Alternative fuels will help shape Minnesota’s transportation future

The mix of fuels used to power the vehicles on our nation’s roadways is diversifying rapidly. While gasoline and diesel are still dominant, an increasing percentage of vehicle power is coming from alternatives such as biofuel, natural gas, and electricity. What could this shift mean for Minnesota’s transportation future? The Minnesota Department of Transportation and the Minnesota Local Road Research Board turned to U of M experts for analysis.

“The rise of alternative fuels is something we need to keep a close eye on, because it presents a number of issues that may significantly alter our state’s transportation system,” says Adam Boies, an
University of Minnesota Extension researchers have identified and tested a promising plant that has the potential to make the creation of living snow fences faster and more affordable. The plant—shrub willow—also could become a source of biomass and income for farmers.

When planted alongside rural roadways, living snow fences—rows of trees, shrubs, or other vegetation—serve as windbreaks to keep snow and ice from blowing off farm fields and onto roads. They help improve safety for drivers while reducing maintenance operations costs for local agencies.

“Shrub willows have been used successfully for living snow fences in other states,” says lead researcher Dioni Zamora, Extension Professor/Extension Educator. The shrubs are easily planted with dormant stem cuttings, have fast growth rates, offer numerous ecosystem services, are adaptable to an array of growing conditions, and even have the potential to serve as a fuel for biomass energy production. “Because of their numerous benefits, we wanted to determine whether shrub willows would work for living snow fences in Minnesota,” he says.

Despite the many benefits of living snow fences, adoption has been slow. In most cases, state-owned rights-of-way are not wide enough to accommodate living snow fences; they must be planted on private land, and many farmers don’t have the time or money to invest in planting or maintaining them or are reluctant to remove cropland from production.

In the first part of the research project, researchers evaluated designs for living snow fence plantings at a test site along a Minnesota Department of Transportation (MnDOT) right-of-way. In 2013 they planted three shrub willow varieties in both two-row and four-row arrangements. During the next two growing seasons, they measured the plants’ growth and snow-trapping ability.

“The willows had high survival and growth rates after two growing seasons, with the potential to trap all of the mean annual blowing snow at the site after three or four growing seasons,” says Zamora. “We also found that the four-row plantings tended to catch more snow than the two-row plantings, and that many different shrub willow varieties make effective living snow fences.”

Researchers also worked to determine the costs of planting shrub willow living snow fences and the viability of harvesting the shrub willows for biomass energy. They discovered that shrub willows are easier to plant and more cost-effective to install than other plants used for living snow fences in Minnesota; they estimated the cost of a 100-meter, four-row living snow fence at less than $8,000.

MnDOT is planning to implement findings from the research project. “We are currently developing plans for two shrub willow living snow fence plantings to be installed in the spring of 2016,” says Dan Gullickson, MnDOT’s living snow fence coordinator.

The team found that the cost of using shrub willows for biomass is likely prohibitively expensive for the individual farmer and that there is currently little demand for shrub willow biomass in Minnesota. “However,” Zamora says, “if an entire corridor was planted as a shrub willow living snow fence, it could compete with field-scale production and provide a possible energy source in the future.”

A webinar recording about this MnDOT-sponsored research—covering the establishment, design, functionality, and potential environmental impacts of the plant—is available online.

Overall, researchers believe shrub willows have a high potential for providing effective and affordable living snow fences in Minnesota, which bodes well for future growth in this cost-saving—and potentially life-saving—transportation program.
Students recommend safe routes to school at Chaska intersection

As part of a U of M course last semester, students analyzed access to an elementary and middle school complex adjacent to a busy intersection in Chaska, Minnesota, and made recommendations aimed at helping local agencies improve pedestrian safety and access around the site.

Their work was part of a safe-routes-to-school project sponsored by the Resilient Communities Project (RCP). RCP is an initiative supported by the U’s Center for Urban and Regional Affairs that organizes yearlong partnerships between the University and Minnesota communities. This year’s partnership, with Carver County, includes participation by Chaska and the school district.

Professor David Levinson incorporated the project into one of his courses: CEGE3201—Introduction to Transportation Engineering. To launch the effort, community partners from Carver County and the City of Chaska visited the classroom. Students then visited the site to understand critical pedestrian and traffic conflict points and applied the “three Es” of Safe Routes to School (engineering, education, enforcement) to recommend improvements.

The northeast corner of the intersection of State Highway 41 and County State-Aid Highway (CSAH) 10 is home to the Chaska Community Center, Chaska Elementary School, Chaska Middle School West, and Chaska Middle School East. Almost none of the students at the site walk to school; most ride buses. A study of nonmotorized facilities completed in 2011 identified a number of potential concerns within a two-mile radius of this site, including numerous pedestrian/bicycle crashes and high traffic volumes and speeds, says Bill Monk, Chaska city engineer.

The students delivered a presentation and final reports in December with key recommendations (see below). Monk, the project lead, says that Chaska, School District 112, and Carver County plan to use the recommendations to determine ways to improve the pedestrian environment at the complex while meeting traffic flow and safety goals. Results will also be used to inform Carver County’s CSAH 10 corridor study.

