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News from ITS

[CCIT Wins 2008 Tranny Award for Traffic Operations]

[Adib Kanafani Honored by National Research Council] *The National Academies of Science name the former ITS Director a lifetime National Associate of the National Research Council for his service.*

["Greening GM," College of Engineering Profile of Lawrence D. Burns] *ITS Advisory Council member and Berkeley Engineering alumnus discusses the automaker's research in alternative fuel vehicles in the October 2008 issue of* Innovations.

[Dan Kammen New Director of TSRC]; Tim Lipman and Susan Shaheen are co-directors.

PATH Researchers showcase [bus that steers itself]: *The thought of a bus moving along city streets while its driver has both hands off the wheel is alarming. But a special bus introduced today (Friday, Sept. 5), steered not by a driver, but by a magnetic guidance system developed by engineers at the University of California, Berkeley, performed with remarkable precision.*

Meet the [TransLiblog]: *Transportation information from the ITS Library.*

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Fall 2008: Stories This Issue

Director's Message

ITS Director Samer Madanat returns from sabbatical with a new ITS collaboration with the City of Amman, Jordan.

Joan Walker: Former undergrad joins ITS faculty

A new faculty member joins transportation faculty. Joan Walker remembers her undergraduate days at Berkeley, but teaches students how to look into the future.

Energy and Emissions in Transportation: How Mikhail Chester Makes it Easier to be Green

Think you know which transportation mode leaves the most environmentally-friendly FOOTPRINT? ITS graduate Mikhail Chester's research may surprise you.

New Students: Welcome to ITS

ITS welcomed 34 new graduate transportation and planning students from eight countries during its orientation on August 25. The majority comes from around the United States, but 15 call China, India, Japan, Colombia, the United Kingdom, Brazil, or France home. They join 47 continuing transportation students.

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Message from Director Samer Madanat

During my sabbatical year, which I spent in my native city, Amman, Jordan, I had the opportunity to do something academics often avoid: I got involved in the real world. I did this by providing technical advice to the Greater Amman Municipality (GAM).

GAM has set for itself the ambitious objective of transforming the city's public transportation service from an ad hoc collection of privately operated small systems into an integrated and modern system.

This objective followed logically from the recommendation of GAM's master plan, which aimed to reduce the spread of urban sprawl of the fast-growing city. The master plan envisioned achieving this through urban intensification and densification, two processes that depend heavily on shifting a large fraction of commuters from automobiles to public transportation. By increasing the mode share of public transport, GAM also hoped to improve air quality in the city and reduce fuel consumption, thus contributing to a reduction of the country's energy bill. (Jordan imports petroleum from its neighbors Saudi Arabia and Iraq.)

My work with GAM exposed me to the complete range of issues facing growing cities in developing countries as they attempt to improve their public transport services: from the choice of institutional arrangement and operators' contract, to detailed bus network design, passing through the economics of fare structures and subsidies. I came away with an awareness of the extremely difficult task that city officials face in making decisions with limited time and information. My small contribution to GAM was to impress upon my hosts the value of performing detailed and thorough studies that can inform their longer-term decisions.

As a step towards providing the type of studies that the city needs, Berkeley's ITS and the Amman Institute (a non-profit organization owned by GAM) signed a Memorandum of Understanding in July. The MOU includes three areas in which ITS can contribute to assisting GAM: research, student internships and training. With our ongoing collaborations with Chengdu, China and Nairobi, Kenya, this MOU is another example of Berkeley's ITS increasing global engagement.

This issue of *NewsBITS* reports on a number of other positive developments. First, we are very pleased to have added two new members to the Transportation community at UC Berkeley. Joan Walker joins our community as Assistant Professor in the Department of Civil and Environmental Engineering (with a joint appointment in the Global Metropolitan Studies center). Joan, who obtained her PhD from MIT in 2001, brings with her several years of professional practice and academic experience in the field of Travel Behavior Modeling. NewsBITS's Chris Cosgrove interviewed Joan earlier this month.

Across campus, the City and Regional Planning Department has successfully recruited Dan Chatman, currently on the faculty at Rutgers University, to fill the position that was created by Marty Wachs' retirement in 2006. Dan will join Berkeley next summer, at which time we will have a longer piece on his research and experience.

I am also pleased to announce that Dan Kammen, Professor in the Energy and Resources Group and the Goldman School of Public Policy, and Class of '35 Distinguished Chair in Energy, has taken over at the helm of the Transportation Sustainability Research Center. Dan is arguably one of the most prominent experts in the U.S. in the field of alternative energy sources. Among Dan's many leadership positions on campus, he is co-director of the Berkeley Institute for the Environment and director of the Renewable and Appropriate Energy Lab. And he is no stranger to the faculty, researchers, and students at ITS, having led the Urban Sustainability Initiative, of which our Chengdu Transit project was a component.

