RESEARCH NEWS

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Quantum Dots for the DOT: Development of a Portable Petroleum By-Products Sensor

Michael A. Carpenter, Ph.D., College of Nanoscale Science and Engineering
Marina A. Petrukhina, Ph.D., Department of Chemistry
University at Albany-SUNY

The University Transportation Research Center and the Nanoscale Science and Engineering, University at Albany-SUNY are presently cooperating in the study, "Development of a Portable Petroleum By-Products Sensor" for the New York State Department of Transportation. The study develops nanoparticle based chemical sensors for the sensitive, selective and field portable analysis of soil samples for petroleum spills. By moving these tests from off-site analytical laboratories to a field portable device, the overall cost of construction budgets will be significantly lower and construction projects will experience fewer delays due to untimely lab results.

The sensitive, selective and field portable analyses of soil and water samples for petroleum spill indicating hydrocarbons (such as benzene, toluene, ethyl-benzenes, and xylenes) is a necessary requirement for transportation related construction and research. Specifically, the NYS-DOT spends approximately $10-12M/yr testing soil and groundwater samples and these costs do not include those incurred by delays in construction resulting from sample collection and their subsequent analysis. By moving the majority of these tests from an off-site analytical lab, to a field portable device, the overall cost of construction budgets will be significantly lower and construction projects will experience fewer delays due to untimely analytical lab reports.

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Director's Message

Robert "Buz" Paaswell, Ph.D.
Director & Distinguished Professor

Late this Spring, UTRC had a site review from the University Transportation Centers Office at RITA/USDOT. The review process is an important one. It allows to see if we reached goals we had set – if our plans and their development were consistent. What came out through this review and reflection process is how the strength of UTRC is built upon strong partnerships. These are the partnerships among colleagues within the consortium and other schools in our region.

But we also have partnerships with other UTCs; we have a joint MIT-Columbia project that is eagerly supported by NYSDOT. We have strong partnerships with the regional transportation agencies – and there are plenty of these in Region 2. The partnership has been strengthened by constant visits between researches, students and agency personnel. We work closely with other Centers within Region 2 – at Rutgers, SUNY, NYU and within CUNY. And our students work with all of these – graduate and undergraduate.

The results of these partnerships are seen in the breadth of our research and its support, in the innovations in the curricula, and in the quality and energy of our future professionals. As Director, I would like to take this public occasion to thank all of our partners for their strong participation in the work of UTRC and their role in the building of a strong organization.

Region 2, University Transportation Research Center

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Robert E. Paaswell, Ph.D.
Director

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Therefore, it is clear that significant transportation cost savings at both state and federal levels would occur if field portable chemical sensors were developed for continuous on-site environmental monitoring of groundwater and soil samples.

At the College of Nanoscale Science and Engineering and the Department of Chemistry, University at Albany – SUNY, we are developing novel hydrocarbon sensors based on tailored nanoscale semiconducting quantum dots (QDs). These QDs are incorporated into polymer matrices to form nanocomposite films whose fluorescence properties have shown a selective response towards selected hydrocarbons. Currently, we have been able to achieve a 15ppm detection limit for xylenes in an ambient air mixture, and a 50ppm detection limit for toluene, with a potential detection range over 3 orders of magnitude. The factor of 3 enhancement in the selective detection of aromatic hydrocarbons, which only differ by a single methyl group, is an example of the scientific promise tailor designed nanosystems have for the development of portable chemical sensors.

Assistant Professors Dr. Michael A. Carpenter (CNSE) and Dr. Marina A. Petrukhina (Chemistry Department) have established a strong interdisciplinary collaboration to develop high technology solutions for the transportation industry. Their combined expertise in synthetic, physical and materials chemistry has resulted in a collaborative research team that is developing, with support from the NYS and US DOT, technology for the next generation of hydrocarbon sensing systems. Furthermore, these programs have a strong educational initiative and support a postdoctoral associate, several graduate and undergraduate students, as well as summer undergraduate and high school research interns.

