News from ITS

July 12: NEXTOR's Mark Hansen Testifies at Senate Finance Hearing on FAA Modernization Costs.

Michael Cassidy named Acting Director of ITS: Samer Madanat goes on sabbatical as of July 1, 2007.

June 21-24: The Air Transport Research Society's World Conference, at Berkeley: Includes participation from all facets of the aviation industry: airlines, airports, air traffic control (ATC), aerospace, government officials, consultants and academics. Hosted by NEXTOR.

PATH pays tribute to Anthony Brennan, Assistant Director: the 12-year veteran of the California Partners for Advanced Transit and Highways program died on May 31, 2007 after a long illness.

May 17: TSRC Director Alex Farrell Co-Authors Green Biofuels Index: It would aid consumers, market with a biofuels rating system that would reflect the positive or negative environmental impacts of a particular fuel.

Robert Harley, Professor of Civil and Environmental Engineering, has joined the ITS Advisory Council, ITS Director Samer Madanat announced at the council’s annual meeting on May 7.

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Summer 2007: Stories This Issue

Highlights of 2007 World Conference on Transport Research

Nobel Laureate Daniel McFadden gives keynote address, "The Behavioral Science of Transportation;" the 2007 Dupuit Prize is awarded to Moshe Ben-Akiva, of the Massachusetts Institute of Technology, for lifetime achievement; selected photos from the closing night awards dinner.


UC Berkeley Center for Future Urban Transport (a Volvo Center of Excellence) presents special session at WCTR Conference.

Counting Cars (and More) with PeMS: A research project’s transition to the real world

The story of the development of PeMS illustrates how the Institute of Transportation Studies (ITS) and its affiliated centers, California Partners for Advanced Transit and Highways (PATH) and California Center for Innovative Transportation (CCIT), take a researcher’s idea, develop it, deploy and test it, and then send it on its way for use in the wider world.

Our Summer Students from American University of Beirut and Howard University

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Daniel McFadden, "The Behavioral Science of Transportation"

In his keynote address to the World Conference on Transport Research in Berkeley on June 25, 2007, UC Berkeley Nobel Laureate Daniel McFadden urged transportation researchers and policy makers to employ insights from economic and behavioral science to make sure that human behavior doesn't get left out of the calculus as they design transportation systems. He emphasized that they must not overlook the way people use and perceive transportation as individuals and the way they shape it collectively through their political, economic, civic and cultural institutions.

McFadden has direct personal experience in such cross-discipline thinking about transportation. An economist by training, he put his theories about consumer behavior and econometric forces to an early test in a pioneering study of mode choice intended to predict how many commuters would switch to the Bay Area Rapid Transit (BART) system, two years before its 1975 opening. His study predicted that BART would entice about six percent of Bay Area commuters to change modes, less than half the official estimates when the rail system was proposed. When BART opened for business, McFadden's prediction proved to be correct.

McFadden was awarded the Nobel Prize in Economics in 2000 for his discrete choice theory, which evolved with his work on BART, which he did in association with the Institute of Transportation Studies.

Embracing behavioral science runs counter to traditional transportation thinking, he acknowledged.

McFadden told a story to illustrate the old way of thinking. "When I was eight years old, a neighbor was promoted to conductor on the Southern Railroad. I asked him if he would be working on the Southern Crescent, the premier passenger train. 'Oh no,' he said, 'if I did that, I would have to deal with people. Railroad men would rather work with freight.' Today, it is important for transportation workers, and transportation researchers, to recognize that there is no escape from humans and the impact of their behavior on transportation systems. One has to work with people."

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McFadden outlined the three levels at which human (or "consumer") behavior has been modeled over time:

- physical analogies, such as gravitational attraction to explain movement of people and goods,
- economic theory, in which it is assumed that transportation users make choices that maximize their preferences, and
- more recently, popular behavior that can't be expressed by strictly rational constructs, but which requires analysis with tools from sociology, anthropology, cognitive psychology and brain science.

He illustrated the use of economic models with three examples:

- the linkage of demand and utility by 19th-Century French engineer Jules Dupuit, also the namesake of the WCTR Society's highest prize,
- the use of Newton's law of gravitation by Ravenstein in 1885 and Zipf in 1946 to explain the movement of people within a transport system, and
disaggregate travel demand forecasting models developed by Domencich and McFadden in 1972, which used random utility maximization, and which they used to make their BART projections.