As we welcome a new class of promising graduate students in Transportation Engineering and Transportation Planning we look forward to another year of achievement for ITS. Go Bears!

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I think students will like it; they can study themselves, and we will be building up a database."**

PDF of article

Joan Walker: Former undergrad joins ITS faculty

When Assistant Professor Joan Walker arrived this fall from Boston to begin teaching transportation students at UC Berkeley, she felt immediately at home in McLaughlin Hall. The hallways, the office, the names on the doors were like old friends.

Walker, who received her Bachelor's degree in Civil Engineering from UC Berkeley in 1991 and her Master's and PhD degrees in Civil and Environmental Engineering from MIT, was Assistant Professor of Geography and Environment at Boston University until she accepted her recent appointment as an assistant professor in U.C. Berkeley's Civil and Environmental Engineering Department. She has a joint appointment with the Center for Global Metropolitan Studies, which encourages interdisciplinary research.

"I like to tell the students here I took classes from Adib Kanafani, Carlos Daganzo, and Bill Garrison. I worked for Mark Hansen," she said in an interview with NewsBITS. "I also worked for Mike Cassidy when he was finishing up his PhD, and counted cars for him in the basement of Davis Hall."

Although she was transported back in time when she returned to the Berkeley campus, as a faculty member Walker will be teaching her graduate students how to gaze into the future—of planning and transportation—through the crystal ball of behavioral modeling for policy analysis.

Trendspotting

"What I do is statistical models of behavior," she explained. "The idea is, whether you look at sustainability, the environment, even quality of life, there are human agents out there making decisions—supposedly rational decisions. What we want to know is what will happen in society as a result of these human agents making all these decisions."

Typically, behavioral studies in transportation are based in a classic microeconomic paradigm of rationality. In other words, people calculate and compare the value of their transportation options and follow that which works best for them. But Walker says research in behavioral economics raises "serious questions" about humans' ability to choose rationally. In her research she hopes to infuse some of those findings into transportation in order to better predict behavior—and influence it.

For example, the current trend in environmentalism is one she's examining closely. But to determine how humans will be thinking in 20 years requires collecting very detailed data over time to capture such dynamics.

Walker uses statistics as well as well as psychology and behavioral economics in order to identify attitudes that will frame the decisions of groups of people about where they will live and work in the future. And, for want of better words, fads or trends are really important, says Walker, who won a National Science Foundation Career Award in 2007 for her work in this field. "It's hard to figure out where these trends are going, but in transportation and planning we're trying to do 20-year forecasts, and I think if you miss this piece of it, you're missing a lot."

"My plan is to use the campus as a lab, to study students and their transportation patterns, lifestyle, etcetera over time—maybe years and even decades. I think students will like it; they can study themselves, and we will be building up a database."

She will also use her expertise in the Amman, Jordan transportation project to determine a fare structure that passengers are likely to respond to positively, including the introduction of smart cards.

"I'll be looking at the riders and trying to get into their heads to help the transportation team building a new system for the city determine how to encourage ridership and how much to charge," she said.

ITS Students

This semester, Walker will not be teaching, but will be overseeing the PhD seminar, where students meet weekly and present their research. Questions and feedback from peers at these seminars help students refine and strengthen their research. The experience also provides good practice for future presentations. In addition, older students mentor newer.

Walker says it is a great introduction to the students she will be teaching and advising. “They do all the organizing. All I have to do is listen and learn more about their research and provide some helpful direction.”

In fact, one of the things she likes so much about Berkeley is the caliber of the students. The first graduate student researchers she hired for her projects were so eager to get started that they came up with their own ideas before she had time to meet with them. “I am really so impressed. They are such self-starters!”

Next semester she will be teaching a class in her area: Behavioral Modeling for Engineering, Planning, and Policy. “Because I have this affiliation with the Center for Global Metropolitan Studies, I will try to keep the class very broad. So although I mostly work in transportation, I will talk about these methods for public health, marketing, or whatever.”

She is also excited about the breadth of knowledge and level of expertise here at Berkeley. “In my work I need to collaborate with people. I have this very strong statistical knowledge, but I need applications, and those applications can come from anywhere—whenever there’s a human involved.” She anticipates working with researchers who work more conceptually and qualitatively with human behavior.

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Energy and Emissions in Transportation: How Mikhail Chester Makes it Easier to be Green

As we've all learned in recent years, travel, by car, bus, train, or plane, has varying consequences that can be calculated in terms of the amount of energy consumed and emissions spewed into the atmosphere.

But direct energy use and harmful emissions are only part of the problem. Indirect and supply chain costs are harder to enumerate and measure, yet significant. To truly understand real costs in terms of energy use and polluting byproducts, it is necessary to analyze the lifecycle of a particular vehicle or group of vehicles and their infrastructures from cradle to grave. That means calculating the energy used and environmental impacts of building a roadway, say, or constructing an underground BART station, or maintaining the floors of Caltrain cars, or junking a jet.

