged Bridges"
Chanvut, K., "Corrosion Protection Methods for Reinforced Concrete Highway Bridges"

Xie, Z.H., "A Comparative Study on Corrosiveness of Different De-Icing Agents (Magnesium Chloride, Sodium Chloride, and Caliber M1000)"
Cusson, R., "Durability Properties of Fiber Reinforced Polymer Bars under Low Temperature Environment"
Hoyland, Jorg, "Analysis of collapse mechanisms related to the disaster at the World Trade Center, September 11, 2001"

2003

Sakulyanontvittaya, Tanarit, "Evaluation of ISCST3 and AERMOD for Modeling Benzene Dispersion in Commerce City, 2003"
Shane, Jennifer, "Design-Build Highway Construction: An Examination of Special Experimental Project Number 14 Performance"
Won, Spencer. "Classification of Life Cycle Criteria in Design-Build Highway Projects"
Wormer, Jeffrey, "Three-dimensional nonlinear analysis of slope stability in heterogeneous soils"
Woodruff, Ryan, "Centrifuge modeling for MSE-shoring composite systems"

4. "Three Full-time Faculty in Transportation Fields"

INFRASTRUCTURE SAFETY AND PERFORMANCE

Maintenance, Management, Reliability and Life Cycle Performance

Dan M. Frangopol, Professor, Civil, Environmental and Architectural Engineering, Director, COALESCE (Consortium on Advanced Life Cycle Engineering for Sustainable Civil Environments), President, IABMAS (International Association for Bridge Maintenance and Safety)
George Hearn, Associate Professor, Civil, Environmental and Architectural Engineering

Structural Reliability and Life Cycle Analysis

Ross B. Corotis, Denver Business Challenge Professor of Engineering, Civil, Environmental and Architectural Engineering, Structures Co-Director, Consortium on Advanced Life Cycle Engineering for Sustainable Civil Environments

ENVIRONMENT AND ENERGY POLICY

Environment and Air Quality

Jana B. Milford, Associate Professor, Mechanical Engineering, Center for Combustion and Environmental Research, Center for Science and Technology Policy

History, Development and Energy Policies

Patricia N. Limerick, Professor, History, Founding Director, Center of the American West

FACILITY DESIGN

Geotechnical Engineering and Centrifuge Laboratory Testing

Hon-Yim Ko, Professor, Glenn Murphy Chair of Engineering, Civil, Environmental and Architectural Engineering

Materials Engineering and Fracture Mechanics

Yunping Xi, Associate Professor, Civil, Environmental and Architectural Engineering, Director, Colorado Local Technical Assistance Program (C–LTAP)
Kaspar Willam, Professor, Civil, Environmental and Architectural Engineering
Victor Saouma, Professor, Civil, Environmental and Architectural Engineering

Dynamic Structural Analysis and Dynamic Structures Laboratory Testing

Benson Shing, Professor, Civil, Environmental and Architectural Engineering, Director, NSF Network for Earthquake Engineering Simulation Center

CONSTRUCTION MANAGEMENT

Construction Engineering and Management

Keith R. Molenaar, Assistant Professor, Civil, Environmental and Architectural Engineering
James E. Diekmann, Professor, Civil, Environmental and Architectural Engineering

TRANSPORTATION CENTER, UNIVERSITY OF COLORADO AT DENVER

Bruce N. Janson, Professor, Civil Engineering, CU–Denver, Director, Transportation Research Center

5. "Twenty Journal Publications in the Past Five Years"

1999—13 publications
2000—12 publications
2001—10 publications
2002—9 publications
2003—28 publications

In addition to the above, there were numerous reports and conference presentations.

BIOGRAPHY FOR JOANN SILVERSTEIN

Education

Ph.D., *Civil Engineering,* University of California, Davis, 1982 (Environmental Engineering)
M.S., *Civil Engineering,* University of California, Davis, 1980 (Environmental Engineering)
B.S., *Civil Engineering,* University of California, Davis, 1977, (Summa Cum Laude)
B.A., *Psychology,* Stanford University, 1967 (Honors)

Awards

Clarence Eckel Faculty Achievement Award, CU, Dept. CEAE, 2001
Faculty Appreciation Award, CU Multicultural Engineering Program, 2000–2001
Distinguished Engineering Educator, (national) Society of Women Engineers, 2000
Faculty Award for Women Scientists and Engineers, National Science Foundation, 1992–1997

Academic Experience

1998–Present—Professor, Dept. Civil, Environ. & Arch. Engr., Univ. Colorado, Boulder
1989–1998—Assoc. Professor, Dept. Civil, Environ. & Arch. Engr., Univ. Colorado, Boulder
1982–1989—Asst. Professor, Dept. Civil, Environ. & Arch. Engr., Univ. Colorado, Boulder
Registered Professional Engineer, Colorado #26151, since 1989.

Interests

Research and teaching in civil and environmental engineering, especially on the use of microbial processes to remove contaminants from waste water and water supplies, to treat waste water and biosolids for beneficial reuse, and to restore damaged environmental sites such as abandoned mines. Achieving greater diversity in the engineering workforce and academia by increasing participation of women and people of color.

Publications and Research

Over 50 papers in reviewed journals, conference proceedings, and books on sustainable remediation of acid mine drainage, nitrogen removal from water and waste water, pathogen survival in waste water recovery processes, biodegradation of toxic contaminants and health effects of land application of treated biosolids. Patent: "Biological Denitrification of Water."

Teaching

Twenty courses in engineering. Sixteen Ph.D. student advisees graduated since 1989, 11 in academic positions. Director, NSF-sponsored environmental engineering Research Experience for Undergraduates Program, sponsoring eight summer interns per year.

Current Service at CU

Department Chair, VCAC, Faculty Advisory Boards: Center of the American West, Women in Engineering Program, interdisciplinary Environmental Engineering program.

DISCUSSION

Mr. CALVERT. I have a couple of questions, and an observation I'd like to make. It was a movie a number of years ago. I don't know if you all saw it, starring Steve Martin, called L.A. Story.

There was a particular part in this movie where the character that Steve Martin was playing told his wife that he was going to go see his best friend. He went out of the driveway, got in his car, and he drove next door. And being from California, I didn't know what was so funny about that.

But as we talk about mass transit and you've mentioned, Mr. Luber, the concept of a monorail going up by Interstate 70 or Mr. Vidal, you mentioned the conflicts sometimes between trying to get people into transit, how do people accept it in this region? I know in the West, whenever I go in the West, because of the wide open spaces and so forth, it seems culturally people are attached to their automobiles. Is that any different here in Denver? How successful—I think for the whole panel—how successful have buses, mass transit rail, how successful has it been up here? People accept it?

Mr. VIDAL. I think—a couple of comments on that. I think we need to, in terms of the acceptance out here in the West, as you know, it's your God-given right to have a car, I mean, and people look at it that way. I think the acceptance is somewhat based on whether or not you've got a Light Rail line on your corridor—and right now, the Light Rail lines that we have opened have been incredibly successful. I think what—the education piece that's missing is that most people need to understand that these solutions are peak-hour solutions. They're not solutions to take your car away from you, and I think that's the big part of the problem. But I've got to say that part of the acceptance here is that—I always describe it as the Tarzan Syndrome, you know, when Tarzan goes swinging in the jungle, he's not going to let go of one vine until he sees the other one in his other hand. And I think that some of the lack of acceptance is just not having the facilities available.