"Dupuit is one of the founding fathers of both transportation science and economic theory," McFadden noted. "He recognized that a product will be demanded up to the point where the dollar value of the marginal utility of an additional unit purchased falls to the opportunity cost of that dollar amount." This gave transportation planners the tool to quantify the benefits and costs of policies such as setting tolls and to evaluate investments in new infrastructure.

The gravity model postulated in 1946 by Zipf was widely embraced as a way to make long-range travel forecasts, McFadden explained, though it does not work as well under heterogeneous conditions and does not reconcile easily with individual choice or decision models.

The final type of model, which he and Domencich developed, is based on the premise that people have different tastes and needs. Coupled with observed individual (or "discrete") choices, it can be used to estimate utility and how it changes when the transportation system is altered, such as whether BART is a commuting option or not. While these models have been used regularly, he pointed out that there might be less awareness that they can be used for broader questions over larger geographic regions and longer time periods than many researchers currently do.

This sort of thinking about models is especially important given the interest in using market forces, such as congestion-pricing, to form more efficiencies out of the transportation system. Although congestion pricing is relatively easy to implement, and has been demonstrated to work well under the right conditions, there is still strong resistance, McFadden noted.

From the traditional economics point of view, this irrational resistance to congestion pricing is a puzzle. To get the answer, McFadden said, it is necessary to turn to cognitive psychology and brain science. People feel their losses more deeply than their gains, so that, for example, the majority of drivers in a traffic jam are convinced that the other lanes are moving more rapidly than the one they are in: a logical impossibility. This loss aversion results in an innate fear of change in the status quo and, by extension, market-based schemes that require consumers to choose among a menu of options, all of which require them to act differently.

The cause for this aversion to change? The way our brains are wired, according to neuroscience research. Our evolutionary path results in our processing potential threats at a much more primitive level of the brain than where we process potential rewards. Trade, or participation in the marketplace, occurs at this very primitive level, with a large emotional component, which explains the cliché about sex and shopping activating the same neural regions.

As a result, people are natively agoraphobic, afraid of the marketplace, and make the wrong choices and because they don't trust themselves to be fully in command of their marketplace decisions. Pelotons, the wedge-shaped groupings that bicycle racers form to conserve energy and limit wasteful sprinting, are an example of a human adaptation to this fear of being singled out for punishment. In exchange for giving up some freedom of choice, the peloton riders are rewarded with a more certain and more efficient outcome—until they see their chance to break away.

McFadden posited the likelihood that a small group of congestion-pricing opponents have formed their own pelotons, and the majority of consumers have joined up out of a defensive reaction. He suggested work be done on better understanding pelotons as they apply to collective decision-making for achieving social welfare, or "how consumers pack together when they drive, ride transit, or vote on transportation projects.

"Perhaps by understanding the formation and stability of anti-tax, anti-road-pricing pelotons, one might see how to encourage pelotons that support efficient market solutions to congestion in transportation." Without careful framing of market solutions, the public will continue to resist them, he said.

Finally, he repeated his advice to transportation researchers to work closely with behavioral scientists and take advantage of new findings as they continue to be made, so that researchers can better understand and estimate the ways that human choices will shape and respond to transportation systems.

**Other links:**

- [Daniel McFadden's Nobel Prize Acceptance Speech, with an introduction by UCTC founding director, the late Mel Webber, excerpted in ACCESS Magazine, Spring 2002, the publication of the University of California Transportation Center](http://www.its.berkeley.edu/newsbits/summer2007/wctr2007mcfadden.html).
Moshe Ben-Akiva (right), of the Massachusetts Institute of Technology, accepts the 2007 Dupuit Prize for lifetime achievement from Roger Vickerman of the University of Kent.

At the World Conference on Transport Research dinner, on June 27, Moshe Ben-Akiva of the Massachusetts Institute of Technology was awarded the 2007 Dupuit Prize for lifetime achievement. Presenting the prize was Roger Vickerman, a member of the selection committee and a professor at the University of Kent.

The prize is named after Jules Dupuit, the 19th-Century French engineer considered by many to be the founder of transport research. According to Vickerman's citation, it is awarded to a member of the World Conference on Transport Research Society (WCTRS) who has "a record of outstanding scientific work; a significant reputation in transport policy; a reputation for truly international activity, involvement in the creation of global networks; particular contributions to WCTRS, and a high reputation within WCTRS." The prize is donated by Rambol-Finland through Antti Talvitie, of the Helsinki University of Technology. The Dupuit Prize Committee for 2007 consisted of Vickerman, Talvitie and Hideo Nakamura, President of the Musashi Institute of Technology and the 2004 Dupuit Prize winner.

