

CMS

UNIVERSITY OF FLORIDA

Spring 2009

CMS Research Funds Help Improve Traffic Analysis Tools



UF UNIVERSITY of
FLORIDA

Center for
Multimodal
Solutions for Congestion Mitigation
University of Florida

*A publication of a USDOT/RITA - funded
Tier 1 University Transportation Center*



message from the director

Dear Colleagues,

These days, the threat of budget cuts and layoffs is on many people’s minds, and universities are certainly experiencing the effects of the economic downturn. At the same time, transportation infrastructure and plans for improving it are at the forefront of the national agenda. This presents a unique challenge and also an opportunity for University Transportation Centers (UTCs) to play a key role in shaping the future of transportation policy and practice. To that end, we at the CMS have been deeply engaged in developing new ways to mitigate congestion, reduce transportation-related impacts on the environment, create livable communities and improve the quality of our lives. As we enter our second year of operation as a USDOT-funded Tier 1 UTC, we are working on improving several widely used traffic analysis tools, on considering the impacts of intelligent vehicle capabilities on congestion, as well as on emergency evacuation strategies, among other topics.

In this issue, you will read how the CMS is playing a key role in improving CORSIM, a traffic simulation software produced by our affiliate center, McTrans. One of our projects will incorporate two-lane highway analysis and passing maneuvers into CORSIM, while another one uses CORSIM to study the impacts advanced vehicle technologies are likely to have on congestion. In our Featured Research section, you will read about a CMS-funded project led by researchers in the Department of Industrial & Systems Engineering, which is looking into ways to improve evacuation efficiency in emergency situations.

We have now completed the second round of research project selection (see page 10 for a complete list), and we are expecting the first group of final reports to be completed soon. These will be posted on our Web site as soon as they are available. Abstracts of all on-going projects are provided on our Web site (<http://cms.ce.ufl.edu/research/>).

Also on our Web site is our new “Ask the Expert” link, which invites transportation professionals and the general public to ask transportation-related questions. Responses will be obtained by transportation experts and posted on the site.

I hope you will enjoy reading our newsletter, and I look forward to hearing from you with any questions or suggestions.

Sincerely,

Lily Elefteriadou, Ph.D.
elefter@ce.ufl.edu

In this Issue

Message from the Director	2
CMS at TRB	3
McTrans	4
Featured Research	6
Q&A with Richard Long	8
CMS Projects	10
RITA Site Visit	11
Workshop on Roundabouts	11
Featured Researcher	12
EAB Meeting	13
Annual Student Conference	13
Student Awards	14
CMS Distinguished Lecturer	14
Student Spotlight	15

Ask the Expert!

Do you have a transportation-related question or concern? If so, send them to us. Questions will be assigned to our experts and responses will be posted on the CMS Web page, and a selected few will be published in our newsletter. Ask the Expert serves several useful purposes, such as stimulating discussion among profes-

sionals, and it assists the CMS in focusing research and educational activities. Additionally, publicizing questions and answers serves as a form of technology and information transfer. All questions will be posted or reprinted with permission. For more information, visit: http://cms.ce.ufl.edu/contact_us/ask_the_expert.php.

Dear Transportation Alumni...

Help keep our database up to date by registering with us at http://cms.ce.ufl.edu/contact_us/. The CMS will provide you with notices on transportation-related activities such as conferences, workshops, webcasted seminars and other activities. Additionally, we will send

you our bi-annual newsletter and annual report. Also, if you have moved or are receiving duplicate copies of this newsletter, or if you are receiving mail for folks who are no longer with your institution, agency or company, please let us know.



Clockwise from right:
 Bill Sampson manning the *McTrans* booth at the TRB Exhibit hall
 Sherrilene Classen and Ruth Steiner at the UF reception.
 Siva Srinivasan, Abishek Komma, Lily Elefteriadou and Aaron Elias at the Omni Shoreham Hotel during the CUTC Awards Banquet.
 George Chrysikopoulos, Dimitra Michalaka, Grady Carrik and Lily Elefteriadou at the UF reception

CMS Representation at TRB

Several CMS faculty, staff and students attended the 88th Annual Meeting of the Transportation Research Board (TRB) in Washington, D.C. on January 11-15, 2009. CMS affiliates made technical paper presentations, participated in various committees, attended the CUTC meeting and awards ceremony (see page 14 for information on UF student awardees) and participated in various events sponsored by the Southeastern Transportation Center of which the University of Florida is a participating university. They also attended the University of Florida/Transportation Research Center Reception on January 12, 2009 at the Marriott Wardman Park Hotel.

CMS Participation in TRB Committees

- Ken Courage, P.Eng., Professor Emeritus, CCE**
- Member, Traffic Flow Theory Committee
 - Member, former chair, Subcommittee on Joint Traffic Simulation
 - Member, former chair, Subcommittee on Signalized Intersections
 - Member, Subcommittee on Simulation
- Janet Degner, Florida Transportation Technology Transfer Center (T²), Director**
- Friend, Technology Transfer Committee
- Lily Elefteriadou, Ph.D., Professor, CMS Director**
- Secretary, Highway Capacity & Quality of Service Committee
 - Member, Traffic Flow Theory & Characteristics Committee
- Siriphong "Toi" Lawphongpanich, Associate Professor, ISE**
- Friend, Transportation Network Modeling Committee
 - Friend, Congestion Pricing Committee

- Bill Sampson, McTrans Director**
- Member, Highway Capacity & Quality of Service Committee
- Siva Srinivasan, Assistant Professor, CCE**
- Member, Traveler Behavior & Values Committee
 - Member, Telecommunications & Travel Behavior Committee
- Ruth Steiner, Associate Professor, URP**
- Member, Transportation & Land Development Committee
 - Chair, Subcommittee on Research for Transportation & Land Development
 - Member, Pedestrian Committee
 - Member, NCHRP Project Panel on Enhancing Internal Trip Capture Estimation for Mixed-Use Developments
- Scott Washburn, Associate Professor, CCE**
- Member, Highway Capacity & Quality of Service Committee
 - Chair, Subcommittee on Freeways/Multilane Highways
 - Member, ACRP Project Panel on Airport Curbside & Terminal-Area Roadway Operations
- Tiffany Wise, LTAP Director**
- Member, 10th International Conference on Low-Volume Roads Committee
- Yafeng Yin, Assistant Professor, CCE**
- Member, Transportation Network Modeling Committee
 - Friend, Traffic Signal Systems Committee
 - Friend, Artificial Intelligence & Advanced Computing Applications Committee

CMS Research Funds Help Improve Traffic Analysis Tools

Center for Microcomputers in Transportation – McTrans

Mention *McTrans* in the transportation industry, and most people will immediately know what you are talking about. That's because *McTrans* has been around for a long time. In the 23 years since its inception, the center has become a standard in the industry, distributing and producing software to practitioners in the transportation and planning communities and, more recently, focusing on three major products (HCS, TRANSYT-7F and TSIS-CORSIM) which have come to define the center. *McTrans* is an affiliate of the Center for Multimodal Solutions for Congestion Mitigation (CMS), often collaborating with the University Transportation Center (UTC) on various research projects.