And so right now your only option in many of these corridors is to take the car. So I think we need to educate our people in the urbanized areas that this is a way to resolve the problem for peak periods. Jason mentioned T–REX. If we were not doing that as a multi-modal corridor, it would require 10 more lanes. We would have to buy 500 homes and 200 businesses. You know, in the metropolitan areas, even if we want to stay attached to our cars, there's no room. We have got to come up with some other way to use the existing footprint and so I think we're dealing with that conflict of acceptance of Light Rail or transit over the car, but I think it becomes a necessity. And that's why planning for these things to be accessible and cost-effective becomes really important in urbanized areas.

Mr. LUBER. I agree with Bill about you can't force people out of their cars, you just can't, especially out here in the West. People just love to drive. I mean, that's part of being out here. You know, people like to do their own recreation thing. But I do believe that the Light Rail has been a good success in the Southwest corridor where it's going down the Santa Fe line. You'll look at the Light Rail that's already there and then you have an HOV lane along Santa Fe in the same corridor which nobody uses. That's just a waste of highway right there. HOV lanes are really a waste of good productive highway unless you put a dedicated bus service that would only go on that line.

Rail service is much better only if they can get people to where they want to go quickly, efficiently, faster than what they're going to do, or at least the same time as their cars, most likely it would be faster, but also cheaper. Parking downtown is very expensive now. And if you work downtown, let's say on a monthly basis, you are paying $100 a month, you pay $50 for the Light Rail, jump on the Light Rail anytime. I think that Light Rail down through T–REX is going to be packed Day 1 when it opens. It's going to be a great system. If we can find a way to expand that up to Boulder, here through Broomfield, up I–25, up through Loveland, and Fort Collins, and even maybe to Greeley, down to the South towards Castle Rock, and eventually maybe into the Springs. That would be a good way to go. But you could never ever get rid of people driving their cars. You just got to give them a better option than driving. Because I know during a Broncos game or even if I was going downtown—last night went to see Cirque du Soleil, I would definitely use it since I live down the Park Meadows Mall. I would have jumped on the train in a second just to get down there because it dropped me off where I need to go efficiently, relatively inexpensively.

Mr. HERNANDEZ. The question that you asked is more based on ridership. Keep in mind that in Denver, we have the number one transit agency in North America voted by the American Public Transit Association. We have regional routes that carry well over 5,000 people a day, and these are just buses, so the vehicle is actually not the kind of framework discussion we're having. We're talking about people choosing transit, people who are choosing transit. The town that we work and live in has an enormous, extensive transit system that interconnects. We carry five to six thousand people a day on our transit system along some routes. We've made investments in that transit system network so it's not so much the attitudes of people that don't want to ride transits. It's more of the attitude that is get-me-to-where-I-need-to-go-efficiently. And in some communities, they've been able to balance that need and they've had extensive growth in ridership. Other communities just have kind of piecemeal transit decisions which together have had lackadaisical results, so the idea of "Is a Light Rail going to solve the problem?" isn't really the best answer. It's more of our people's attitudes to use the connection actually better.

Dr. SILVERSTEIN. I think the element of choice has always played a role in the culture of our preferences in the West for transportation systems. And I think multi-modal systems, because they are inherently flexible systems, can speak to that cultural preference for choice. And so, I believe that the new systems that emphasize multiple modes of transportation are going to be a way to drive public acceptance of more sustainable transportation systems. So I would just speak to continue in on that line of transportation development.

Mr. CALVERT. Thank you. Mr. Udall?

Mr. UDALL. Thank you, Mr. Calvert. Yeah, and I want to thank the panel. Your testimony is very helpful to me. I am hoping we're going to have a couple of rounds and we'll also have some people here in the audience, particularly CDOT may be represented, and

if they are I'm sure the Chairman would be willing to have CDOT to share some of their perspectives as well.

Jayson is great to put a face to the name. We all here hear you all the time and thank you for being willing to take your time and share your experiences which I think will be very worthwhile and very helpful.

You talked about HOV lane on the Santa Fe corridor and you don't see it being used. Do you want to talk a little bit about what might be some options there in your point of view?

Mr. LUBER. Well, right now, at least along the Santa Fe corridor, there is not much room. They've done so much work down there—built some new bridges, incorporated the Light Rail—it's part of the Southwest project. It should just be opened up to general purpose lanes, at least at this point. Nobody is using it and it really is a waste of time. We've tried HOV lanes here on the north side of town, between the Boulder turnpike and downtown Denver. They're used occasionally. But in this city, you are not going to have people that are carpooling. You're going to have the occasional couple that might go into work, the occasional motorcycle that's going in there. It's very tough to get people out of their cars, especially if they want to be downtown, and let's say, you want to run over to the mall after work, or you have to go here or go there. I have never thought that HOV lanes are a very good idea. You just got to give people a better reason to get out of their car and onto something else.

Mr. UDALL. Uh-huh. You have an opinion on hot lanes or anybody else in the panel?

Mr. HERNANDEZ. On the hot lanes and on the HOV topic, when the lanes were constructed on U.S. 36, it saved eight minutes off the time for transit to get from downtown Denver up to the Broomfield Park and Ride. And so, the HOV lanes don't just serve a single purpose of getting people out of their cars. There are significant improvements for transit and if you ride the bus from Denver to Boulder, seven minutes is a lifetime so they do have definite improvements.

Mr. UDALL. Anyway, yeah I can see the point of it. It does help some of the buses that do move up and down there.

Mr. VIDAL. A hot lane would be a decent idea. People would want to pay for it, sure let them drive it. I mean, why not if you're going to get a little bit of revenue out of it. Cost is a huge factor in building anything, especially now with construction. The cost of construction is astronomical. So let the people who are using it pay for it.

Mr. CALVERT. Anybody else in the panel like to.

Mr. HERNANDEZ. You know, it's interesting to hear it, Jayson, if people aren't going to use the HOV lanes for free, why would they pay to use it? It seems counterintuitive. But I think all of these strategies, whether it's HOVs or hot lanes, I think they have their specific use on perhaps a specific corridor. But I don't think they're over—becoming overall solutions for every single congestion problem. And I think both the hot lanes and HOV lanes, part of the reason we don't see them as successful, is in a 24-hour period, yeah, it doesn't look like anybody is using them. But during the peak period, and I still want to concentrate on that, there are

transportation problems or congestion problems. What we really are measuring are peak period problems. And during those peak periods, the north HOV lanes do carry a fairly significant amount of traffic. But again, and you know, you see those lanes relatively empty for hours of the day when you don't have the peak period pressure.

Mr. LUBER. Even during the rush hour I have seen them, they're not very busy at all.

Mr. VIDAL. Well, they're at levels of service A. But I know that they're carrying thousands of cars for the peak period, you know, but it's at a much higher level of service than the congested lanes.

Mr. UDALL. I know this discussion will continue on that. In that regard, we have some other examples now with E–470 in the Northwest parkway to look at that in comparison. But I would like to move to I–70. I have the best congressional district in the country except for Mr. Calvert's. I want to be clear about that.

When the new district was drawn after the census was completed, I suddenly was representing some of the major highways and corridors in the state, I–25 North, 36th Corridor, and I–70. And I represent the Ski Counties of Eagle and Summit and Grand as well as Clear Creek and Gilpin. And those—their economies are dependent on recreational use, on people having access to the mountains, and I think Mr. Luber's experience is not uncommon to many of us. You talked about, you don't think the Maglev Monorail works, I want to let Mr. Hernandez talk a little bit about what he's learned and some of the work that he's done with those ski communities and what they think the solutions would be to these very significant challenges we have.