In making the presentation, Vickerman noted Ben-Akiva's early work on discrete choice modeling, about which he co-authored a textbook that is still considered a core text, and his current interests in intelligent transport systems. His connection to WCTRS dates back to his time as a student, when he worked with Marvin Mannheim, the founder of WCTRS, and attended the 1973 conference that was the precursor to WCTRS.

Ben-Akiva has been Editor in Chief of Transport Policy, the society's journal, since 1998.

In accepting his prize, Ben-Akiva jokingly said, that it "means a lot to me. It means I'm old."

On a more serious note, he said, "I'm grateful to those who created this prize and to those who nominated and supported me. This honor is a significant milestone in my professional life. I have been engaged with the WCTRS since the conference that was held in Bruges, Belgium in 1973, 34 years ago. I attended the first WCTR in Rotterdam in 1977, exactly 30 years ago. And I have attended all the 11 WCTR's since then."

While noting that there were too many people to single out to thank by name, he said he would make an exception for "two admired mentors and friends whose intellect and kindness have influenced my career the most. The first is my advisor, the late Marvin Manheim, who is the father of transportation systems analysis and the founder and first president of the WCTRS. He introduced me to the excitement of research and taught me to think about thinking. He received the Dupuit prize during the Sydney WCTR in 1995. It is a great honor for me to receive the same prize that Marvin received. But I'm also sad that he is not here today.
"The second is Dan McFadden, our keynote speaker in the opening session, whose groundbreaking contributions have been recognized by the Nobel Prize and who have fundamentally shaped our field. It has been a privilege to have Marvin and Dan as my mentors and friends.

"I was pleased that Dan’s historical review of transportation research began with the 1844 paper by Jules Dupuit. Dan mentioned that he actually read the original work and was amazed to find that a civil engineer—interested in the benefits of infrastructure investment and pricing—invented the basic concepts of consumer surplus and benefit-cost analysis that economists developed many years later.

"Economic historians refer to Dupuit as a full time engineer and a part time economist who pioneered mathematical microeconomics. Dupuit was a graduate of the ENPC, the premier French civil engineering school, and became a self-taught economist later in life while working on public works projects. I am proud to say that I was also schooled in Civil Engineering—at the Technion in Israel—and later became interested in economics and econometrics while pursuing graduate studies in transportation at MIT."

Ben-Akiva noted that much progress has been made, but many challenges remain. "The richness of transportation and the crucial role it plays in our lives is what’s makes this field exciting."
Counting Cars (and More) with PeMS: A research project's transition to the real world

A good idea's journey from research paper to a successful product in the real world can be long and winding, or worse, terminate in a dead end. But PeMS, or Freeway Performance Measurement System, went from one professor's concept to a powerful computer tool in record time, and is changing transportation research and planning not only in California but other states and countries.

The story of the development of PeMS illustrates how the Institute of Transportation Studies (ITS) and its affiliated centers, California Partners for Advanced Transit and Highways (PATH) and California Center for Innovative Transportation (CCIT), take a researcher's idea, develop it, deploy and test it, and then send it on its way for use in the wider world.

PeMS is the brainchild of Electrical Engineering and Computer Science Professor Emeritus, Pravin Varaiya, who published a paper in December 1997 entitled "How to measure transportation performance." In it, he suggested that PATH and Caltrans could design and build a performance measurement system that would not only help Caltrans decide what measures to take to improve freeway travel, but more effectively incorporate new intelligent technology systems. He also urged that the information be available to the public on the web: More information about how the freeway system performed, he argued, would also allow the transportation community to make better decisions about allocating precious transportation resources.

In early 1998, Hamed Benouar, then chief traffic engineer for Caltrans and more recently, the Director of CCIT, arranged to fit Varaiya into a previously scheduled annual luncheon of Caltrans' top management.

"He showed up with only a few slides," recalled Benouar. "But he really caught their attention when he said something like, 'If you don't know what your system did yesterday, how can you know what it will do today or tomorrow.'"

As Varaiya explained recently, Caltrans at that time had an impressively large system of sensors embedded in its freeways, "but the data that they were producing was not used by anybody. If they could collect the data and use it well, or process it well, they could...learn how well the system is performing in terms of delays, speeds, and historical trends."