As policy makers struggle to write environmental regulations and develop transportation plans for the future, it is critical to acknowledge and calculate these lifecycle costs rather than making decisions based simply on tailpipe emissions. And if the task of sorting out and quantifying all these pieces of various transportation modes that use energy and contribute to harmful emissions seems daunting, well, as a famous frog once warbled, "It ain't easy being green."

Former Civil and Environmental Engineering grad student, Mikhail Chester, and his adviser, CEE Associate Professor Arpad Horvath, however, have taken a big step toward making it easier. Four years ago, when Chester started on the road toward a PhD, he set out to produce the first comprehensive environmental lifecycle assessment of passenger transportation modes in the U.S.

The zero emission AC transit bus may eliminate pollutants from its tailpipe, but that's only part of the problem. The manufacturing of its parts, maintenance, the required infrastructure—asphalt roadways—also require energy and produce harmful emissions. (Photo by M. Chester)

Horvath's primary research area is lifecycle assessment. Under his guidance another former CEE grad student, Cristiano Facanha, had tackled the lifecycle of freight in the U.S. a few years earlier. Taking on passenger travel was an even more complex challenge because of the multitude of transportation options, and for Chester, one that would become his doctoral thesis.

Recently, Chester, who has conducted research as part of ITS' Center for Future Urban Transport, and Horvath published their preliminary results in a paper titled "Environmental Life-cycle Assessment of Passenger Transportation: A Detailed Methodology for Energy, Greenhouse Gas, and Criteria Pollutant Inventories of Automobiles, Buses, Light Rail, Heavy Rail and Air."

Comparing and Contrasting Modes

[PDF of article]

Chester, now a post-doc, has gathered or, in cases where it didn't exist, developed data for five modes of passenger travel—automobile, bus, heavy rail, light rail, and air. Based on those modes and the 12 sample vehicles (ranging from a Toyota Camry to a Boeing 747) used in his investigation, he provides an environmental inventory of more than 100 different components that affect energy use, contribute to greenhouse gases, and produce other direct human health impacting pollutants across the five modes. These include not only the manufacturing, maintenance, and operation of the specific vehicles, but also the building and maintenance of the infrastructure they require and the fuel they consume, from the oil field to the gas station. The inventory runs the gamut from a bus's idling to an aircraft's take-off and landing, from laying down rail tracks to roadway maintenance and pesticide use.

As greener jet fuels are developed, aircraft emissions will be reduced. But runways, taxiways, tarmac, airport parking lots, runway lighting, ground support equipment, and a host of other components necessary to air travel require energy and degrade the environment. (Photo by M. Chester)

Then he normalized the numbers to determine the environmental performance of each vehicle per vehicle and passenger mile traveled. When factoring in the lifecycle of each mode, he found that energy and greenhouse gas emissions increase by 1.3 times for automobiles, 1.4 times for buses, 2.6 times for light rail, 2.1 times for heavy rail, and 1.3 times for air. Criteria pollutant and volatile organic compound emissions (sulfur dioxide, carbon monoxide, nitrogen oxides, particulate matter, and lead) rise a whopping 25 times for automobiles, seven times for buses, 220 times for light rail, 98 times for heavy rail, and 11 times for air.

Chester acknowledges that his study is not the first lifecycle assessment of passenger transportation, but he believes it is the most thorough to date.

"We have not seen this comprehensive a lifecycle assessment that includes the number of components we included…an inventory that quantifies the total environmental performance of each mode with such a comprehensive list of components," he told NewsBITS. Horvath added, "This has been a lot of work, but there is really no other way to determine the environmental footprint of transportation. One has to fill in all the gaps. Everything else is a surrogate and incomplete measure."

For each mode Chester has quantified 30 to 40 components; some shared—like the use of asphalt and concrete in construction of roadways, railroad stations, and runways—some unique to a mode—like production and application of de-icing chemicals for aircraft operation.

"Infrastructure components for a car are much different than infrastructure components for a plane, but we have inventoried infrastructure components and maintenance for both of them," he explained.

After several years of digging for data, determining which data were reliable, and constructing data where it did not exist, he came up with results: some intriguing, others surprising. For example:

Roadway construction particulate matter emissions are as large as tail-pipe emissions for the automobile per passenger-mile-traveled.

• Urban buses with peak-hour occupancies have the best energy and greenhouse gas performance, followed by rail and then air systems, and trailed by automobiles. But off-peak bus travel is the worst performer.

• Air travel is environmentally competitive with rail travel and can outperform rail modes when the aircraft is about 80 percent utilized.

• The use of ground support equipment at airports contributes roughly one-third of the total carbon monoxide lifecycle emissions for aircraft.