Mr. HERNANDEZ. Sure. And you're exactly right. They're huge and significant. Last fall, we completed the study for the town of Breckenridge because they were looking to transfer their state highway from Maine Street to Park Avenue. And one of the issues that they struggled with, and in the evening you saw that photo, you get just gridlock in downtown Breckenridge. And that's not what people want to see in Breckenridge. A lot of it comes down to how we get people up to Breckenridge, but also how we get people around Breckenridge once they're in town. And if you look at how a Light Rail system or a high speed corridor on I–70 would do that, it just falls apart.

People bring a lot of gear with them when they come up to the mountains. How do you get all that gear and those people from I–70 and Highway 9 all the way 12 miles into Breckenridge? Once they're in Breckenridge, you have to provide transportation for them.

When working with their resorts, we learned about how people actually get from DIA up to the mountains. Most of the time, they'll take a resort shuttle. Sometimes they'll rent a car. When you rent a car, you have mom and dad and three other people in the car, so dad goes off and go shopping, mom wants to play golf, the kids want to go the pool, and their daughter wants to go skiing. Well, those are five different transportation trips that can't be served by one vehicle. So it's very important to have a balanced transportation system in Breckenridge to serve all those needs. So

the need is not just to get the resort people up to the mountains and dump them at Highway 9.

The need is more for in-town transportation. We have a huge influx of people coming to the mountains now that didn't before with the buddy passes. And the buddy passes are fueling parking. And so Breckenridge is one example, you can look at—Winter Park is another example—they're trying to balance where they put their parking investments and transportation investments because they don't want these people to get out of their vehicles, get into a bus, and be carted halfway across town. So there are a lot of transportation issues that are locally based that would affect the regional transit issue.

Mr. CALVERT. But on the subject of, talking about research, and after a number of years of investing money in the actual construction, ISTEA, TEA–21 and obviously we're talking about a new transportation bill this year, hopefully we're going to conference here this next week and get the transportation bill passed. But it seems, whatever community that we all go to throughout the country, it seems that the money that we're spending is not obtaining the goals we would like it to accomplish. And as was mentioned by Dr. Silverstein, the cost of these projects in every case inevitably exceeds whatever estimate that was placed before. I mean, the famous one of course is the Big Dig in Boston, for instance. You'll be there shortly, I know. And of course the L.A. Subway system and it goes on and on and on.

What kind of research is necessary, do you believe is useful, and has results that are palatable and that shows that we're going to get our money's worth out of these transportation investments because we're talking about hundreds of billions of dollars in this transportation bill that's coming before us shortly. I think this is for the general panel. Doctor?

Dr. SILVERSTEIN. I just surveyed some of the transportation research projects that have been conducted at the University of Colorado over the last five years. An amazing number of them—virtually all—are single mode, what I would call single mode research projects. So there are things like highway infrastructure design and maintenance, road way materials and testing durability of concrete, methods to reduce crashes at rural intersections, modeling ozone episodes, surface swelling and airport structure movement. And these projects are largely supported by transportation agencies, which have as their own charge, single mode transportation systems, whether it's the Federal Highway Administration, the National Cooperative Highway Research Program, the Insurance Institute for Highway Safety, the Federal Aviation Administration, and university administrators, save for our part, have historically and unfortunately developed in-depth expertise on various circumscribed topics rather than investigating more complex systems with interdisciplinary approaches. And I think that funding agencies can have a very strong impact on the kind of research that gets done on transportation. And that as funding agencies broaden the scope of the problems that people need to investigate—or the scope of solutions that need to be considered—then research will begin to deal with more relevant problems.

You've mentioned the safety legislation. There's an interesting part of the safety legislation called Alternative Park Transportation Program. And it just struck me that the Rocky Mountain region, of course, has at least three national parks in the state, which could be added to that program which could provide a great opportunity for looking at multi-modal and modal transportation solutions to what can also be a significant transportation problem in the State of Colorado.

Mr. HERNANDEZ. ISTEA and the reauthorizations were really important. If you leave today and you go a little bit further north, you'll see this great underpass that was built as part of a research project that was funded exactly by that program. It allows children that wouldn't be able to cross the eight-lane 40 to 50 mile an hour roadway—they can do that now. They can get over to a grocery store, they can get over to daycare, they can get to the park across the street.

The Embarcadero area in San Francisco, much of the great pedestrian places and activity that's happening there came out of research and how you actually get people from transit to land uses. Zion National Park has implemented a program where now you park at the park entrance—that's a good way to put it—you park at the entrance of the park and you get on transit, and you take transit vehicles throughout the park. The wildlife is coming back to the park, emission in mobile sources are down in terms of pollution in the park, and that all came out of this legislation in research. I could go through a long list, but yeah, I mean, the Big Dig, yeah, that may not be the best case example for the research, but there are plenty of successful examples all around the country.

Mr. LUBER. I guess my point is—I would think research for each area has got to be specific for the area. I mean, what happened in Boston is not going to necessarily happen here and nor would it work for us here what happened there or elsewhere. We just got to find out what's right for us, for the communities that live here, for the people that live here, what they want, I mean, at the service of those people. I mean, that's what we're in the business for.

Mr. VIDAL. I gave you several areas to consider but let me concentrate on a couple. And one of them, having built a lot of highway projects in the State of Colorado and the change in scope and price, I got to tell you that we work a lot with long-range plans. It's very difficult for a 20-year plan to accurately predict what I–70 West would cost. And so, I think that we need to be careful with that scope issue because a lot of times you need to actually be in the design of the project before you can actually get to what's the actual cost. But perhaps some research on what are some best practices on scoping projects for long-range plans is probably an important piece.

But I would just want to comment that part of what I see as the problem, having worked in the transportation field now for 30 years, it's difficult to articulate what the heck our goal is. What is it that we're trying to achieve in our transportation system? Is it that we are trying to get off use of the gasoline because that would certainly necessitate something. Are we, you know, are we—what exactly is it that we trying to do? And I can tell you right now we have no clue what are congestion relief goals in urbanized areas.

There is no place in the country right now that measures the congestion and what it means. What is it, what is the, you know, we have levels of service, you know, A through F, but we really don't talk about what can we do to relieve congestion, what is an achievable goal that we should go after. And that's why I would say we really need to do some research on how do we deal with congestion relief? How do we come up with a congestion relief management system as we have done with maintenance?

And a lot of times, we talk about maintenance as, you know, when we talk about maintenance, we talk about the structural value of the inventory. You know, what's the pavement structure? What's the bridge structure? And that's what we talk about under maintenance. We never talk about the de-grading of the levels of service of that road due to congestion. And so, it really is an area that we're not spending any time on and it's hard to articulate what we should do. I would submit to you that I think for the urbanized areas, trying to come up with some measurements for congestion and how to budget money for congestion and what it means to do so will help.

And I think last but not the least, we clearly under-state or we don't talk enough about how badly we're under-funding our transportation systems. You know, we—not only are we not really clear about what the goal is, but we're really not talking about how much money it would really take us to meet that goal we're trying to achieve. And in many cases—yeah, I can tell you building highways in a metropolitan area, the day we opened them they were already at overcapacity, you know, and so—and I'm sure that's the same way all over the Nation. So we're clearly under-funding in this area and we can't really articulate what it is what we're trying to achieve especially on the congestion relief side.

Mr. CALVERT. Mr. Udall.

Mr. UDALL. Thank you. I have to hold myself in check because with so many people here from the 2nd district and all of us who live along the 36th quarter on the I–70—and concerned about I–70, I want to talk about all the specific problems and the dynamics that are at play right now. And we hopefully will have some more time to do that but I also want to—as the Chairman has done, focus on the research needs and the overall efforts that we've put forth. And, again, the panel has been very helpful in that regard.