McTrans has humble beginnings. Housed in the Department of Civil & Coastal Engineering at the University of Florida, the center was established in 1986 through a two-year grant funded by the Federal Highway Administration (FHWA). Its mission was to serve as a focal point for the sale and support of transportation software products, primarily those produced by the federal government, to practitioners in the field. The center's plan from the very beginning was to eventually establish itself as a completely self-supported entity. That's when Bill Sampson stepped in. Formerly a manager at *McTrans* and now the center's director, Sampson, an engineer, was tasked with the job of administrating the center very much like a small business and keeping it afloat without the aid of a federal grant.

"From day one, the plan was that after the first two years of funding, the center would become self supporting, relying on revenues from the sale of software," Sampson said. "So I came to work here on April 29, 1988, literally the day the funding ended and we went self supporting. We are a little business. All the money comes from the end users."

McTrans is now considered an auxiliary, a revenue-generating center at the University of Florida. Membership is free as are most of the services provided. The center offers expert technical advice with various Levels of Support (LOS), information exchange which includes the *McTrans* newsletter, a technical assistance hotline, training courses for popular software packages and a wide range of transportation-related software.

If you go to the *McTrans* online catalog (<http://mctrans.ce.ufl.edu/catalog/>), you will see software for use in construction management, environmental, highway design, pavements, bridges and hydraulics, maintenance safety, surveying, traffic engineering, transit and urban transportation planning. *McTrans* also distributes software developed by the FHWA and state departments of transportation, universities, local transportation agencies and private individuals. Privately developed commercial software packages are also distributed by the center.

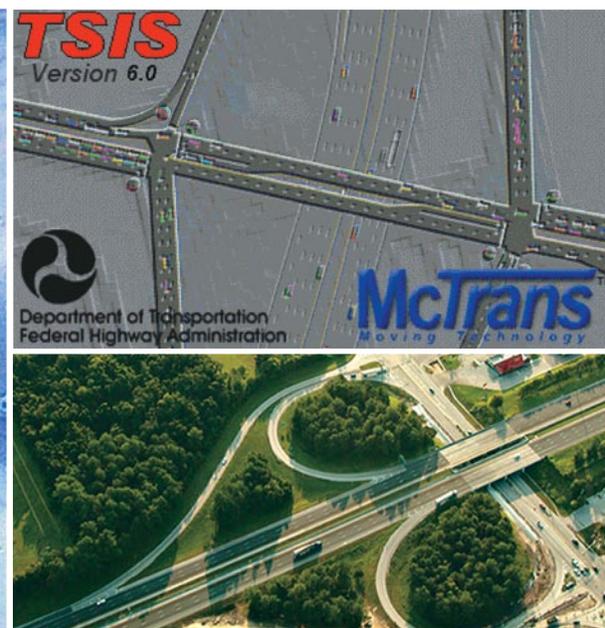
The center's continued success has come primarily from three internally produced transportation software packages: the Highway Capacity Software™ (HCS), TRANSYT-7F™ and TSIS-CORSIM™.

"HCS is likely the most widely used transportation engineering and planning program in the world," Sampson said. "CORSIM is probably the most used traffic simulation tool worldwide, but without some of the attributes of some other privately developed simulation packages."

What does HCS do? The program analyzes the capacity of intersections and roadways to quantify their level of service for the traveling public. It is used to compare alternative strategies and determine the impact of new developments on

Left to right:
Screen shots of two popular
McTrans software products:
HCS+ T7F and TSIS-CORSIM

Bottom right:
An aerial view of an interchange
in Florida taken by Dave
Bloomquist, a CCE faculty
member. This highway system
is simulated in the *McTrans*
Highway Capacity Software.



neighboring systems to quantify capacity improvements needed to mitigate that impact. Then there is CORSIM, the popular traffic simulation tool. CORSIM models the operation of intersections and roadways by tracking each individual vehicle's movements, essentially second-by-second, to produce a large number of parameters. It can show when and where congestion will develop, what the expected speed of a freeway will be, or what the impacts of an incident will be on corridor operations. The program includes animation output that graphically shows movements and queuing, among other things. Also there is TRANSYT-7F which is now regenerating its niche, helped somewhat by its integration with the HCS and easy interaction with CORSIM.

"TRANSYT-7F is not as widely used as it once was," Sampson said. "But the inclusion within the HCS+ package has reintroduced it to many users, and it has always maintained a significant following internationally."

TRANSYT-7F is a signal timing optimization tool that uses different models with data on traffic, geometry and phasing to arrive at the best allocation of green times needed to achieve maximum efficiency at each signal as well as parameters that provide coordination among signals along an arterial or within a network.

As long as there are roads to build, bridges to fix and urban communities to plan, or any transportation need for that matter, McTrans will certainly continue to exist. And as long as there are these needs, research will certainly play a major role, and that's where the CMS will continue to benefit from its affiliation with McTrans.

"It's a natural partnership," Sampson said. "That is the benefit CMS gets from McTrans, and McTrans receives from CMS - the ability to work together to modify software to increase its usefulness in research and practice. There are a lot of things in common such as subject matter, research goals, the use of software and interfacing with graduate students."

For more information on McTrans, visit: <http://mctrans.ce.ufl.edu/>.

Where the rubber meets the road: How CMS interfaces with McTrans and the practitioner benefits

So exactly how does the CMS benefit from its affiliation with the McTrans Center? There are various ways in which it does, and it primarily involves research. For example, faculty and graduate students are working with programmers at McTrans to improve CORSIM, a microsimulation program, so that it can replicate passing maneuvers on a two-lane highway. Faculty and graduate students are also working with McTrans on the CORSIM modeling of emerging vehicle technologies. These CMS projects have real-world applications because they ultimately make their way into programs such as CORSIM, which are used by thousands of practitioners in the field of transportation.

Title: Development of a Simulation Program for Two-Lane Highway Analysis

CMS project: 2008-002

Principal Investigator: Scott Washburn, Ph.D., Associate Professor

Co-Investigator: Lily Elefteriadou, Ph.D., Professor

This project will research ways to modify CORSIM's capacity to model passing on two-lane highways. Two-lane highways constitute the vast majority of highway facilities in the U.S. Scott Washburn, in collaboration with McTrans, is developing new algorithms to modify CORSIM so that it can handle passing maneuvers on two-lane highways. There is currently no analysis tool that can replicate two lane highway operations within a highway network. Developing this method for implementation into McTrans' CORSIM will benefit the transportation community and will also strengthen the CMS-McTrans relationship.