Carpenter and Petrukhina's research is part of Albany NanoTech's Energy and Environmental Technology Application Center (E2TAC), which houses multiple programs designed to leverage nanotechnology to support advances within the energy and environmental sectors. Ongoing E2TAC research programs focus on thin film science and technology applications including sensors, fuel cells, power electronics, superconductors, and solar cells.

About Albany NanoTech
One of the largest global centers for nanotechnology, Albany NanoTech is home to the College of Nanoscale Science and Engineering (CNSE), established in 2004 as the world's first college devoted to nanoscience and nanoengineering education and research, and the New York State Center of Excellence in Nanoelectronics (NYSCEN) of the University at Albany-State University of New York. Albany NanoTech is a 450,000 square foot complex, including the only 200mm/300mm wafer facilities in the academic world, encompasses nanoelectronics, system-on-a-chip technologies, biochips, optoelectronics and photonics devices.

Student of the Year Award Given to UTRC Supported Student: Joseph Davis

Mr. Joseph Davis was raised in Colonia, NJ. He graduated from the School of Engineering at Rutgers, The State University of New Jersey in 2001 with a Bachelors Degree in Civil and Environmental Engineering. Joseph continued his education at Rutgers thereafter receiving his Masters in Structural Engineering in May 2003.

Presently Joseph is a Teaching Assistant for the Reinforced Concrete Lab in addition to being a PhD candidate. The UTRC supported Mr. Davis in his work with Dr. Hani Nassif , Rutgers University on the instrumentation of the newly constructed Doremus Avenue Bridge in Newark, NJ. This crossing located in the Port of Newark is a vital link for truck traffic between the Port and intermodal facilities. Additionally, this bridge was the first in NJ to be designed using the newly adopted LRFD design approach. During his research at Rutgers, Joseph has worked under the direction of the Rutgers Center for Advanced Infrastructure and Transportation on projects for the New Jersey Department of Transportation and was supported by the University Transportation Research Center. Joseph was a CAIT fellow for the academic year 2002-2003 and a UTRC fellow for the 2001-2002 academic year.

University Transportation Research Center, Student Research

Identification of Traffic Control Measures for Mobile and Short Duration Work Operations,

Waqar Azam, UTRC Research Associate

Waqar Azam is a recent graduate with Masters Degree of Science in Civil Engineering from The City College of New York, City University of New York. He worked as a Research Associate with the Region 2, University Transportation Research Center at The City College of New York. and was awarded "Outstanding University Student in Transportation Award" by NJDOT for his effort on the "Identification of Traffic Control Measures for Mobile and Short Duration Work Operations" project.

Originally from Pakistan, he did his Bachelors Degree in Civil Engineering in 2000 from the University of Engineering and Technology, Taxila. He was awarded the "Government Merit Scholarship" for his academic achievement. Before coming to U.S.A, he worked for Highway Engineering Firms and supervised the construction of different highways and working of the Asphalt Plant. He is currently working with the Tennessee Department of Transportation.

His project "Identification of Traffic Control Measures for Mobile and Short Duration Work Operations" was a study of mobile and short duration work zone safety with particular attention to the identification of work zone safety devices, information systems for the reduction of safety and congestion, and implementation of innovative techniques to reduce delays and crashes due to work zones.

The study recommended existing and new measures and techniques and devices catching driver's attention, improving traffic control within work zones, and recommendations to reduce delays and crashes due to work zones.

Alternatives For Mitigating Negative Externalities Associated With The Mainline Toll Plazas

Anne Meehan, UTRC Research Associate

Anne Meehan completed her B.S. in civil engineering at Bucknell University. She received her M.S. in civil engineering at Rutgers, The State University of New Jersey. The research presented here was completed under the direction of Professor Kaan Ozbay. Ms. Meehan's research focus was in transportation planning and transportation safety. Anne Meehan's graduate studies were supported by University transportation Research center at CUNY, CAIT at Rutgers, as well as NJDOT. She also worked for the Transportation Safety Resource Center at Rutgers in conjunction with the New Jersey Department of Transportation.