Mr. Luber, Mr. Hernandez, you've talked, and I want to direct this to Dr. Silverstein, about being area or regional-specific in our research. And can you talk a little bit about that, particularly, in terms of the mission you have but also are we doing enough of that when we deploy these dollars? Do we look at the regions? And are there other formulas that are useful countrywide that are applicable in any metropolitan area or in any multi-modal situation?

Dr. SILVERSTEIN. I think both. Certainly the current Department of Transportation policy of partnering with regional transportation agencies is very, very important in understanding that a lot of transportation problems, I think, have to be solved in a regional context. I'm an environmental engineer and certainly one of the things that I've observed and just thinking about as we're talking today, we have a tremendous impact on the environment just because we've paved so much of it. I'm on the board of a foundation

in California that's looking at the impacts of beach closures in Southern California which is very, very significant to towns like Huntington Beach. And part of those beach closures stem from runoff, urban storm water runoff. So that kind of relationship—what I'm talking about is the importance of regional considerations when you're looking at transportation systems and solutions to transportation.

On the other hand, I believe that some of the tools and methods you use to develop regional solutions are portable. And so you can generalize on the tools that you develop and take them to other regions or even internationally, provided that you understand what are the local aspects that are there on the project and what are the portable aspects that are there on the project.

We can—people on our construction engineering management group are looking at the ways that projects have been financed in Europe that encourage sustainable or so called "green transportation systems," and economic incentives for green development. Not certainly a portable concept as long as it applies to our own market-based system of making choices for building projects. So I believe in the importance of developing solutions in the context of regions and regional environments but I also believe in the idea that we can learn from each other in various parts of the world.

Mr. UDALL. Mr. Hernandez, you want to comment?

Mr. HERNANDEZ. Sure.

I think there's definitely applicable research that could happen in Colorado that can affect other areas. Give you a specific example. University of California, Riverside is getting ready to expand their campus across a major arterial beltway. And they're trying to deal with how do you get pedestrian activity—students across both sides of this major highway. They came to Boulder and looked in an example of Boulder in Broadway. And what we've done in Broadway is built a spectacular underpass so that the students on University Hill can walk to the campus and vice versa. Professors can go up on the hill and get lunch. University of California, Riverside took that example to heart and now they're designing their campus with that integral part into that.

So the examples that we have in this region can provide case studies for other areas. I also think that regionally as well, Aurora is not exactly going to do what Boulder's going to do and we know that. But there's things in terms of congestion management techniques that could work for both places, that could work in Austin, Texas, that could work in Davis, California, that could work in Redmond, Washington. So, yes, these examples can apply across the board.

Mr. LUBER. And as Mr. Hernandez said, Boulder's going to want something different than downtown Denver. And the research should be, what do these people in these communities—how do we get these people around their city. So let's get people around there around people in downtown Denver and then connect them. Get people around Broomfield. So let's find out how to get these people—because it'll be different for the people that live inside of Boulder, they'll want a different way than in downtown Denver with the 16th Street Mall or how they are going to walk around—there'll be a lot more walking around the 16th Street Mall than there will

be in Littleton just because of the wide open spaces. So we just got to find a way to get those people moving in those communities and then link those communities together.

Mr. UDALL. If we do too much of that, are we going to put you out of work?

Mr. LUBER. Yes. I guess in a perfect world, yeah. I mean, you would have that. I mean, like in a perfect world, nobody would speed and the police wouldn't be able to get that revenue.

Mr. UDALL. I guess I owe you an apology.

Mr. LUBER. Those speed control vans wouldn't be around. But, you know—yeah. I mean, we're always going to have, especially as Bill keeps talking about, in the congestion times, the morning and afternoon rushes to work and to home and that sort of thing, or to a Broncos game or to a Rockies' game, obviously we're going to have those issues. Right now, I'm sure, traffic is sailing along the Boulder turnpike if there's no accidents or stalls out here. I mean that's just the way it is. So we're looking at ways to get people around efficiently, easily, especially in a congestion—in most congested times of the day. And that's really what we're looking at.

Mr. CALVERT. When we solve all these traffic problems, you'll get into politics.

Mr. LUBER. Okay.

Mr. CALVERT. Perfectly.

I congratulate the panel. You've done your homework. I represent the University of California, Riverside and I also represent part of the coastal communities in Southern California, so that's great.

One of the other issues that, obviously, we're concerned about as a committee when we do this research is that it's practical. I mean, that we can get—you know, we do a lot of things in Congress that's somewhat visionary but when it gets down to transportation or water issues—I chair the Water Committee—at the end of the day, we've got to do something that works and works for the tax payer in the most efficient and effective way possible. And the research that's been done to date by the Federal Government, has it been practical? Has it been effective has it been efficient? And are there ways that—obviously, that I surely would think that there would be—ways that we can improve that to make sure that it works here in the Denver area or in Chicago or in New York or wherever we're doing that research.

Mr. Vidal.

Mr. VIDAL. I think a lot of money has been invested in doing research on materials, improving construction methods, standards. And that research has been tremendous. I think, you know, every transportation department around the country really benefits from that and you have a certain amount of standardization and expectation that's, I think, been incredibly valuable. I think on the planning side, it's pretty poor and I think that's probably where we need to spend some money.

And, you know, I articulated a few things but I can tell you—and I've seen this from the DOT side and then from the MPO side—ISTEA has language about collaborative and cooperative planning and resource allocation, all of those things. I think only a state or two have figured out exactly what that means. And I

think that those are the areas on the planning side that I think we can spend some money, what are best practices, you know, where are some of the partnerships working, where is integrated planning that considers land use and transit with highways being done, how is it working effectively? Because I think right now, every state is kind of up to their own doing and I just don't think there is that resource to get those best practices, and to figure out how that should be done, and how do you form those partnerships.

Mr. CALVERT. You see much money being spent in research on traffic management. For instance, you know, I have to go back to my own experiences. When we had the Olympics in Los Angeles, everybody was horrified that L.A. would be more at gridlock than it already is. But remarkably, they spent a tremendous amount of time to work with the trucking companies, working with commuters, working with major employers to stagger times when people went to work and so forth. And it worked. And then after the Olympics is over, it all went back to what it was.

Mr. VIDAL. Exactly. Exactly.

Mr. CALVERT. And, you know, it had the same, I think, issue in Atlanta. And then so—I mean, I think that probably a normal citizen will think, "Well, why don't we do this all the time?"

Mr. VIDAL. I think there's a—when I was with CDOT, I had to manage the traffic control and crowd control for the Pope's visit when he came here in '93 on the state highway system. Actually, I'm Catholic. My mom was always sorry I didn't become a priest but she was really proud that I actually helped the Pope. So that was a—but——

Mr. CALVERT. You're a good son.

Mr. VIDAL. Yeah. But having said that, you know, the reason it worked is you scare the crap out of everybody that it's really going to be crowded and people listen. So for those special events, everybody knows, yeah, we're going to have to do something different. What I see happening—and that's where I mentioned in here about researching the value of the TDM strategies is that since there's such few dollars and there's such competition for dollars, they're all either going to go to highways or transit.

We haven't figured out a way to articulate the value of these strategies on a permanent basis, that if you do this, this is how it's going to reduce traffic congestion or what have you. And that's an area that I think we need to work on because right now, the TDM strategies are left to the new—it's almost a marketing strategy. Can you convince somebody to do it? But there's no particular mandate, there's no particular incentive, there's nothing tied to doing that. So you'll get it on special occasions or during a crisis situation, but you just don't get it on the regular basis and then the competition of the dollars just goes to the two main venues that we end up talking about.