PATH develops and tests PeMS

Caltrans liked the idea, and six months later the first PeMS contract was awarded to PATH to develop Varaiya's idea into the first generation of PeMS and test it on one freeway in Orange County.

"There was a requirement that the data should be transmitted to a single location," recalled PATH Director Alex Skabardonis. "The only Traffic Management Center that could handle this enormous amount of information was Caltrans' District 12 in Orange County. So that is why we began there in October 1998."

The initial foray was successful. "This exercise had given us a structure, the know-how to process this information," explained Skabardonis. It also provided new contracts from Caltrans to expand the project to the rest of California's freeways where 25,000 traffic sensors—mostly loop detectors—had been
implanted in the pavement more than three decades earlier.

**Boost for A New Business**

For PeMs, the next step along its journey involved the private sector. While UC researchers designed the algorithms and applications, a key decision was made to turn over the software development, including the maintenance of the database system to professionals.

"In contrast to the usual scheme to have grad students or post-docs do that, we decided very early that was not the way to go in order to maintain continuity, to maintain documentation, to be certain that the system would function. In this way, the reliability of PeMS was never in question," said Varaiya.

He turned to a former grad student, Karl Petty, and his new software development company, Berkeley Transportation System. Varaiya believes that decision was key to how quickly the project moved, and Petty agrees. "It didn't really make sense to have grad students buying machines, running a data base, developing software," he explained. "They're researchers, not software developers. We were able to pay the rates to find the expertise to build something like this."

**Users Beyond Caltrans**

"By 2002 it became quite clear that the way we were processing the data—and more importantly, the fact that we were making it available on the web for anybody to use the data—was extremely useful," Varaiya recalled. PeMS generates 15 or 16 billion gigabytes of data to users per week.

This enormous amount of data was not only helpful to Caltrans, but to transportation students and traffic analysts who mine it freely to better understand how traffic moves—or doesn’t—on congested freeways.

With each new iteration, PeMs added new features. A few years after Varaiya’s paper was published, PeMS was collecting and processing information from detectors in all the state’s freeways, as well as incident reports from the California Highway Patrol and FastTrak data. The complex computer tool can report causes of delay, such as too much traffic, traffic accidents, or special events. It can predict travel times based on historical trends. And although it can’t solve bottlenecks, it can help traffic engineers find their causes and devise solutions. It allows them to analyze any freeway segment over any time period—an hour, day, week, month, or year. PeMS even reports when its sensors aren't working right.

In a recent issue of *Traffic Technology International*, Randell Iwasaki, Caltrans’ chief deputy director, praised the tool. "PeMS allows both department and regional agencies the capability to see how the system is performing (on the most highly congested urban corridors) and identify periods of congestion. With that information, staff can then disaggregate the data further to identify causes. Detection is being expanded rapidly to support system and corridor management based on performance measurement."

**CCIT’s role**

Before the development of PeMS, when Caltrans needed traffic data on a particular section of freeway, it took awhile. Employees were sent out to the location to gather information the old way—by counting. Now, explains Benouar, a Caltrans employee familiar with PeMS can find the same information—and it will probably be more accurate—by pushing a couple of buttons.

But CCIT needed to help Caltrans employees learn how to use the tool that it had underwritten.

"We provide a little bit of hand-holding," to help them get the hang of its new tool and understand and apply its full capabilities, explained Benouar. CCIT also identifies who in Caltrans’ districts needs to know what about PeMS: Directors and managers need a good overview of how the tool works, engineers want to know how to find more specific information, such as how to look for recurring bottlenecks, and planners hope to use it to track trends over long periods of time.

"CCIT is basically the interface between the customers who want to use the tool and the researchers who continue to develop new versions of PeMS," explained Benouar.

As it has grown, it has become more user-friendly for customers outside Caltrans, such as local transportation agencies and the private sector.

Skabardonis reported that a marketing employee for the San Diego Chamber of Commerce recently called asking for information about the number of vehicles coming into her city on freeways during the summer compared to the winter months. "She’s not a transportation engineer, she’s a marketing person. But with a little help, in five minutes on the PeMS site she had the information," he said.

In its latest incarnation, commuters can sign on and set up MyPeMS, which allows them to customize frequent freeway routes in order to check travel times and receive other useful traffic information for a
particular segment of freeway. Down the road, PATH hopes to devise a system for arterial roads. "We have a prototype, but we don't yet have a continuous flow of data," explained Skabardonis. "We hope to get data from the city of Los Angeles, which has a huge data base."