A screen capture of TSIS-CORSIM showing queue activity at various intersections.

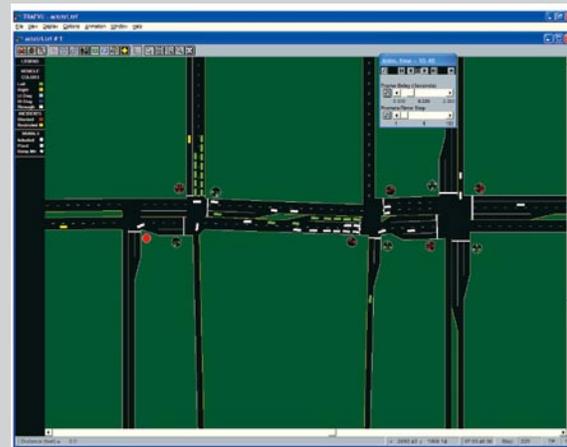
Title: Using Microsimulation to Evaluate the Effects of Advanced Vehicle Technologies

CMS project: 2009-006

Principal Investigator: Lily Elefteriadou, Ph.D., Professor

Co-Investigator: David Hale, Ph.D., McTrans; Tom Simmerman, McTrans

Automobile companies have been developing advanced vehicle technologies for quite sometime now. These include Vehicle-to-Vehicle (V2V), radar cruise control systems to monitor speed and following distance, and "brake assist" technologies, with sensors detecting the possibility of a crash, lateral skidding and emergency braking conditions. However, unknown is how these technologies could affect congestion and the flow of traffic. Lily Elefteriadou is working with McTrans to modify CORSIM so that these technologies can be evaluated through simulation. Algorithms in CORSIM would be modified to replicate the operation of various selected advanced vehicle technologies in traffic. When completed, this research could provide the automotive industry with a new way to determine which technologies might help improve congestion.





featured research



Panos Pardalos, Ph.D.



Optimization Models for Improving Emergency Evacuations

**By: Panos Pardalos, Ph.D., Distinguished Professor and Ashwin Arulsevan, doctoral student
Department of Industrial & Systems Engineering**

This article is based on ongoing research under CMS Project # 2008-005

Purpose of study: Minimize the total evacuation time for a given highway network

Approach: Make traffic flow more efficiently by identifying lanes to be reversed and by establishing optimal evacuation routes for passenger cars and buses

Conclusions to-date:

- Identifying the optimal set of lanes to be reversed is computationally complex and exact analytical solutions would have unrealistically high running times.
- The problem is solved in two steps: first, the lanes to be reversed are identified, and second, the optimal evacuation routes are established for the reconfigured network.
- The model provides evacuation routes for passenger cars and for each origin- destination pair and the frequency of departures for buses.

The Florida Division of Emergency Management reported that Hurricane Frances required 1.8 million people to be evacuated, Hurricane Ivan required 545,000 and Hurricane Jeanne required 4.4 million¹. The Department of Homeland Security in the nationwide report for the year 2006 identified a significant inadequacy in evacuation planning effort for using multiple modes of transport to evacuate people from different risk zones². According to the report, only less than 20 percent of state and 10 percent of urban areas have sufficiency in their plans for accommodating multiple modes of transport. Some of the important measures in an evacuation plan that are listed in the report include contraflow measures, identifying evacuation routes and consideration of alternative and safe modes of transportation besides the personal vehicles used by the evacuees.

The objectives of this study are to make traffic flow more efficiently by identifying lanes to be reversed, and by establishing optimal evacuation routes for passenger cars and buses.

Lane reversals have been a proven strategy to improve evacuation efficiency in an emergency situation. Generally, the lane reversal strategies vary depending on the need. For instance, lane reversals due to work zones or incidents do not require a global strategy, as these pertain to a specific link in the network. On the other hand, emergency situations and sporting events that require mass transit would require more sophisticated lane reversal plans. Also, for hurricanes, the intensity of the hurricane and the population in the area to be evacuated needs to be considered. The illustration in Figure 1 describes how lane reversals would help in improving flow. The numbers in parentheses indicate the capacity and the travel time of the arc respectively.

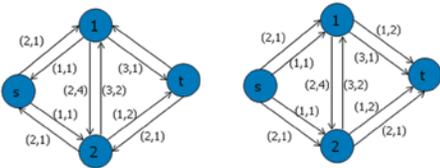


Figure 1. a) Original network b) Reconfigured network

Figure 1a presents a directed graph with four nodes. Origin is indicated by O and D destination. In figure 1a it takes 1 time unit to send 2 units of flow from node O to node 1 and 2 time units to send 3 units of flow from node 1 to node D. Thus, the time required for evacuating 21 units of flow from O to D, using all the possible routes, is 10.

The graph in figure 1b is a reconfigured graph with lane reversals, and it takes 1 time unit to send 5 units of flow from node O to 1 and 2 time units to send 4 units of flow from node 1 to node D. Thus along the path O-1-D we can send 2 units of flow in 3 time units in the original network, whereas in the reconfigured network we could send 4 units of flow in 3 time units. In this reconfigured network the evacuation time for 21 units of traffic is 5, which is half of that for the original network.

A complexity study performed on these types of network flow problems³ indicated that these types of problems are computationally hard (i.e. they require exponential running times.) Several issues may arise during a

reconfiguration of a network. These include permitting only a subset of arcs (i.e., lanes of roadway segments) to be reversed, imposing a switching cost to the arcs involved in the reversals, and considering multiple origins and destinations. Ford and Fulkerson⁴ studied the maximum dynamic flow problem, where one tries to maximize the flow sent from source to sink, within a given time horizon T and proved that this problem is equivalent to solving a minimum cost flow problem with the arc costs as travel times on the arcs. Then the optimal flow on the arcs from source to sink is decomposed into a set of paths or chains.

A simple graph transformation that involves replacing each directed arc with an undirected arc with increased capacity would allow solving the minimum cost flow problem to identify lanes to be reversed in a single origin/single destination dynamic contraflow problem. The details of the transformation and a proof of correctness of this transformation are provided in reference⁵. The problem becomes NP-hard³ for multiple sources and multiple sinks. The problem is NP-hard for single origin/single destination scenarios if we consider the cost of reversing an arc. These results indicate that the optimization problems are computationally difficult and polynomial time algorithms are available only to the simplistic single origin/single destination network flow scenarios.

A bimodal transportation network is a reasonable assumption in an emergency situation as buses and cars could serve as the predominant modes of transportation. In this ongoing research effort, the researchers consider the bimodal evacuation problem with multicommodity flow, where travelers (or evacuees) have destination preferences from their respective origins. In this problem, there are two sets of travelers, depending on their modes of transport. It is assumed that the demands of passenger cars and bus passengers for every pair of origin destinations in the network are known and do not vary. It is also assumed that the bus routes have already been established. The links of the network under

consideration are shared by both cars and buses. Each link has a given travel time and a given capacity. The objective is to determine the most efficient path for passenger cars between the origins and destinations, and the frequency of the buses along their predetermined routes, without exceeding the capacity of the arcs.