Mr. CALVERT. Any other comments about it?

Mr. HERNANDEZ. I just want to say a few things on research. And the first thing hasn't been said. The research that we're talking about is to help out people that are, like, working upstairs right now, people in Engineering and Public Works and Planning Department. They need a resource they can pull off the shelf when they're reviewing a plan, when they're reviewing a land use deci-

sion that has 30 homes that says, "Oh, here's what happened in Palo Alto, California and this was the implication of this decision." They need a resource like that. We're not talking about huge, large capital dollar expenditure or research grants. We're talking about things that you could spend a reasonable amount of money on and have a big impact.

The second part is we're in, kind of, a new era of research. I work with city planners and engineers everyday. And most of the research that they go to is no longer from the shelf. They go to the internet for research. They go to photo examples. They go for live cams on state highways that show traffic congestion, that show all different types of factors. So the research that we're going to do in this next era, with this next reauthorization of the bill, is going to be different than we've done previously. That might lead to better results because that what you and I've been asking questions on, how are we actually going to get the bang for the buck. And using this new technology that's around, we're going to get a lot of bang for the buck on it.

Dr. SILVERSTEIN. I think one of the interesting things about—and we see this in university research all the time is how do you disseminate your work. And we've talked about things like decision support where fundamental research can be used in the service of professional decision-makers and planners. But I think there needs to be another step of outreach where research is shared with the general public. And there's communication of research, active communication of research with all of the stakeholders that are involved in transportation planning. And I think that's an area where we really haven't done a lot of work exploring all the methods that we can use to do that well.

Mr. CALVERT. Mr. Udall.

Mr. UDALL. We were just talking about this concept of intelligent transportation system technologies. And they've been heralded as providing some real time solutions. And I don't know if that's really the case or not and I wondered if the panel would be willing to share their opinion. We'll start with Mr. Hernandez, Mr. Luber, and Dr. Silverstein.

Bill's always got an opinion so...

Mr. HERNANDEZ. They're working. We could get online right now and find out when the next speed bus is going to arrive at the Broomfield Park and Ride within 30 seconds. We could find out when the next bus would be around right after our lunch appointment. So the ITS systems that were developed in a highly sophisticated level trickle down into all types of transportation modes now. In terms of, we're talking about the Breckenridge example, they use ITS during the day and in the evening. So when you get off the gondola at the end of the day and you get to the parking lot, there's a sign and it tells you the congestion at I–70. So you know that you could decide, should I stay in town and have dinner? Or is the congestion at I–70 really low and should I go now? The joke that various resource programs assigned will say that congestion's always bad on I–70 so everyone stays in town and eats. But the idea is, is that——

Mr. UDALL. How is that metric expressed? Is it and hour away toward—is there different levels of congestions that.

Mr. HERNANDEZ. Yeah. I mean, in terms of congestion, it's all relative, right?

Mr. UDALL. Yeah.

Mr. HERNANDEZ. But the way that they program signage and the way that they actually plan the systems, this technology is very accessible.

Mr. UDALL. Dr. Silverstein, do you have——

Dr. SILVERSTEIN. I think the other the issue that—I think that's very important as well. Intelligent system is a result of all of the IT developments in the last decade or so and really can be important. And the other is the possibility for control systems and expert systems. So that would be the next level. We have one level which is monitoring and sharing information, things like letting people know about congestion or where a bus is. But then we have the next level where a system could perhaps be programmed to actually respond and change the way it's operating based on specific conditions at any time. And I think that's an area for future research. Certainly that's not implemented across the board but, again, it gets into that—it speaks to the flexibility that I think will improve people's feelings about the responsiveness of their transportation systems to their needs.

Mr. LUBER. Yeah. I mean, I'm obviously in the communication business, information sharing business. For me, it is vital for the drivers to understand what's going on ahead of them.

If you've never been stuck in traffic—and I'm sure everybody has—you just want to know, is that an accident, is that a stall, or is it just the regular every day slowdown that I'm dealing with. And that's obviously what I do for a living.

And so variable message signs are a great way, I've seen some cities—we have some of those, they kind of tell you if there's a big accident or a highway closure. We could have more of those that just alerts the drivers even if it's just some congestion ahead: 15-minute travel time from where you are now to get to, let's say, downtown Denver.

The CDOT website is outstanding in its development of getting information to travelers before they even leave the house. They have a speed meter where they have sensors, road sensors that measures volume, speed. That could be expanded to many more of the highways than it is now. They have some cameras that show traffic that could be delivered—it's already delivered to the TV stations where they can get live video from that. On the website, they could also either deliver what? Live video or more frequent updates. Delivered to your cell phones. People have the GPS units now in new cars. Traffic information could be sent out from CDOT or from whomever. It could be a partnership with a broadcast station like mine that then sends out a signal to a cell phone and that says, "Hey, you're going to have the backup just ahead," that kind of a thing.

It's just all about information. The more information somebody has—if we're just going to be doing information and we want to obviously wait on wider roads or more transit and that sort of thing. Information is a big key especially in these sort of things.

Mr. UDALL. Bill, do you have any experience with——

Mr. VIDAL. Yeah. I think——

Mr. UDALL. Trails and transportation?

Mr. VIDAL. I think a lot and we probably all have had an opinion on traffic signal timing, for example, and coordination. I think there's two answers to this. And one is the importance of having good information and how good that is and how important it is that you know the next bus that's going, coming or you know, that's congestion—and that's one piece of it.

I think the other piece is optimizing the performance of that corridor. And unfortunately that continuously needs to be done. A lot of citizens don't notice it because it's incremental improvement. And so it might be, you're sitting at a signal light 10 seconds shorter, you know, kind of thing.

Or—so I'd like to see some research concentrating on that optimization of the corridor itself. I mean, it's great to have information but knowing why I'm in the jam doesn't change that I'm still in the jam, you know, that it just says that I know why.

So I think the two areas to look at is definitely incident management which continues to be an issue that how do we get those traffic accidents off that corridor as quickly as possible? How do we do it legally, how do you coordinate the law enforcement agencies, the EMTS, and all of those people that move those incidents off the road?

And then the other is, just going back to traffic signal timing, clearly we need to continue the smart signals so that you can have the different signal timing for different times of the day. Clearly, most of our signal timing is done for rush hour traffic but that changes at 10 o'clock in the morning and so on. So I think the development of those kinds of technology is still important to pursue.

Mr. CALVERT. I'd like to just follow up on these concepts here because I'm sure there's people out in the audience and people probably watching would say, "Why are we spending any money on research?" I'm going to ask the question just because I'm sure there are folks out there. "Why don't we spend every nickel on adding lanes and adding more highways rather than spending money on research because, simplistically, if we add more lanes, doesn't that relieve congestion?" And I guess that would bring this question: "What has research told us about the effect of expanding highways and roads on congestion? Does that help?"

Mr. LUBER. Well, it's kind of like—yeah. The field of dreams, that if you build it, they would come. If you're going to build a highway as we talked about, people will drive on it as——

Mr. CALVERT. (Unintelligible) I used to have a saying on the water, well, don't build it, they come anyway.

Mr. LUBER. Yes.

Mr. CALVERT. And they do.

Mr. LUBER. Yes, they do. Exactly.

Let me—and obviously, we've talked about, I addressed that in my opening statement is, there are some areas that you can't expand the highway to 15 lanes. And they've tried it in Atlanta and then the highway is still jam-packed during rush hour. It's unbelievable. If you've ever been in downtown Atlanta and you have 16 lanes of highway right there and it is still jammed solid. It is really unbelievable.