In her research, several alternatives for mitigating negative externalities associated with the mainline toll plazas on the Garden State Parkway were analyzed using benefit cost analysis. The negative externalities studied were higher crash rates, long delays, and increases in emissions associated with toll plazas.

Statistical analysis of data provided by the New Jersey Department of Transportation found a significantly higher crash rate at mainline toll plazas than at non-toll sections of the Parkway. Additionally, there was a significant increase in crash rate at the mainline toll plazas after the introduction of Electronic Toll Collection (ETC) that did not occur at non-toll sections. Using linear regression, it was found that the toll volume, the speed limit near the toll, the percent transactions that are paid with ETC, and the percent of toll lanes that are ETC are significant predictors of crash rates at toll plazas.

The increase in delay was predicted by a combination of steady state and deterministic queuing theory, using a method frequently used for analyzing signalized intersections. Increased emissions are based on queue length and emission rates provided by FHWA's SPASM model. The alternatives that were developed in addition to the base case alternative are: Remove Mainline Tolls, Remove Problem Mainline Tolls (identified using integer programming), Remove All Tolls and Replace with All ETC (AETC), and Remove All Tolls and Replace with AETC and a 50-cent toll.

Additionally, implementing alternatives to reduce toll and time costs to users would stimulate a latent demand on the Parkway that would increase congestion. Using ranges of price elasticity, the volume from latent demand and the resulting change in congestion cost was estimated. This, along with the social costs, maintenance and operating costs, capital costs, and other Parkway revenue were used in benefit cost analysis to compare alternatives. It was found that the base case alternative has the highest net present value, but it fails to mitigate any of the social costs. The next best alternative, with the highest benefit cost ratio, calls for the removal of the problem toll plazas: Raritan, Union, and Essex.

Pavement Damage and Road Pricing

Sajjad Hussain, UTRC Research Associate

Sajjad Hussain, is a Ph.D. Candidate at City College of New York, and Senior Highway and Traffic Engineer, at Konheim and Ketchum Consultants. He is presently working with Dr. Neville A. Parker, Director, CUNY Institute for Transportation Systems, and Herbert G. Kayser Professor of Civil Engineering on the project, "Pavement Damage and Road Pricing".

Sajjad's research will quantify the pavement damage caused by different classes of vehicles and find an efficient pricing mechanism to regulate demand for highway services. The study assumes that the number and weight of vehicles that will use a road significantly influence the pavement damage and cost of the construction and maintenance. Studies conducted by the federal government and various state governments conclude that heavy vehicles typically do not pay their share of the cost, while lighter vehicles tend to be taxed for more than their share.

Road deterioration is broadly a function of the original design, material types, quality, traffic volume, axle load characteristics, speed, tire pressure, road geometry, environmental conditions, age of pavement, and the maintenance policy pursued. Several models were reviewed and Kenlayer was selected for the purpose of this analysis because of its ability to use actual axle load applied to the pavement eliminating traditional ESAL approach; and to incorporate effect of load distribution, tire pressure and speed on viscoelastic material.

The analyses show the extent to which a 4-axle truck causes more pavement damage as compared to a 5-axle truck when carrying the same amount of the load. When fitting a curve to the data set, the compressive strain curve follows the AASHTO 4^{th}-power curve, while the tensile strain follows a 3^{rd}-power curve. At heavier loads, the damage inflicted becomes increasingly more costly to repair as the pavement starts to fail at the top of the subgrade instead the bottom of the surface course. The model demonstrates that the same truck can cause different damage depending on load, i.e., whether empty, partially loaded or fully loaded, and how the load is distributed over the axles. A damage simulation exhibited that an equal load distribution over the axles yields least pavement damage. The spread between two consecutive axles in a tandem- or tridem-axle group also affects pavement life or performance. The lower speed and congestion significantly reduces the design life of the flexible pavements. The higher tire pressure results in more damage due to the increase in load per unit area. Adding more axles to each class of vehicle reduces the pavement damage and increase its life.