This optimization problem which considers multimodal and multicommodity flows is non-trivial as it is NP-hard³, and it is modeled with a large number of variables. The solution developed attempts to exploit the combinatorial structure of the problem. The researchers are proposing to use the column generation procedure, where the variables are generated iteratively and added to the model. A computationally efficient subproblem is solved at each iteration to generate a subset of variables. The entire procedure has been successfully implemented and tested in C++. This iterative procedure has difficulties with the convergence to an optimal solution and the researchers are currently experimenting with the numerical acceleration of this convergence.

References

1. Contraflow Plan for the Florida Intrastate Highway System, Technical Memorandum, Version 1, June 6, 2005.
2. Department of Homeland Security (DHS), Nationwide Plan Review, Phase II review, 2006.
3. M. R. Garey and D. S. Johnson. Computers and Intractability: A Guide to the Theory of NP-completeness. Freeman, 1979.
4. L.R. Ford and D.R. Fulkerson. Flows in Networks. Princeton University Press, 1962.
5. S. Rebennack, A. Arulselvan, L. Eleferiadou, and P.M. Pardalos. Complexity Analysis for Maximum Flow Problems with Arc Reversals, Journal of Combinatorial Optimization (accepted).

Q&A with Richard Long

Director of Research
Florida Department of Transportation (FDOT)

Richard Long is a member of the CMS's External Advisory Board and has been a great resource to the center as it gains momentum. He has for many years supported the research, educational and technology transfer activities in transportation at the University of Florida. Long will be retiring from FDOT at the end of June 2009.

What was the career path that led you to your current position as Research Director at FDOT?

Aimlessly wandering around. By 1984, I had developed a decent background in maintenance, construction, long range planning, finance, contracting, and project scheduling. I also spent some time as a legislative analyst in the Florida Senate. I was working as staff to the State Highway Engineer (SHE) when I was asked to develop a white paper on the Department's research efforts. Management wanted a department-wide research program and asked if I would assist in its development. While I initially expected to be here for a couple of years to get things started, I found a home and have never considered doing anything else.

What were some of the biggest challenges you faced as a rookie?

Convincing the research community as it existed that there is more to transportation research than asphalt and concrete and then building a culture for multi-modal research and working with all of the other functional offices.

Your innovative thinking and practices helped other DOTs in blazing the way for creative solutions to problems impacting their state DOTs. What are some of the Research Office practices you have implemented that stand out in your mind?

Our research Deployment Plan, which is made up of five separate components: implementation, performance measures, technology transfer, training, and marketing. Before funding any research project, we look at it in light of each of these components to ensure usage of the results.

Top:
Richard Long



Bottom:
Richard Long, Dwayne Henclewood, Kevin Heaslip and Ananth Prasad at TRB in 2007



What are some of the research projects that have really enhanced the success of FDOT?

Our multi-year Florida Bridge Pier research effort has to be the single biggest success. It has saved the Department tens of millions of dollars, at least. However, in another light, I could say all of them! Whenever a need for knowledge is satisfied through research, the Department benefits. What may be important to some may not be important to others, so "benefit" can be argued on a number of different levels. The fact remains that an important need for knowledge was satisfied for the office that requested the funding. Across the functional areas of the Department, research is regularly changing and improving how we do business.

Contrast the current research environment today to when you came on board.

There is more sharing of research results. Some may call this technology transfer but I think it is more. There is a general awareness that a major part of the research effort is deploying the results; otherwise, the outcome is just a report to sit on someone's bookshelf.

How have transportation problems in Florida changed over your tenure?

They really haven't. Our business is to provide a safe, reliable transportation system to the citizens. We have always been at the mercy of unconstrained growth, never able to catch up to needs, and that is still the case today. Sure, projects cost more and urbanization has made land acquisition and what you can do within the rights of way more complicated, which increases the time it takes to provide improvements, but the basic problems haven't changed. They have just become more complicated.

What are some of your most memorable experiences working with FDOT?

The people. I have been blessed to know and work with hundreds of people in all walks of transportation representing all 50 States, national organizations, universities, private groups and citizens, and the FDOT. While my staff is most special, I have learned, grown, and been influenced by everyone I have met.

What would you like for our transportation systems to look like 50 years from now?

Fifty years is hard to put my arms around. Within the near term (10-25 years), I expect to see cars doing more and more

thinking for us with onboard computers initiating evasive action to avoid crashes and to keep our elderly and young drivers safer. I expect travel demand to flatten as more people work in virtual offices. There will be less congestion since everyone will not have to be at the office at the same time. There will be less demand for fossil fuels and more electric vehicles as the next generation demands that we become better stewards of the environment.

What do you consider the biggest challenges of the future besides funding?

The creation of, or at the very least a common agreement on, a national research agenda combined with a strategic vision. The major players today are the USDOT (FHWA and RITA), the Transportation Research Board (primarily the Cooperative Research Programs), and the individual state research programs. Combined, these groups look at all aspects of transportation and transportation-related issues. They also look at a combination of basic and applied research efforts to varying degrees. What is lacking, in my opinion, is a strategic plan that not only links these groups together but also provides guidance and a balance between research to satisfy our daily needs and research that will affect our future. The Standing Committee on Research is beginning to look to the future, but they will need coordination and collaboration with other agencies.

If you could change one thing about transportation, what would it be?

In the final analysis, nothing. Everyday, I see outstanding efforts by transportation professionals across the country who are passionate about their work. Improvements to the system are occurring daily, maybe not fast enough for some, but we are moving forward and, in the end, that is all you can ask.

What does the future hold for Richard Long?

Make me an offer!

Advice for the CMS?

Stick to your knitting and do it better than anyone else. The UTCs that I have seen fail provide no real benefit to transportation, try to do too much, or try to grow too large. You were established because of your theme and the impact of congestion on anyone who travels. Expand congestion issues to the extent that funding will allow, and be the "go-to" center on the subject of congestion.

CMS

Projects Update

THE CMS WRAPPED up its research project selection process for 2009-2010 this past February. Our RFP yielded a total of 13 pre-proposals. Eight of those pre-proposals were selected by the CMS's Project Review Committee to proceed to the full proposal stage. After review by external evaluators, it was determined that six projects would be funded for 2009-2010 (see 2009 Projects). Most of the projects selected from the center's first RFP in 2008 are scheduled to be completed this year and are listed below. The CMS has various matching projects with the Florida Department of Transportation (FDOT), which are also listed below, and the list is expected to grow. Additionally, CMS-affiliated faculty are involved with other related projects such as those with the NCHRP.