Mr. VIDAL. I also think that there's not enough information on the kinds of land use that accompany the kinds of transportation solutions. If you're going to build a 16-lane highway, I can tell you even a six-lane highway, you're going to really affect the livability of the community you're going through. And I think that that's a conflict that we have right now in understanding what the consequences, I think specially in urbanized areas, what the consequences of the different techniques are.

The other is, we have no real clear understanding of what it costs to widen lanes and we always—those comparisons with transit always come out well but, you know, I've done this alternative selection often. When you consider transit, you've got to consider the cost of the vehicle, the vehicle itself, where it's going to be stored, the cost of operating that vehicle. When you consider highways, you're just considering the concrete and asphalt so we have a misconception of "Gees, you know, we got a lot of money, let's just put it in to more lanes because that's the easiest thing to do." And the fact is, in the urbanized areas, it may be the most expensive thing to do. And again, I think we need to figure out a way to communicate what does each form of transportation encourage in terms of land use, effects on the livability of communities, and what's the real cost to differentiate between the two.

Mr. CALVERT. Mr. Udall.

Mr. UDALL. Let me, if I could, talk about a particular problem not only in the I–70 corridor but most corridors had some noise. And we hear a lot about noise and it fits what Mr. Vidal's talking about in terms of livability. Bill right now is really feeling like they have to do something because the noise is really plaguing people both who live there and people who visit. Bill, what do we know about noise technologies? I know there's—noise is created more by, I believe, tires on the roadway than the sounds of engines and/or the cars' movement through the air. Could you share with me the ideas that are out there and maybe any successes, and I'm looking at Mr. Hernandez and Dr. Silverstein in that regard.

Mr. HERNANDEZ. Sure. In the Vail corridor, especially one of the big issues is the "jake brake" issue. So, that's the largest source of noise. Tires obviously are another, but "jake brakes" are pretty large. You know, on the noise issue, from a local community's standpoint, I now use Crested Butte as an example because it worked in Crested Butte. We looked at a study that talked about having buses circulate between the town of Crested Butte and mountain Crested Butte versus a having a gondola system and the decibel differences that we presented to the public in the alternatives made it become one of the most feasible options for the study.

So, I think that the sound considerations are huge. When the people are thinking about the long-term livability of their community, but I don't—I'm not an expert on pavement technology or decibel readings, but I know that when we work in communities and we talk about bus transit systems, the conversation always comes up about diesel motors and about the decibel ratings of those vehicles. And we try to present alternatives for all different types of fueled vehicles to eliminate the decibel concerns.

Mr. CALVERT. I'm curious, we have all, I think, spent some time in the Crested Butte area. Are you suggesting that gondola was a better, more cost-effective, quieter option or was it the buses back and forth between the two towns?

Mr. HERNANDEZ. Actually—yeah, during that study, what we looked at was the feasibility of connecting the two areas together. And the public really caught on to the concept of loud diesel buses between these two areas would have a large impact. Diesel buses would be sitting in traffic stream of the people trying to get back and forth. And so, when we presented the third alternative which was the sound and noise, they really caught on to the gondola concept, but obviously there were environmental impacts associated with running a gondola between some pretty serious wetlands between the two areas. Likewise, Breckenridge is dealing with that same issue of, "Do we do gondola, or do we do bus to get people from the town up to the mountain?"—Same wetland issues, but they've also talked about what a transit center would really feel like in downtown Breckenridge with noise, with emissions and so forth and have a look at other options such as gondolas.

Mr. CALVERT. So, both towns are still in the process of determining what option they might embrace?

Mr. HERNANDEZ. And a hooky here. So, what we did was we looked at Telluride, because Telluride has the gondola that carries people back and forth. We looked at Park City—we looked at areas that had built systems and used that for our pair of examples. So that's why the research is really important to that problem.

Mr. CALVERT. Dr. Silverstein, do you have experience in this area with noise.

Dr. SILVERSTEIN. I was just reflecting that—so noise is not my area—but noise is similar, I think in some ways to odor, which is very close to my area as an environmental engineer. And it's kind of the unseen "sleeper" problem that always comes up around particular things like wastewater treatment projects and noise, same thing around highway projects. It's not the first thing you think about when you think about the impact of a transportation project.

And I really agree that research is important in considering then mitigating. You can have technical solutions which involve vehicles, roadways, noise barriers that do the source control for the noise. You also can deal with planning issues like separation of the source of the noise, the highway—in a particular case where a train—from where people are living. And those are decisions that need to be made in a kind of a balancing mode, I think with active participation of the public and all these decisions are made.

Mr. VIDAL. Just to live up to my reputation of having an opinion on everything.

Mr. UDALL. Who said that?

Mr. VIDAL. You did, Mark, but having built some barriers in my career, it's funny, because I think this is one that the technological solution, because there are things you could do to the pavement or, you know, the road itself, there's a psychological factor with noise and livability. And just so you know, the design criteria for the height of a noise barrier is a six-foot person standing on their patio looking at the highway and where do you plan on putting the bar-

rier, and then you look into the point that it intersects their line of sight.

And so, there is a psychological aspect to noise mitigation that has really nothing to do with technology of whether or not you make the road quieter. It's just the perception of traffic coming closer or there's more of it to your backyard. And so, the solutions for noise sometimes are more psychological than they are technical.

Mr. UDALL. So you're saying this relates between the visual proximity to the highway or the sense that the traffic is close to you and that affects your sense of——

Mr. VIDAL. Right.

Mr. UDALL.—sound?

Mr. VIDAL. Exactly. If you live right next to that highway, the fact that you see more traffic on it or that a lane was added that brought it closer to your house, you are naturally going to perceive that it's going to be noisier. And it may more than likely will be. They may not exceed the 65-decibel barrier that we have for noise barrier, but there's a psychological, "I have been—my property has been damaged as a result of the increasing traffic or bringing traffic closer to me."

Mr. CALVERT. So, you have—oh, yes.

Dr. SILVERSTEIN. I just wanted to bring up another issue that I've seen some research in that's also similar to noise and that's light pollution. Obviously, transportation facilities, particularly highways light use is a major safety concern, but on the other hand, for people who live near these systems, light contamination is a very, very strong psychological factor in their response to the impact of the system. And another area for interesting research is finding ways to light these systems that don't result in impacting neighborhoods that are near highways or transit systems.

Mr. CALVERT. I have one more question for Mr. Vidal. You mentioned something in your testimony that kind of reminded me as something. I was in China a number of years ago for the first time. I think it was 27 years ago. And I remember they put me up in this very nice place and it came to my attention that some people were more equal in China than others. And so, you mentioned that some miles are more equal than others and I wonder what you meant by that and what kind of research should go into that.

I think I understand where you're going with this, but as the regions pay taxes, as you know, states pay taxes and the feds pay taxes, we all pay taxes—and we start making decisions on where that money should go. And of course, from our own parochial interest, we wanted it to go—where it does the 2nd District of Colorado the most good, or 44th Congressional District of California, but there may be areas in which they have more necessity than others. So, I suspect that's where you're going, but why don't you ask—answer the question?

Mr. VIDAL. I think, you know, again, having been with CDOT for 23 years, having been a Director, being around other directors of DOT, the tendency by Departments of Transportation, which are on the most part highway departments, is the argument that maintenance of the system has to be at a higher level of priority than everything else.