The best way to economize on maintaining and using an existing road is to apply a user charge reflective of the damage each vehicle inflict on pavements based on the damaging power of their axle loads, time of the day they travel (congestion and speed) and tire pressure. The current tax structures do a poor job to capture the pavement damage. Charging by number of axles or imposing fuel taxes creates an incentive to use fewer axles to conserve fuel by minimizing friction; by the same token, however, it increases road damage by increasing the weight per axle. Implementation of a real-time weight-mile tax based on actual weight, speed and tire pressure promotes two distinct objectives: one is to apportion the cost of road construction and repair in an equitable manner among users according to their fair share of damage; second is to discourage the use of heavy axle-loads and thus reduce the wear on the road system.

Two Years After 9/11, The Impact On Inter-City Travel Behavior

Wei Li, UTRC Research Associate

Wei Li is a first year Ph. D. student in the Department of Civil Engineering of City College of New York. She graduated from Tsinghua University, China, with a Bachelor of Science Degree in Civil Engineering. July, Her research interest is travel behavior. Currently, she is working on a National Science Foundation project, "Two Years After 9/11, The Impact On Inter-City Travel Behavior" which examines the impact of 9/11 on inter-city travel behavior.

Her research examines the profound impact of the events of 9/11 on people's inter-city travel behavior in the New York Metropolitan Region. One impact can be, as hypothesized, that people might reduce their inter-city trip frequencies due to security concerns. To assess the

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hypothesized impacts, she conducted a survey from Oct. 2003 to May 2004, followed by an in-depth analysis of the data collected. The sample comprises responses from 124 subjects, randomly drawn from the staff and students in the City College of New York. About 27 of these 124 subjects also participated in a previous survey, which was conducted about six months after 9/11. Six different corridors were included in the survey, including New York City (NYC)-DC, NYC-Boston, NYC-Montreal, NYC-Buffalo, NYC-Chicago and Boston-DC. Subjects were asked to report their past travel behavior, rate different travel modes (air, car, Amtrak and other), and indicate the change of their inter-city trip frequency before and after 9/11. To control the possible differences in travel behavior that may come from individuals with different personalities and preferences, subjects were also asked to provide their socio-demographic and personality related information.

In terms of the socio-demographics, 63% of the subjects were male and 85% of the subjects were less than 36 years old with at least college education. More than half of the subjects had one or more children in their households. About 63% of them earned less than $50,000/year and 13% of the subjects earned more than $100,000/year.

The UTRC Sponsors ISIS Canada Seminars on Fiber Reinforced Polymers

The University Transportation Research Center sponsored two seminars at the New Jersey Department of Transportation and the New York State Department of Transportation on Fiber Reinforced Polymers. Dr. Aftab Mufti and Dr. Kenneth Neale of Intelligent Sensing for Infrastructure Structures Canada gave the seminars.

Dr. Mufti and Dr. Neale discussed fiber reinforced polymers for civil engineering structures such as bridges, high-rise buildings, dams and marine platforms have contained iron or steel as the reinforcement for concrete or wood. The useful lives of these structures have often been severely limited by the corrosion of this ferrous component. Much thought has been given in recent years to constructing structures that are lighter, stronger and non-corrosive. ISIS Canada intends to significantly change the design and construction of civil engineering structures by developing innovative new structures. For these new structures to be accepted by the engineering community, it is mandatory that they be monitored and the results reported to the engineering community as well as being incorporated into civil engineering codes.