2009 PROJECTS (NEW)

Innovations in Pricing of Transportation Systems: Theory and Practice

PI: Siriphong "Toi" Lawphongpanich, Ph.D. (ISE)
Co-Investigators: Janet Degner, M.S. (T²); Yafeng Yin, Ph.D. (CCE)
CMS Project # 2009-004

Using Microsimulation to Evaluate the Effects of Advanced Vehicle Technologies on Congestion

PI: Lily Elefteriadou, Ph.D. (CCE)
Co-Investigators: David Hale, Ph.D. (McTrans); Tom Simmerman (McTrans)
CMS Project # 2009-006

Tour Generation Models for Florida

PI: Siva Srinivasan, Ph.D. (CCE)
CMS Project # 2009-008

Development of a Multimodal Transportation Educational Virtual Appliance (MTEVA) to Study Congestion during Extreme Tropical Events

PI: Peter Sheng, Ph.D. (CCE)
Co-Investigators: Panos Pardalos, Ph.D. (ISE); Renato Figueiredo (ECE); Justin Davis, Ph.D. (CCE)
CMS Project # 2009-010

Robust Congestion Pricing under Boundedly Rational Travel Behaviors

PI: Yafeng Yin, Ph.D. (CCE)
Co-Investigators: Siriphong "Toi" Lawphongpanich, Ph.D. (ISE); Yingyan Lou, doctoral candidate (CCE)
CMS Project # 2009-012

Needs Assessment of Land Use Modeling for FSUTMS, Phase I

PI: Zhong-Ren Peng, Ph.D. (URP)
CMS Project # 2009-013

2008 PROJECTS (ONGOING)

Central Data Warehouse Configuration, Data Analysis for Congestion Mitigation Studies

PI: Kenneth Courage, P. Eng., Professor Emeritus (CCE)
CMS Project # 2008-001

Development of Simulation Program for Two-Lane Highway Analysis

PI: Scott Washburn, Ph.D. (CCE)
Co-Investigators: Lily Elefteriadou, Ph.D. (CCE)
Project # 2008-002

Simulation-Based Robust Optimization for Actuated Signal Timing and Setting

PI: Yafeng Yin, Ph.D. (CCE)
Co-Investigators: Scott Washburn, Ph.D. (CCE); Farid AitSahlia, Ph.D. (ISE)
Project #2008-003

Characterizing the Tradeoffs and Costs Associated with Transportation Congestion in Supply Chains

PI: Joseph Geunes, Ph.D. (ISE)
Project # 2008-004

Multimodal Solutions for Large Scale Evacuations

PI: Panos Pardalos, Ph.D. (ISE)
Project # 2008-005

A Pricing Approach for Mitigating Congestion in Multimodal Transportation Systems

PI: Siriphong (Toi) Lawphongpanich, Ph.D. (ISE)
Co-Investigators: Yafeng Yin, Ph.D. (CCE)
Project # 2008-006

Vehicle-Miles-of-Travel-Based Traffic Impact Assessment Methodology

PI: Ruth Steiner, Ph.D. (URP)
Co-Investigators: Siva Srinivasan, Ph.D. (CCE)
Project # 2008-007

FDOT MATCH PROJECTS

Implementation of the Statewide Traffic Engineering Warehouse for Regionally Archived Data (STEWART)

PI: Kenneth Courage, P.Eng., Professor Emeritus (CCE)
Project # 72734

Field Data Collection and Analysis for Freeway Work Zone Capacity Estimation

PI: Lily Elefteriadou, Ph.D. (CCE)
Project # 67207

Travel Time Reliability Modeling for Florida

PI: Lily Elefteriadou, Ph.D. (CCE)
Project # 77415

Investigation of Freeway Capacity: A) Effective Capacity of Auxiliary Lanes and B) Segment Capacity as a Function of Number of Lanes and Merge/Diverge Activity

PI: Scott Washburn, Ph.D. (CCE)
Co-Investigators: Yafeng Yin, Ph.D. (CCE)
Project # 73157 & 74022

Multimodal Arterial LOS Modeling and Testing

PI: Scott Washburn, Ph.D. (CCE)
Project # 76279 & 76293

Development of a Prototype Land Use Model for Statewide Transportation Planning Activities

PI: Zhong-Ren Peng, Ph.D. (URP)
Project # 78101

For information on the abstracts related to the individual projects, visit <http://cms.ce.ufl.edu/research/>.

OTHER RELATED PROJECTS

NCHRP 3-60A Validation and Enhancement of the Highway Capacity Manual's Interchange Ramp Terminal Methodology

Investigator: Lily Elefteriadou, Ph.D. (CCE)

NCHRP 3-85 Guidance for the Use of Simulation and Models

Investigators: Ken Courage, P. Eng., Professor Emeritus (CCE); Scott Washburn, Ph.D. (CCE); Lily Elefteriadou, Ph.D. (CCE)

NCHRP 3-87 Proactive Ramp Management under the Threat of Freeway Flow Breakdown

Investigators: Lily Elefteriadou, Ph.D. (CCE); Scott Washburn, Ph.D. (CCE)

NCHRP 3-92 Year 2010 Highway Capacity Manual

Investigators: Ken Courage, P. Eng., Professor Emeritus (CCE); Scott Washburn, Ph.D. (CCE); Lily Elefteriadou, Ph.D. (CCE); Bill Sampson (McTrans)

Prime Contractor: Kittelson & Associates, Inc.

NCHRP 3-96 Analysis of Managed Lanes on Freeway Facilities

Investigator: Yafeng Yin, Ph.D. (CCE)
Prime Contractor: University of Washington

SHRP L-11 Evaluating Alternative Operations Strategies to Improve Travel Time Reliability

Investigator: Siva Srinivasan, Ph.D. (CCE)
Prime Contractor: Kittelson & Associates, Inc.

Key:

CCE (Dept. Civil & Coastal Engineering)
ISE (Dept. Industrial & Systems Engineering)
URP (Dept. Urban & Regional Planning)

CMS Hosts Its First RITA Site Visit

Representatives from the USDOT Research and Innovative Technology Administration (RITA) visited the CMS on March 19, 2009 to assess the overall management and progress of the center, including its research, educational and technology transfer activities. RITA university program specialists Robin Kline and Amy Stearns, and program analyst Denise Dunn spent their day in meetings, taking note of the activities and accomplishments reported by CMS faculty and staff. They also met with CMS-affiliated students and grants management personnel, and they provided useful feedback regarding future activities of the center. Our RITA visitors were taken on a tour of the CMS-affiliated research facilities, which included the computer simulation lab, the signals lab, the instrumented vehicle, the transportation library and faculty and staff offices.

Robin, Amy, and Denise:

Thank you for the visit, we enjoyed sharing our accomplishments and goals with you and hearing your insights on UTC program operations!