• While rail systems are the best energy and greenhouse gas performers, they exhibit the largest shares from infrastructure effects in the lifecycle. This results from environmentally much larger infrastructure requirements per passenger-mile served.

High-Speed Rail in California

One of the more interesting, and relevant in this election year, calculations are performed by Chester for the yet-to-be-funded California High-Speed Rail project. Since it does not yet exist, he used information based on European high-speed trains as well as proposed system designs. He determined that California's proposed high-speed rail will perform well—better than the automobile and aircraft--but only if it gets the high ridership proponents suggest it will. And the history of transit projects, he says, shows they rarely manage to attract the high ridership they predict.

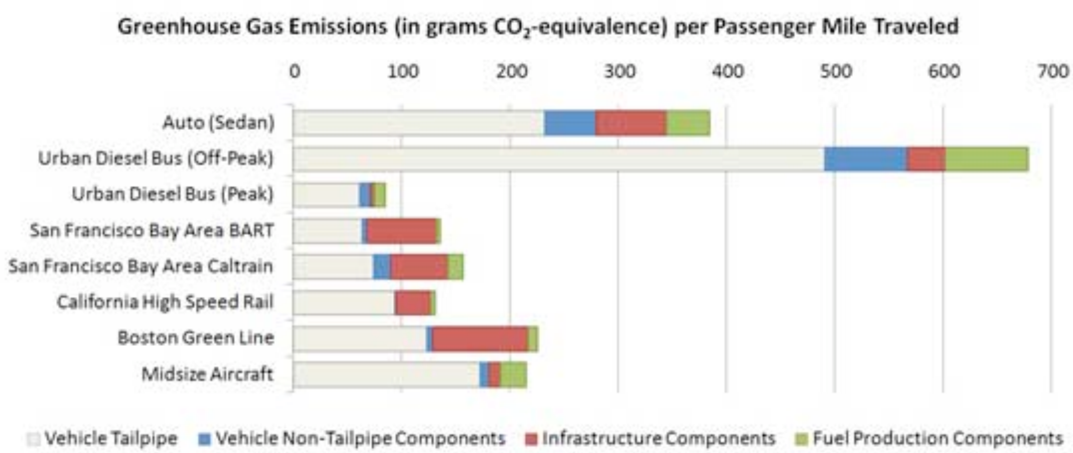
If high-speed rail draws only half the ridership it says it will attract, its environmental performance will be twice as bad per passenger miles traveled. And, if compared to typical aircraft travel in situations where 70 percent of rail passenger seats are filled, high-speed rail performs worse (the crossover occurs when high-speed rail achieves 65 percent of estimated ridership compared against current aircraft utilization rates at 70 percent).

When Chester began this project, he hoped it would result in something that "wouldn't just sit on a shelf." He believes he has succeeded. Although his extensive inventory doesn't cover every automobile, bus, plane, or train model, it provides a template and methodology that allows others to plug in data for a specific vehicle or operating condition and produce a reliable lifecycle assessment. As he points out, many of the components for automobiles—asphalt, roadway lighting, manufacturing—will remain the same except for minor differences specific to a particular model.

He points out that knowing just how large the role of asphalt production plays, for example, in energy consumption and emissions for automobiles and buses can guide researchers to provide new and better methods for manufacturing and using it in the infrastructures of various transportation modes.

He takes heart, too, in the response he has received since the paper was posted on the ITS Web site through the publications database.

"We've had calls from federal transportation officials and one of the largest global airlines," he said, adding that the document has been downloaded more than 100 times in the last 10 months. A magazine has asked him to use his methodology to determine the effects of motorcycle travel. So the work for Chester and Professor Horvath will continue.



Average occupancies are shown with the exception of the Urban Bus which has 5 passengers during off-peak times and 40 during peak times.
"Vehicle Tailpipe" represents emissions from gasoline, diesel, or electricity use in active operation. "Vehicle Non-Tailpipe Components" are components associated with the vehicle outside of active operation (e.g. manufacturing, maintenance, etcetera).
"Infrastructure Components" capture construction, maintenance, operation, and other materials, processes, and services required to build and operate each mode's infrastructure.
"Fuel Production Components" capture the emissions from gasoline, diesel, electricity, and other fuel input production including mining, refining, production, and distribution.

Important Links:

"Environmental Life-cycle Assessment of Passenger Transportation" Project Web site.

Mikhail Chester's Home page

PDF of the abstract of Mikhail Chester's ITS Friday seminar of August 29, 2008, "An Environmental Life-Cycle Inventory of Passenger Transportation in the United States."

Professor Arpad Horvath's Home page:

Freight LCA papers by Cristiano Facanha and Arpad Horvath:
Environmental Assessment of Freight Transportation in the U.S. (11 pp)
Evaluation of Life-Cycle Air Emission Factors of Freight Transportation

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