RCP’s goal is to provide the community with efficient access to the resources and expertise of the University, offer students a professional opportunity to apply their knowledge and skills to a real-world project, and provide faculty with ready-made applied-learning opportunities for the classroom. Mike Greco is the RCP director.

For more information about the RCP–Carver County partnership, please visit rcp.umn.edu.

David Levinson (front) leads a site visit with students.

Students’ key recommendations:

- Alter bus and car routes and the location of parking areas on the site.
- Implement protected left-turn lanes for cars, pedestrian crossing countdown timers, and well-marked crosswalks; eliminate rounded corners that encourage drivers to turn at high speeds; time traffic signals to allow pedestrians a head start.
- Add sidewalks and paths, widen existing narrow sidewalks, add lighting along sidewalks, reduce traffic speeds during school hours, and add pedestrian refuges with pedestrian-activated traffic signals.
- Educate parents and other users of the school complex about the coming changes.

Minnesota’s Transportation Conference
March 8–10, 2016
Saint Paul RiverCentre
St. Paul, MN

Registration is now open for the 2016 conference, the largest transportation event in the state. Attendees will learn about the latest transportation innovations and network with fellow professionals.

The event will kick off with an opening reception on March 8, followed by two days of knowledge sharing, networking, and continuing education on March 9 and 10.

Learn more and register at mntransportationconference.org.
CTS hosts policymaker forum on unmanned aerial vehicles

In collaboration with the Airport Technical Assistance Program, CTS held a special forum on unmanned aerial vehicles (UAVs) for Minnesota state legislators and their staff on December 7.

The forum’s goal was to provide attendees with a greater understanding of the challenges and opportunities—as well as the policy and regulatory implications—of operating UAVs in Minnesota. Sessions offered information and facilitated discussions on issues related to safety, integration, economic impacts, and privacy and ethics.

The event also included a panel discussion that explored perspectives of different UAV user groups, including retailers, law enforcement personnel, and hobbyists. Demoz Gebre-Egziabher, co-director of the U’s UAV Laboratories and associate professor in the Department of Aerospace Engineering and Mechanics, participated on the panel. He offered his perspective on the benefits and challenges of UAVs as a researcher, pilot, and educator.

“[UAVs] provide a huge potential for all kinds of applications,” Gebre-Egziabher said. “At the same time, I happen to be a pilot, so I’m on the other side as well. There are some things I see about how drones are operated that kind of scare me. So our research is looking at the technologies that are going to be required to make these devices safe.”

Gebre-Egziabher also emphasized that regulations for UAVs will likely not be one-size-fits-all, since UAVs span such a wide spectrum of sizes and capabilities. In addition, he and other panelists expressed hope that future regulations will take the educational value of UAVs— including their ability to interest young people in aviation, engineering, and technology—into account.

“Drones have been a boon for education,” Gebre-Egziabher said. “I’m hoping that in coming years we have a clear picture of how to deal with this technology and make sure we have rules and laws that foster the education aspect and also protect safety.”

Scott Dibble, chair of the Senate Transportation and Public Safety Committee (and a member of the CTS Executive Committee), gave closing remarks. He noted the many potential applications of UAVs—including precision agriculture, package delivery, and bridge inspection—and the need to consider a wide range of perspectives when thinking about regulations, resource allocation, and privacy issues.

“We don’t know what the future holds,” Dibble said. “We’re in a learning mode, and we invite everyone to participate in this conversation—to bring ideas and to present real-world opportunities for what we might be doing in terms of economic development, transportation, and public safety.”

Innovative asphalt mixture leads to new patent

Researchers in the Department of Civil, Environmental, and Geo-Engineering (CEGE) were granted a new patent last year for their innovative asphalt mixture formulas.

Developed by a team led by CEGE assistant professor Jia-Liang Le, the mixture formulas are part of ongoing U of M research efforts aimed at reducing low-temperature cracking—a major concern for asphalt pavements in cold regions.

The mixtures incorporate a unique powder made of graphene nanoplatelets (GNP)—layers of carbon particles that are arranged in a honeycomb lattice and have superior mechanical and electrical properties—in the asphalt binder. Including GNP doubles the asphalt’s strength at cold temperatures and improves its strain tolerance and creep stiffness, helping to prevent low-temperature cracking.

“Although the cost of GNP-reinforced asphalt mixtures is slightly more expensive than some other asphalt mixtures, it allows for building a better, more durable product,” Le says. The cost

Patent continued on page 5
Ying Song joined the U of M’s Department of Geography, Environment and Society as an assistant professor this semester. As a human geographer, Song’s main research interest is geographical information science (GIScience), focusing on the development and application of spatial analytic methods to visualize, explore, and analyze movement and change in geographic space with respect to time. Related to transportation, Song is interested in human mobility and accessibility within transportation networks, especially at the urban and regional level.