Dr. Aftab Mufti is a Professor of Civil Engineering at the University of Manitoba, Winnipeg, Manitoba, Canada and Dr. Kenneth Neale, University of Sherbrooke. Dr. Mufti is the Program leader and President of ISIS Canada, a Network of Centres of Excellence, and President of ISHMII (International Society for Health Monitoring of Intelligent Infrastructures).

Dr. Mufti and Dr. Neale are the key persons to initiate interest in the uses of Advanced Composite Materials (ACM) for Civil Engineering structures in Canada through his founding work as Chair (1989 to 1993) of the Canadian Society for Civil Engineering (CSCE) Technical Committee on the use of ACM in Bridges and Structures. With support from Industry, Science and Technology Canada and External Affairs Canada, and working through the auspices of the CSCE, Dr. Mufti was the leader of fact-finding missions to Europe in 1990 and Japan in 1992. These visits resulted in two CSCE publications, the first of their kind, on the state-of-the-art of ACM in Civil Engineering structures. In July 1993, with support from External Affairs Canada, Dr. Mufti organized and co-chaired a successful Canada-Japan Workshop on ACM in Bridges and Structures. He is the founding Chair of the non-profit Advanced Composite Materials in Bridges and Structures Network of Canada (ACMBSN).

The UTRC was proud to sponsor this international event of information exchange between USA transportation engineers at the NYSDOT and NJDOT, and the Canadian researchers at ISIS Canada. Over 150 engineers attended the event from both State DOTs.

Final Research Report

Frequency of Work Zone Accidents on Construction Projects,

by Yi Qi, Ph.D. Texas Southern University, Raghavan Srinivasan, Ph.D. University of North Carolina Highway Safety Research Center, Hualiang Teng, Ph.D. university of Nevada, Robert F. Baker, University Transportation Research Center

Safety in work zones continues to remain a high-priority issue for highway agencies partly due to the limited understanding of the causes of the crashes. According to the National Work Zone Safety Information Clearinghouse, in one year, work zones in this country are associated with more than 700 fatalities, 24000 injury crashes, and 52,000 property damage-only crashes, and the estimated cost of these crashes exceed $4 billion per year. One could argue that the work zones are likely to increase in number due to the emphasis on repair and reconstruction. Hence, it can be expected that the number of accidents in work zone will increase correspondingly

The overall objective of this research was to study work zone accidents in New York State, with particular attention to the occurrence and mitigation of rear-end vehicle accidents. The specific objectives were to:

- Recommend changes to the NYSDOT's accident database system for more efficient management and analysis.
- Conduct a detailed investigation of rear-end crashes in work zones and recommend measures that can reduce the frequency of these types of crashes.
- Report on traffic exposure data and accident patterns / parameters to be incorporated into future NYSDOT accident data analysis.

Task 1 focused on evaluating the current NYSDOT work zone accident reporting system, surveying practices used in other states, and providing recommendations for improvement. The results of this task revealed that the current NYSDOT work zone accident reporting system is the most comprehensive in the country. Further changes to improve the system were recommended based on a review of the literature and practices being implemented in other state agencies.

The first part of Task 2 was focused on analyzing rear-en accidents in work zones that occurred in New York State between 1994 and 2001. Since data were available only on work zones that had accidents, truncated count data models were estimated to study the relationship between crash frequency and work zone characteristics. Ordered probit models were developed to study crash severity.

The second part of Task 2 provides some corrective actions to reduce frequency of work zone accidents. These actions are primarily based on a review of the literature since information on changes made by NYSDOT at the project level was not available to the research team.

The first subtask of Task 3 provided some recommendations to incorporate more project information to the work zone database either through adding more variables or including project information in a separate database that can be linked through a project identification number. The second subtask of Task 3 focused on various venues and approaches for obtaining exposure to traffic for various types of work zones. The final subtask of Task 3 focused on identifying parameters correlated with work zones and the county level.