Top: RITA and CMS representatives pose in front of Ben Hill Griffin Stadium at UF. (Back row) Siva Srinivasan, Yafeng Yin, Bill Sampson, Toi Lawphongpanich, Janet Degner (front row) Lily Elefteriadou, Denise Dunn, Ruth Steiner, Amy Stearns, Robin Kline

Bottom: Scott Washburn gives RITA visitors a tour of the Traffic Signal Control Lab.



SAVE THE DATE!

UF/TRC Workshop on Roundabouts

A workshop for transportation professionals interested in roundabouts design and operations

Co-sponsored by the CMS and McTrans

August 18, 2009

Sheraton Orlando North Hotel

Maitland, FL

Sponsorship Opportunities Available!

REGISTRATION FEES

Early-birds \$195 USD (register by July 15, 2009)

Regular or on-site \$245 USD

Workshop Sponsors \$145 USD

(All fees include morning and afternoon breaks, lunch and workshop materials)

To register, visit: http://trc.ce.ufl.edu/Roundabouts_Workshop_2009.html

TOPICS & SPEAKERS

- **An Overview of Modern Roundabouts and What They Might Soon Mean for You** (Ken Sides, City of Clearwater, Florida)
- **Design of Roundabouts** (Michael Wallwork, Alternate Street Design, P.A.)
- **Roundabouts and Their Implementation in the United States** (Mark Doctor, Federal Highway Administration)
- **Luncheon & Speaker: Dan Burden, Glattig Jackson Kercher Anglin, Inc./Co-Founder, Walkable Communities, Inc.)**
- **Roundabouts in the 2010 Highway Capacity Manual and Updated FHWA Roundabout Guide** (Lee Rodegerdts, Kittelson and Associates, Inc.)
- **Modeling of Roundabouts Using SIDRA** (Rahmi Akcelik, Akcelik and Associates Pty Ltd)
- **Modeling Roundabouts Using CORSIM** (Aaron Elias, University of Florida)
- **Designing Roundabouts with TORUS** (Milton Carrasco, Transoft Solutions)

SPONSORSHIPS

There are three sponsorship levels available (\$1,500, \$1,000 and \$500). Your donation will provide your company a discounted workshop registration rate and more. Sponsorship Deadline: July 15, 2009. Visit our Web site for details.

For more information on registration and sponsorship opportunities, contact Ines Aviles-Spadoni at iaviles@ce.ufl.edu or at 352-392-9537, Ext. 1409.



featured researcher:

*Scott Washburn, P.E., Ph.D., Associate Professor
Transportation Program, Civil & Coastal Engineering*

As you walk into Scott Washburn's office, it doesn't take long to notice that he likes fast cars and motorcycles, with numerous models on display. Thus, it is no surprise that he ended up in the field of transportation engineering. Washburn has been with the Department of Civil & Coastal Engineering at UF since 1999, and from just about the day he got here, he has been working closely with the Florida Department of Transportation (FDOT) on traffic analysis and level of service research.

"Much of the research I do for FDOT is aimed at developing new traffic analysis and level of service methodologies or improving existing ones," Washburn said. "Additionally, I write the software (LOSPLAN) for FDOT that implements their traffic analysis and level of service methodologies, which is used extensively throughout the state."

Some project examples in this area include the development of a two-lane highway facility analysis procedure, the development of models to estimate the impact of left turn spillover at a signalized intersection on through capacity, identification of performance measures and thresholds to be used for level of service on rural freeways based on traveler-perception, and the identification of appropriate level of service measures for the commercial truck mode. One of Washburn's current projects, funded through CMS, deals with implementing two-lane highway modeling into the CORSIM simulation program.

Complementing his research in the areas of traffic operations analysis and level of service, Washburn is a member of the Highway Capacity and Quality of Service committee of the Transportation Research Board. This committee oversees the development of the Highway Capacity Manual, and he chairs the Freeways/Multilane Highways subcommittee, which is responsible for several chapters in the manual.

As much as Washburn enjoys the research opportunities in the university environment, he just as much has passion for the educational opportunities. "I really enjoy teaching and interacting with the students," Washburn said. "Even for the same course, every semester is different because of the different students, and it keeps things fun and interesting. I was fortunate to have some really good professors in college, and it was very obvious to me the big difference a good professor made to my enjoyment of the class and how much I learned from the class. The opportunity to be a great educator was part of the appeal of academia."

All the more proof of his commitment to education, he is co-author of the textbook "Principles of Highway Engineering and Traffic Analysis" 4th Edition, which is one of the most popular textbooks used for introductory transportation courses.

A method to the madness

But what was the driving force behind his interest for transportation engineering? It seems that it all began when he moved from Spokane, Wash., to Seattle to begin college (Washburn obtained his BSCE, MSCE, and Ph.D. at the University of Washington).

"Seattle was a traffic nightmare," Washburn said. "Spokane is a city of a few hundred thousand people, but there was no notion of traffic con-

gestion at that time, so I had never experienced driving in it until I got to Seattle. As I was sitting in traffic, I thought to myself that someone had to address this issue. I broke out the university course catalog and started looking for anything related to transportation."

Initially, Washburn thought he would study computer science. As a youth, he was fascinated with computers, and started doing his own computer programming at the age of 12. But after spending a lot of time in congested Seattle traffic, transportation engineering became his primary professional passion. However, he realized that he could still apply his computer programming skills to solve transportation problems, as he still does to this day.

"Initially, I kept thinking to myself, there has got to be a better way to design a roadway system, and not-so-humbly thought I would be the one to solve all of Seattle's congestion problems," Washburn said. "Of course, I think a lot of people driving on congested roadways think they have the solution, but once you get into the profession, you quickly learn that eliminating congestion is a very complex problem, and that there is often, although not always, a method to the madness."

Going east to UF

It was the offer of a tenure-track faculty position that brought him to Florida. He found it very appealing for several reasons: FDOT's active research program in his research areas, UF's very good reputation as an engineering school, and the opportunity to learn from the renowned Kenneth Courage, now retired. Plus, how could he pass up the great Florida weather?

"Coming from Seattle, I was definitely ready for more sunshine," Washburn said.

The transportation academic program at UF has as much to offer as many of the top programs in the country, Washburn said, and it has excellent faculty and strong relationships with other departments, colleges and centers. This is confirmed by the tremendous amount of ongoing activity at UF aimed at solving the problems in transportation and in educating the future of the transportation workforce, he said.

The future workforce

Transportation engineers will be in high demand for decades to come, according to Washburn. He describes it as a diverse field which needs to continue to employ people with skills in planning, operations, and policy analysis. As long as people continue to demand safe and efficient transportation systems, vital to societal economies and quality of life, there will be a need for transportation professionals, Washburn said.