And several other states, as well as the Greek capital city, Athens, have bought the PeMS system for their own freeway systems.

"PeMS has become so useful that if PeMS goes down we get emails from all over the world," said Benouar. "In fact, one way to test who is using PeMS is to shut it down and see who calls."

In the end, Pravin Varaiya's idea was transformed into a useful tool within a few years. Benouar said that is as it should be. "We're not just about creating papers here, but really about helping society. With the structure we have here, we can do that."

PDF of story
Our Summer Students: ITS hosts young scholars from Beirut and Washington, D.C.

There are some new faces this summer at ITS from Beirut and Washington, D.C. Seven engineering undergraduate students from the American University of Beirut (AUB) are working on a variety of projects under the direction of ITS researchers. Two additional students are visiting from Howard University.

The summer program for AUB students began four years ago as the result of a long-standing friendship between Adib Kanafani, former ITS director, and Ibrahim Hajj, Dean of Engineering at AUB. Kanafani and Hajj were undergraduates in engineering together at AUB, and later did their graduate work in engineering at UC Berkeley.

"Engineering students at AUB are required to spend the summer between their third and fourth years overseas working in private industry or at a research university," explained Kanafani, "So Ibrahim and I put together a collaboration agreement to facilitate exchanges between students and faculty at our campuses."

This summer, three AUB students are working at California Center for Innovative Technology (CCIT). Omar El Ayach, who is majoring in computer communications engineering, is working on the Berkeley Highway Lab, setting up a new method for transferring information from loop detectors and cameras to computers. Nicolas Kseib, a mechanical engineering student, is working on a project aimed at improving predictions of travel time on Bay Area freeways. Rami Aboujaoude is also a mechanical engineering student whose summer project involves improving the graphical interface Caltrans uses to configure its changeable message signs.

"This is my third year working with the AUB students, and we've always been very happy with their work," said Jean-David Margulici, acting director of CCIT.

Omar El Ayach, Nicolas Kseib and Rami Aboujaoude at CCIT

Twenty-year-old Roula Rbeiz is one of this year’s students who hopes to return to Berkeley for graduate studies. The Beirut native grew up with a father who was a civil engineer, and from the age of 10 has wanted the same career. "He did not put any pressure on me to become a civil engineer, but I was introduced through him to the field. In fact, when an older brother told the family he was thinking about majoring in civil engineering, Rbeiz says she was furious. "That was my choice," she says laughing. She is primarily interested in structural and materials engineering, and this...
Roula Rbeiz analyzes concrete samples

Tarek Ibrahim, Anwar Ghoch, and Nahi Ojeil are participating in a project aimed at modeling currents in bodies of water. Working in the basement of McLaughlin Hall, they are improving the design of drifters, which are made of PVC pipe and plastic sheeting, and float through the water collecting data.

Ibrahim is majoring in the field of architecture and engineering. Ojeil, a computer and communications engineering major, said his work on the project is aimed at getting the GPS data, which is collected from the drifter, sent and stored to a server in Berkeley. “We’re used to having reading assigned,” added Ojeil. “Here it’s more about doing.”

Ghoch, who is majoring in civil engineering, is designing a hull for the drifter that will enable researchers to get it in and out of the water more easily and efficiently.

“The main benefit for the project is to have undergrads who can figure out solutions to relatively simple problems of a non-theoretical nature. We give them a very concrete problem that is very beneficial for the project,” explained Civil and Environmental Engineering Assistant Professor Alexandre Bayen, who has overseen projects with AUB students for two years. “It’s a good way for undergrads to be embedded in a research project and be productive right away. And, they have a complete achievement at the end of the eight weeks.”

Most of the AUB students live at International House for the summer. Last year when war broke out in Lebanon, many of the students were unable to go home, and ITS faculty helped them extend their stay at I-House, as well as enroll in classes at Berkeley for the semester until they were able to return to Beirut.

Many of those students said they forged strong friendships at I-House, and hoped to eventually return as graduate students at UC Berkeley. Several students from past years have returned to Berkeley for graduate studies. Bayen said three of the undergrads he has worked with in the past on an air traffic control project have returned to the U.S. for graduate school: one to Berkeley, another to Stanford, and a third to Massachusetts Institute of Technology.