The current NYSDOT work zone accident reporting system was evaluated. A survey was also conducted on practices used in other State agencies. The survey revealed that the current NYSDOT work zone accident reporting system is the most comprehensive in the country. Further changes to improve the system were recommended based on a review of the literature and practices being implemented in other state agencies. The research team recommended that the more variables need to be added to the database to provide information on the project (e.g., total length and duration of the work zone), traffic control devices, speed limit, and roadway inventory (e.g., number of lanes, lane width, presence of horizontal/vertical curves).

NYMTC Announces First Year of September 11th Memorial Program

The New York Metropolitan Transportation Council (NYMTC) established the September 11th Memorial Program for Regional Transportation Planning to honor its three colleagues lost in the attack on the World Trade Center, Ignatius Adanga, Charles Lesperance, and See Wong Shum. It designed this program to educate and motivate people interested in transportation technology and planning and to encourage innovations in planning activities throughout the region. It has two main components: and Academic Initiative, which funds student research projects and internships, and a Planning Initiative, which promote projects that promote innovation or public involvement in planning. The University Transportation Research Center has worked closely with NYMTC in the design of the overall program, and in administering the Academic Initiative.

On September 8th, 2005, NYMTC announced its first slate of projects to be awarded under this program. Four students were selected for the first year of the Academic Initiative:

Li Chen will intern at the New York City Department of Transportation, where she will examine multimodal transportation and land use issues in Manhattan's rapidly evolving West Side. She will be involved in many different aspects of this project, including organizing public outreach meetings and data collection activities, and analyzing changes in the area's demography, traffic, and land uses. Ms. Chen is starting the Ph.D. program in Civil Engineering at City College of New York this fall, having just completed her Masters at the University of Alabama.

David Dayu Zhang will work as an intern in the Office of the Director of the NYMTC. He will help organize conferences on emerging transportation issues and challenges facing the region, such as bus rapid transit, providing safe routes to schools, and identifying opportunities for transit oriented development. These conferences will provide forums at which the region's stakeholders can discuss and learn more about the issues at stake and what other regions are doing. Mr. Zhang is a Masters student in Urban Planning at Columbia University.

Jeevanjot Singh will research time-of-day pricing strategies in public transit. Variable pricing can improve overall efficiency of the transportation system by encouraging some peak users of transit to shift to off-peak periods, attracting auto users to transit, and providing more affordable mobility options in off-peak periods. Ms. Singh will work in close cooperation with the Westchester County Department of Transportation to evaluate and propose policy actions for time-of-day pricing on its Bee Line Bus system. Ms. Singh is a doctoral student in Civil Engineering at Rutgers University. Her research will be supervised by her academic advisor, Prof. Kaan Ozbay, and by a professional advisor, Patricia Chemka, Director of Planning at the Westchester County Department of Transportation.

Wei Li will develop accessibility indicators for the region's aging population. Her research will examine the accessibility of different kinds of activities – including medical services and grocery stores – in neighborhoods throughout the metropolitan region. She will combine neighborhood accessibility indicators with estimates of the mobility constrained population in each area, to provide a tool that can help policymakers identify areas of particularly high need and low access. Ms. Li is a doctoral student in Civil Engineering at the City College of New York. Her research will be supervised by Prof. Cynthia Chen of CCNY, and by Joel Ettinger, Director of NYMTC.

NYMTC also announced the first round of grants under its planning initiative. Of the four grants awarded, two were proposed by members of the UTRC Consortium:

The **Rudin Center for Transportation Policy and Management** received a grant for a study of "Transportation and Land Use in the NYMTC Region: Strengthening Urban-Suburban Coordination"

The **City College Architectural Center**, in partnership with West Harlem Environmental Action, received a grant for a project entitled, "Harlem in Motion: A People's Plan for an Improved Transportation Network."

Other grants were awarded to Manhattan College for development of a regional air quality model, and to the Hunts Point Economic Development Corporation for the Bronx Green Fleets Planning Initiative.