"So, for students looking for challenges and many opportunities that will last an entire professional career, transportation engineering is definitely a field you should consider," Washburn said.

More information about Scott Washburn can be found on his Web site at <http://www.ce.ufl.edu/~swash/>.

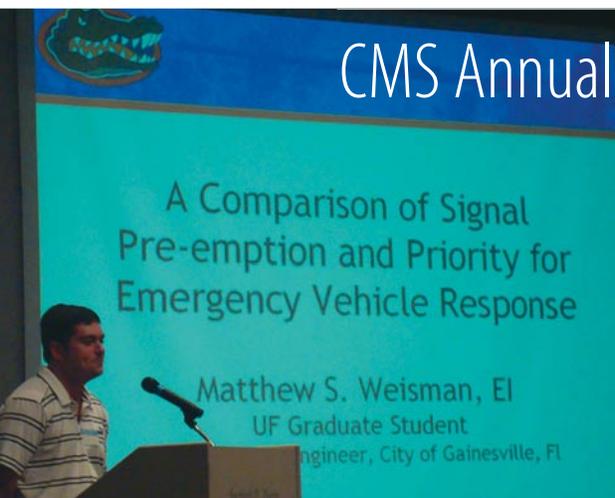
Annual CMS External Advisory Board Meeting

(Back row) Ananth Prasad, Janet Degner, Scott Washburn, Wayne Kittelson, Debora Rivera
(Front row) Toi Lawphongpanich, Ruth Steiner, Lily Elefteriadou, Linda Watson and Laura Kelley



The annual gathering of the CMS's External Advisory Board (EAB) took place on March 5-6, 2009 at the Samuel P. Harn Museum of Art on the University of Florida campus. This year, two new members joined the EAB: Linda Watson, Chief Executive Officer, LYNX (Central Florida Regional Transportation Authority – public transportation for Orange, Osceola and Seminole Counties) and Elizabeth Birriel, Deputy State Traffic Operations Engineer (FDOT – Tallahassee, Fla.). After a thorough report to the EAB by Lily Elefteriadou, the center's director, on the past year's activities, the group discussed three major research focus areas of the CMS: traffic operations, congestion pricing and transportation and land use planning. They also discussed CMS plans related to research, education and technology transfer activities. Lastly, the board, lead by Wayne Kittelson of Kittelson & Associates, Inc., made some excellent recommendations with respect to the center's future activities and goals. Board members also attended the CMS Annual Student Conference on March 6, where students presented their work on CMS-funded projects (see article below).

CMS Annual Student Conference



The CMS held its Annual Student Conference on March 6, 2009 at the Samuel P. Harn Museum of Art (UF campus). The half-day conference was attended by UF students, faculty and staff, and included members of the center's External Advisory Board (EAB) and other transportation professionals. A total of eight students from the departments of civil engineering (CE), industrial and systems engineering (ISE), occupational therapy (OT) and urban and regional planning (URP) presented their work on transportation-related issues. This year, the CMS added a bit of a competitive streak to the conference and decided to

A poster session was held during lunch as part of the conference activities. Several students participated and delivered 1 to 3-minute summaries of their work.

Student Presenters:

- Ashwin Arulsevan (ISE)* – Branch-and-Price Approach for a Bimodal Evacuation Problem
- Dincer Konur (ISE)* – A Competitive Facility Location Game with Traffic Congestion Costs
- Lihui Zhang (CE)* – Robust Synchronization of Actuated Signals on Arterials
- Di Wu (CE)* – Pareto-Improving Congestion Pricing on Multimodal Transportation Networks
- Keirra Gent (OT)* – Occupational Therapy Driving Performance Issues in Post Deployed Military Personnel with TBI, PTSD/Depression
- Russell Provost (URP)* – Using Geographical Information Systems to Analyze Relationships between Factors in the Built Environment and Travel Behavior
- Chad Riding (URP)* – Access Management as a Means of Accommodating Access, Accessibility, and Mobility on an SIS Facility: The Case Study of State Road 26 through Newberry, Florida
- Matt Weisman (CE)* – A Comparison of Signal Preemption and Priority for Emergency Vehicle Response



award prizes to students who were best able to deliver excellent, over all presentations. The students were evaluated by the EAB members, and the awardees were selected based on the EAB's votes.

Our first place winner was Di Wu, who presented on his work in congestion pricing. Wu is a doctoral student in the transportation program. In second place, Chad Riding, a master's student in urban and regional planning, won for his access management case-study work on Florida State Road 26. Our third place winner was Matt Weisman, a transportation master's student, for his presentation on signal preemption for responses to emergency vehicles.

Poster Session Participants

- Alexandra Kondyli (CE)* – Driver Behavior at Freeway-Ramp Merging Areas: Focus Group Findings
- Ashish Kulshrestha & Abigail Osei-Asamoah (CE)* – Estimating Capacity of Signalized Intersection with a Left-Turn Lane Using a Probabilistic Approach
- Yingyan Lou (CE)* – A Robust Approach to Discrete Network Designs with Demand Uncertainty
- Dimitra Michalaka (CE)* – Proactive and Robust Dynamic Pricing Strategies for High Occupancy/Toll Lanes
- Xiaoyu Zhu (CE)* – A Case Study in Spatial Misclassification of Work Zone Crashes

Top:
Matt Weisman presenting his work on signal preemption during the Annual Student Conference

Bottom:
(Left to right) Yafeng Yin, Di Wu and Toi Lawphongpanich



Left to right:
Lily Elefteriadou and Aaron Elias after the CUTC Awards Banquet at the Omni Shoreham Hotel in Washington, D.C.

Abishek Komma (right) standing with his graduate advisor Siva Srinivasan after he was presented with his award during the CUTC Awards Banquet at the Omni Shoreham Hotel in Washington, D.C.

Jessica Mackey, recipient of the Helen M. Overly Memorial Scholarship (Women's Transportation Seminar, South Florida Chapter)

CMS-Affiliated Student Award Winners

Aaron Elias, master's student, civil engineering (transportation)
Student of the Year Award
(CUTC Awards Banquet, January 2009)

Abishek Komma, M.S. (UF 2008)
Wootan Award for Outstanding M.S. Thesis in Policy & Planning
(CUTC Awards Banquet, January 2009)

Anna Lai, master's student, civil engineering (transportation)
Frankee Hellinger Undergraduate Scholarship
(WTS Central Florida Chapter, 2008)

Yingyan Lou, doctoral candidate, civil engineering (transportation)
2nd Place, Student Paper Competition
(2nd International Symposium on Freeway and Tollway Operations, June 2009)

Frankee Hellinger Graduate Scholarship
(WTS Central Florida Chapter, 2009)
Outstanding International Student
(UF College of Engineering, 2008 and 2009)

Jessica L. Mackey, master's student, urban and regional planning/transportation
Helene M. Overly Memorial Scholarship
(WTS Central Florida Chapter, 2009)