And so, I mentioned that here in Colorado, maintenance of the system has a higher priority than dealing with congestion relief. And I think that if that's the philosophy that's going to continue, I'm just arguing that perhaps it's not maintenance of the whole system that needs to take priority over everything else but maintenance of the key elements of the system so that, you know, for example, congested roads have a higher maintenance standard than lesser-congested roads, or farm-to-market roads should have a higher standard than just railroads or, you know, truck routes should have a higher standard than non-truck routes. To at least find a better balance between this argument or not, we have to maintain our existing infrastructure and deal with congestion.

Colorado has 22,000 miles of state highway and I just would submit to you that not all of them are equal. And not—the maintenance of every 22,000 of those miles should exceed saved in with congestion in the metropolitan area. And so, I'm just thinking that maybe there should be a tiered system with different maintenance levels where you can argue what's the imperative maintenance level for that system.

Mr. CALVERT. Any additional questions, Mr. Udall? The people from the audience you would like to recognize?

Mr. UDALL. You know, I don't know that we've given the representative of CDOT a chance to prepare but I would ask unanimous consent that CDOT be included in the record of this hearing and in regards to asking questions of the panelists or including its own statement and its own—providing its own perspective on how we direct this research to others and what conclusions CDOT has gone through its years of work here in Colorado.

Mr. CALVERT. If the gentleman would like to come forward and state his name for the record and his address, he certainly could answer your question. You're all ready to go.

You don't want to push him on the spot. You're his constituent, so we're not going to put you on the spot. Would you like to just come up and please state your name for the record and your address?

Mr. GRIFFIN. I'm Rich Griffin. I'm in charge of the research program at the Colorado Department of Transportation. And I just got word of this conference or this meeting about a day ago, and so I had to—checked that I shouldn't even be coming here, but I'm here and I just wanted to observe. I'll make some general comments that CDOT is very sensitive to the issue of measuring congestion. That's one of our emphasis areas, to come up with performance measures for congestion. So, that's right on target with what Mr. Vidal has said.

I'd also like to say that there is—we have some broader interest besides just congestion. Some of our strategic areas for research—or if we feel this is at a national level 2 of safety, there's a lot of people dying on the highways, 40,000 a year or plus on that end—there needs to be some serious focus on research in those areas, too.

Mr. CALVERT. Thank you, gentleman. Any questions for——

Mr. UDALL. I would thank you for being here and for CDOT's interest and involvement and again, please pass on our regards to Director Norton and we would leave the record open for comments,

additional questions from the panelists. We understand that CDOT plays a crucial role on these research dollars and our transportation systems and our quality of life here in Colorado. Thanks for being here with us today.

Mr. Chairman, do we have other members who might want to speak before, you might want to make a final statement?

Mr. CALVERT. If the gentleman would state his name and address?

Mr. RAPP. Yes. My name is Ed Rapp and I'm from the corridor. I'm a retired Federal Officer and a retired College Professor and a retired County Commissioner from Ouray, and I want to comment about some of the things particularly looking at the research that you all must come to grips with. And I think an essential research question, as simple as it might be is, "What do we do when the well starts to run dry?" Eighty-five percent of all of the funds or all the cost of transportation are tied up in energy, principally around oil, whether it's to run the vehicles or asphalt, which is the primary concern with the planning that affects the outcome for transportation of children who are now born in Colorado.

And that transportation cannot be solely dependent on petroleum. It has to be a broader thought. We've gone through a couple of TEAs, you know, ISTEA, TEA–2, and now you are considering a very important transportation rules of the game for the next five years. If you take the I–70 sample and listen to CDOT, CDOT's event is to—it makes it wider and blacker. That won't work. We have to step back and make another assessment of what transportation will be in the future. And wider and blacker won't cut it. You take up—you won't be able to make anything wider and blacker on I–70 for 10 years and then through Clear Creek County where I serve as $1-a-year County Engineer. That's a 14-year construction period. At the end of that 14-year construction period, with the new widened highway, the hours of congestion quadruple.

In other words, we're going backwards. And I urge you to put research into a new mode or an additional mode and that is high-speed inter-city mode of transportation. Probably the FTA mode and the things that FTA is researching fit better in the mountains, that's a lightweight, medium-speed, 120-miles-an-hour max speed systems. They probably fit better with the mountain and FRA models probably fit better in the East and on the Coast. But we need a very agile, fast, relatively environmentally sound system. And there are numbers that are now emerging to be deployable.

I think that in the next five years we would be making decisions in Colorado about which system to deploy along I–70. Contrary to the anecdotal information you've heard, both that will be a necessity because we can't suffer to commit the citizens along I–70 to give up their first home so that someone can get to their ski area four hours later by car 20 years from now. Or give up their first home so that somebody from the Denver Basin can get to their second home four hours later than they are currently able to do with a highway-only solution. Given the energy crunch, we have to get a lot more traffic throughput on a very narrow right-of-way and a high-speed monorail will give you an equivalent of eight Snow Cat lanes as opposed to highway widening, which gives you two additional lanes, one in each direction.

So that—it just does not make sense that we don't begin to really look at these aspects of that kind of an intermodal system. And that's the deployability of the existing systems. You have the German system, which was deployed in Beijing, probably too big, too heavy for our situation. You have the HSST in Japan, HSST–2 would work beautifully but it needs to come forward a bit more in deployability. We have several that exist in this country that are probably four years away from deployability.

We have one system that has a great potential, but it doesn't have any corporate sponsor and NASA—the Spanish system, called Eurotran Montebega, which was tested about 20 years ago and a steel version probably could be brought forth—very inexpensive, but it's those deployabilities that need to be researched. The constructability needs to be researched whether the system is able to be constructed over itself as you move through the territory, putting in pylons and then constructing the girders. The maintainability—the system that is in Beijing, I doubt, is something that we would want to buy in the mountains because of its maintainability. It does not make sense to have an active guideway and passive vehicles because you can't get the active guideway out of the system in order to work on it. It needs to be active vehicles on passive guideways just like our highways are active vehicles on guideways. So, the maintainability is important.

And then I urge you to do research on commercialization, into and along, and with this high-speed inter-city rail. And then we'll call it high-speed monorail. Thank you, gentlemen.

Mr. CALVERT. Thank you, gentleman.

Mr. RAPP. Thank you very much.

Mr. CALVERT. On one point I'd just like to add that in the bill itself there is discussion and it maybe approved to build a test Maglev bed between Southern California and Las Vegas, somewhat controversial, but the State of Nevada and some interests in Las Vegas are willing to pay the majority of the cost. So, that is a test bed for Maglev similar to the German system and the rail system was built between Beijing and Shanghai, which may be an interesting test bed for that type of facility.

Mr. RAPP. Congressman Calvert, I believe that we are at the tipping point or very close to it, where we may have entrepreneurs step forward with international consortium with a large amount of money, willing to do something like E–470, but in fact, being a high-speed monorail. And I hope that the bill will be receptive to that sort of thing, because looking at the long-term cost, that looks like the way to go. Thank you, sir.

Mr. CALVERT. Thank you, gentleman. Any closing statements, Mr. Udall? Any other comments? Maybe a short statement because I've got to get on that highway of yours to the Denver Airport.

Gentleman, please state your name and address for the record.

Mr. FOWLER. My name is Hugh Fowler. I'm from Denver. And I served for five years with Colonel Rapp on the CIFGA, Colorado Intermountain Fixed Guideway Authority, which was set up by a legislation to do something about the I–70 corridor. I came to Boulder in 1944 in the Navy on a train, and it cost about $0.75 from Denver although the Navy was paying for it. A bus from Denver

in those days was about $0.50, so—but it took at one-time all of (unintelligible) the train got there in about an hour.