Li Xie, doctoral student, civil engineering (transportation)
Frankee Hellinger Graduate Scholarship
(WTS Central Florida Chapter, 2008)

WTS = Women's Transportation Seminar



Distinguished Lecturer Seminar

Spring 2009

Genevieve Giuliano, Ph.D., Senior Associate Dean, Research & Technology
University of Southern California, METRANS Director
School of Policy, Planning and Development

Lecture Topic:

Impacts of Port Gate Operations on the Highway System: A Case Study

PRESENTATION CONTENT: Under continued pressure to adjust operations in ways that mitigate traffic and air quality impacts of port operations and in response to threatened regulatory legislation, terminal operators collaborated to establish and implement a voluntary program of extended gate hours. The program, known as PierPASS, assesses a Traffic Mitigation Fee (TMF) on eligible containers moved into and out of the ports during regular daytime hours. The PierPASS program resulted in a significant temporal shift of cargo moves at the ports. The researchers examined the

effects of this shift on heavy truck traffic. Using a traffic simulation model, they estimated PierPASS effects on highway system performance for various weekday time periods. A shift of truck traffic out of daytime and into evening hours has resulted in little change in the level of peak period traffic volume, and hence in the level of congestion, despite significant growth in container volumes since PierPASS was implemented. The presentation concludes with some observations on recent events and the implications of PierPASS for reduction of externalities associated with port related trade.

CMS Distinguished Lecturers are chosen from academia and industry and are invited once a semester to present on congestion mitigation related issues. All Distinguished Lecturer Seminars are webcast live, recorded and posted on the CMS Web site at http://cms.ce.ufl.edu/news_events/distinguished_lecturer_seminar_series.php.

Student Spotlight Yingyan Lou

Yingyan Lou
Doctoral Candidate
Area of Specialization: Transportation
Systems Analysis
Expected Graduation Date: Fall 2009

Yingyan Lou is working fervently these days trying to figure out how to best prevent congestion by offering drivers attractive options for alternative routes by setting up practical but sensible toll rates on the road network. This is the topic of her dissertation, which she is close to wrapping up this summer before she starts her academic career as a tenure-track assistant professor at the University of Alabama.

On more than one occasion, Lou has received recognition for her excellent scholastic abilities and for her work in congestion pricing, thus validating the knowledge-base she has built over the years in school. She is an exemplary student, and one of the many stars born out of the Transportation Program in the UF Department of Civil & Coastal Engineering.

The path to success

Lou attended Beijing University, in Beijing, China, where she completed a bachelor's degree in mechanics and engineering science and another in economics. The programs were theoretical in nature with vigorous training in mathematics, physics and computer science.

Certainly, Lou had acquired a plethora of knowledge during her undergraduate years, but she was in search for a more practical side to her training and wanted to know how her skills could be applied to real-world situations.

What she did know is that she also had a passion for urban planning and design. Lou pondered how she could merge urban

planning with her training in mathematics and economics. After some very intense months consumed by contemplating her career path, the search eventually led her to pursue graduate studies in transportation at UF – a natural choice flanked by both her technical background and her urban planning interests.

"Transportation is in the middle of these two areas," Lou said. "We need to use a lot of technical skills to solve transportation problems, and transportation problems play a big part in urban planning and design. I feel the knowledge I learned has helped me very much with the research I am doing right now."

Lou currently focuses on systems analysis. Her work involves considering the transportation system in its entirety, which includes freeway and transit, among others. She's done a lot of work in the area of congestion pricing and has collaborated with researchers in other departments. Congestion pricing isn't the only topic she focuses on; she has been expanding to other areas such as transportation network security and reliability, modeling people's travel-choice behaviors and the financing of transportation systems.

Industry or academia?

When Lou initially decided to pursue graduate studies in the United States, she thought she would ultimately end up working in the corporate sector for some consulting firm. But it was her graduate adviser, Yafeng Yin, an assistant professor in the Department of Civil & Coastal engineering at UF, who after observing her progress in graduate school, encouraged her to pursue a career in academia.

"I firmly believe that Yingyan has huge potential to be a great researcher and educator," Yin said. "She is intellectually gifted and possesses an

exceptional capability of quickly digesting existing knowledge, discovering critical problems and proposing innovative solutions."

Through her dissertation research, Yin says that Lou has developed a rational and practical structure for congestion pricing on urban transportation networks.

These days, it's not that Lou is not interested in industry anymore, she is just more passionate about research.

Yingyan in her yin and yang

Ancient Chinese people viewed the world as a harmonious and holistic entity, thus giving way to the concept of yin and yang, a kind of logic which views things in relation to its whole. This is very much the way Lou views her world in relation to how she balances graduate studies at UF with life in general.

When not glued to her office chair and captivated by the blossoming results of her most current research project, Lou is gracefully striking the keys of her piano, practicing Yoga, joining friends for dinner on the weekends or singing karaoke with her friends. The songs she sings are mostly in Chinese, and she does prefer to sing them at home, she says. Lou also likes to visit many of the natural parks in the Gainesville, Fla., area.

Family is very important to Lou. Born in Shanghai, China, she is the only child to very caring parents. When Lou visits her parents in China, she likes to cook with her mother and finds comfort in engaging in long conversations with her parents. Lou even likes to spend time teaching her mother and father how to use the computer. "They learn really fast," Lou said. "They can now e-mail me and share things they like with me."

New beginnings

With her dissertation almost complete and graduation just around the corner, Lou is eager to tackle the next phase in her life, a job as a tenure track assistant professor at the University of Alabama. Although she knows that academia has its challenges, she feels confident that her training at UF will prepare her for her career goal.

"My research goal is to help enhance decision-making in transportation, to achieve a more efficient, reliable, and sustainable transportation system," Lou said. "I plan to build a research program featuring in improving transportation decision-making from a system perspective based on a more comprehensive understanding of traffic phenomena. I plan to apply systems modeling and optimization techniques with more realistic traffic flow and travel behavior models to solve real-world transportation problems."





Center for Multimodal Solutions for Congestion Mitigation

512 Weil Hall

P.O. Box 116580

Gainesville, FL 32611-6580

Phone: 352.392.9537, Ext. 1409

Fax: 352.846.1699

<http://cms.ce.ufl.edu>

Non-Profit Org
US Postage
PAID
Gainesville, FL
Permit No. 94



CMS

Publisher

Lily Elefteriadou, Ph.D.

CMS Director

Kisinger Campo Professor of
Civil Engineering

elefter@ce.ufl.edu

Managing Editor

Ines Aviles-Spadoni, M.S.

CMS Coordinator

iaviles@ce.ufl.edu

Copy Editor

Dan Treat

Designer

Linda Corsair

<http://cms.ce.ufl.edu/publications>