And the team that I had—I'm interested in all of this because they spent five years in trying to figure out what to do about I–70 and I thought we had a pretty good idea but the problem of research, it's nice to be talking about research but when you have political influences, which can just throw them out then what are you going to do? How powerful does the research have to be in order to overcome these political decisions that are so awfully long? I called in length the decision by Governor Lamb here in 1973 to, as he said, "Drive a silver spike through I–470," which was the Western link of the built highway around Denver. He was successful in driving the silver spike and it would be another seven or eight years before we got what we now have, which is C–470, not Interstate 470, but a Colorado highway built with Colorado funds depending on an annual appropriation from Congress in order to get it done.

Instead of using the $85 million of highway trust fund money that was already in the bank to build the damn thing and my—excuse me, I served in our own State Senate here for 12 years. I was on the transportation committee for all of that time. We tried to do things; we did a rail plan in 1975 and said, "Look, common sense says that we can no longer have coal trains going through Metropolitan Denver." They're still going through Metropolitan Denver today. But instead of 12 of them, there are 60 of them today. And can you imagine what that does, bisecting this huge metropolitan area with these coal trains with their own problems, the railroads took out one of the two rail lines to Colorado Springs which made it twice as difficult to get through.

My appeal here is for some common sense and leadership. And I know both of you gentlemen are leaders in your field. And you've got to step up. Now what happened in 1955 when the traffic from Denver to Boulder, both are growing very rapidly with the university and a very large industrial sector going like crazy in Boulder also. Well, a famous highway engineer at the time, the main guy in CDOT, Department of Highways just took his marker pen and he goes, "Here's Boulder, here's Denver, there is the new toll road." And they built it and they put a tollgate right over here in Broomfield. And they said, "We're going to bomb this baby and we're going to pay for it in 20 years." Well, in less than 10 years, of course it was paid for because it was very successful, one of the first toll roads that had been built in years—and it was a model.

And then in about seven or eight years later, of course it was paid for even though the toll had gone from $0.25 to $0.50—all of that. And so, what happened? They scraped the toll booths. What if they haven't done that? What if they continued asking $0.50 for each person? We could have financed a high-speed train from Denver to Boulder and probably on to Colorado Springs. Well, that's a common sense thing, isn't it? We didn't need any research to support that. We knew how many people are going to be driving it, but we had some people here who said, "Oh no, it's not fair to the people in Boulder, they have to spend that money." Listen, we're not paying enough.

And I'm sorry, as a Republican and I have to tell you that our gas tax is really cheap. And that gas tax has to be increased and that's another political matter. I don't know who has the courage to do it. But it's just like who has control of traffic in Denver? The trucking industry. We talk about moving and finally CDOT is thinking about moving the rails over East and they have the—the railroads themselves are willing to do this. Why not have a trucking alternative? We could start with 470, the only trouble is that it dumps you—E–470, which is a toll road—Congressman Calvert, do you know about E–470?

Mr. CALVERT. A little bit.

Mr. FOWLER. It's the eastern part of the belt—absolutely private. I mean, it is not, you know, it was not built with state funds. It's a bonded highway being paid off, thank you, on schedule, with a toll collected automatically. A wonderful idea, but just don't use it why?—it's too expensive. They'd rather cause accidents. How many accidents are caused going through the Valley Highway through Denver because of the truck congestion? Well, those are common sense things. We don't need any research for that. We need some legislators and others who will go "Hey, stand up and say, 'Yes, this has got to be fixed. We'd take those trucks off of there.'" Or at least take them off during the tragedy.

Mr. CALVERT. Okay. If the gentleman could just wrap—I've got.

Mr. FOWLER. Yes, I'm wrapping right now. I'm just asking you Congressman, I know you're interested in this. Keep it up and start embarrassing some of these people who just are letting all of these people get away with trying to do it on a cheap—it ain't cheap. It's going to be very expensive, but we've got to do it.

Thank you very much. I appreciate it.

Mr. CALVERT. Thank you. Mr. Udall would like to do the closing statement?

Mr. UDALL. I just want to thank the previous two people who commented, Senator Fowler, great to have you here and I would look forward to sitting down with you and hearing more of your ideas and you have a sense of history and I appreciate your understanding. We've got to invest in our infrastructure. I have been one who had made the same points that you've made today that if we're going to maintain and improve our infrastructure or transportation infrastructure, we have to pay for it. And in paying for it, we have to look seriously at indexing the gas tax to inflation and I believe that would be a responsible way to proceed and we've had—we're having a debate in the Congress, we'll continue to have that debate.

I also want to make sure that the record reflects my point of view, which is that right now I'm not convinced that we can either afford nor should we build additional lanes up through Clear Creek County. I don't know how we do it in a cost-effective way and also maintain the quality of life of the people along that corridor and so we have to think very creatively and work with the communities along the corridor. Whether a Maglev or an elevated guideway system can actually do the job is something that has to be determined, but this is why this research is so important and I just didn't want to conclude by pointing out that in the fiscal year '03, we spent about $500 million in research and if you cost that out percentage-

basis, it's a very small amount relative to the money that is spent on the projects. And so, I think this money is important. We have to continue to do the work that Congressman Calvert is leading to ensure that the dollars are efficiently used and put in the right places that they can make the most effect.

And I want to, in that light thank the panel today, thank them for their forthcoming answers and for their testimony and I look forward to calling on them in the future here in Colorado, I think perhaps even at the National level as we get about the business of reauthorizing TEA–21. I think we're—was it ISTEA or T–LEU or it has any number of acronyms at this point. But that is good news that we're moving ahead. The job creation potential is enormous and in this day and age of competitive economic environment as well as the war on terrorism and all the other challenges our country faces, we have to have the best in transportation and transit systems in the world, frankly.

With that, again I want to thank Congressman Calvert for taking time out of his schedule to come to Colorado. I know it's tough duty to visit Colorado, but I want to thank him for his leadership and I also acknowledge—Colonel, when you talked about new energy sources, Congressman Calvert and I have worked together, he was the lead sponsor and the author of the bill on hydrogen and promoting a hydrogen economy and we do have to look to make the pie much bigger. We're not going to wean ourselves from fossil fuels completely in the near future but we want to work in a way to take advantage of energy efficiency technologies or new renewable energy technologies that are out there as well as creating greater efficiencies with our fossil fuel supplies. And we take your comments to heart and thank you for standing up and sharing your point of view with us.

So with that, again thanks to all the audience that has been here and to The City and County of Broomfield and Mayor Stuart. Thank you.

Mr. CALVERT. Thank you, Mr. Udall. And again, I want to thank this panel for your testimony. Certainly, transportation is an issue that's important throughout this country and certainly in here in Colorado. And obviously, I deal primarily with water issues in the House but water, transportation, clean air, all of these issues are extremely important to the quality of life for people here in Colorado and throughout the United States and so, hearings like this are important to get the viewpoints of folks throughout the country as we try to move good legislation.

Hydrogen is the next energy economy we're going to move toward, that's going to take some time, though. And it's going to probably—but the infrastructure in this country is enormous to move to that new energy source, but that will happen. And new planning and new research as you move forward, you must remember that that is going to be the next energy source, I think and I think most people would agree with that.

Certainly, when I was in the construction business we used to say, "Make any changes on your plans. Don't try to do it while you're under construction." Change orders to the developer or to a contractor are music to your ears, I guess, but that's no way to save money. And so research is important. And you're right, Mr.

Udall, we don't spend enough money on research and it's important because I think you get returns beyond the small investment that you make.

So, I want to thank you for having me out here. I thank the community for being such good hosts and I look forward to coming back to Colorado in a more social engagement. So, thank you very much. We are adjourned.

[Whereupon, the Committee was adjourned.]