What sparked your interest in transportation?
I developed an interest in spatial modeling, quantitative methods, and urban transportation as an undergraduate GIScience major in China. I have witnessed the ever-increasing demands on mobility and consequent problems such as traffic congestion and air pollution, which persuaded me to apply to a graduate program in the United States and gain frontier knowledge. During my graduate studies and research, I discovered time geography and found myself deeply interested in its individualistic perspective on human geography: it emphasizes the differences in physical and social constraints that create the diversity of human activities and experiences. Time geography has also led to my special focus on sustainable transportation development.

What are your primary research areas?
My research areas include GIScience, spatial-temporal analysis, time geography, and urban transportation. In particular, I am interested in using movement data collected by GPS and other location-aware technologies to investigate spatio-temporal dynamics of individuals and provide additional insights on human mobility and accessibility within urban environments. With respect to transportation, I am especially interested in sustainable transportation development and advocate transit-oriented transportation development that reduces auto dependency and air pollution.

What excites you about your new role?
I am excited about the opportunities available to me at the U of M, particularly potential future collaborations with other CTS Scholars. I am also looking forward to reaching out and building relationships with transportation agencies in Minnesota so I can obtain more experience in real-world practices and contribute to the study of transportation as a geographer.

I am eager to build bridges between the Department of Geography, Environment and Society and these other entities on and off campus. I believe that these collaborations will generate positive synergy and productivity for both my personal research and the research mission of the department, CTS, and the University of Minnesota.

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of GNP could also drop in the future as production improves and the market grows.

In addition, the many benefits of GNP-reinforced asphalt may help outweigh these costs. For instance, GNP-reinforced asphalt requires fewer compaction cycles and can be compacted at lower temperatures than other pavements. According to the researchers, this can help improve construction speed and quality, potentially extend the construction season in cold climates, and result in compaction-related cost savings.

Potential applications of the GNP-reinforced asphalt mixtures include the construction of new pavements, rehabilitation of existing pavements with full-depth reclamation, and pothole repair. Using the GNP mixtures in new pavements would also allow agencies to include larger amounts of recycled materials, such as reclaimed asphalt pavement and reclaimed asphalt shingles, further cutting costs.

CTS provided initial funding for Le, who originally collaborated with researchers from the National University of Singapore on the use of GNP in concrete. This project inspired Le to conduct a second project funded by the National Cooperative Highway Research Program with fellow CEGE researchers Mihai Marasteanu and Mugurel Turos on the use of GNP in asphalt, which ultimately led to the new patent.

Le’s team is currently creating a computerized model that can provide inexpensive simulations of the new asphalt mixtures in a project funded by the Minnesota Department of Transportation. Using the model, the researchers are developing a design chart that provides information about the most effective GNP-reinforced asphalt mixes for use in different applications.
University Professor in the U of M’s Department of Industrial & Systems Engineering and the director of the new Initiative on the Sharing Economy.

“We are witnessing a paradigm shift away from the exclusive ownership and use of resources to one of shared use and, potentially, shared ownership,” Benjaafar says. “This paradigm shift is taking advantage of innovative new ways of peer-to-peer sharing that are voluntary and enabled by Internet-based exchange markets and mediation platforms.”

The consequences of this shift could be promising—or in some cases, undesirable—in areas ranging from traffic congestion to pricing to privacy. The new initiative will shed light on these issues, with a particular focus on peer-to-peer shared mobility.

The initiative was established by CTS in partnership with Benjaafar and other faculty members across the University and is administered by CTS. It aims to position the U of M at the forefront of the development of a science of the sharing economy. Envisioned activities include:

- Establishing the U of M as a center of thought leadership and research.
- Forming a research community across the University and stimulating interdisciplinary research that encompasses economics, urban planning, public policy, behavior, and information technology.
- Engaging local and national government agencies, industry, and nonprofit organizations.

The first major activity of the initiative is the International Symposium on the Sharing Economy, which will be held May 16–17, 2016, in Minneapolis (see sidebar).

According to Benjaafar, most resources are acquired to satisfy peak demand but are otherwise poorly utilized. Several successful businesses—such as AirBnB and Uber—provide evidence for the viability of the sharing economy. “Sharing has the potential of increasing access while reducing investments in resources and infrastructure,” he says. “In turn, this could have the twin benefit of improving consumer welfare while reducing societal costs.”

The availability of a sharing option for cars, for example, could lead some people to forego car ownership in favor of car sharing. In turn, this could result in a corresponding reduction in road and parking infrastructure, freeing up significant land for alternative uses. “Combined with other forms of sharing, particularly office and residential space, the net effect on both access and sustainability could be significant,” Benjaafar says.

To learn more about the initiative or to participate, please see SharingEconomy.umn.edu.

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MARK YOUR CALENDAR

International Symposium on the Sharing Economy

May 16–17, 2016
Commons Hotel, Minneapolis, MN

The International Symposium on the Sharing Economy will bring together leaders from academia, industry, nonprofits, and government to shed light on the emerging area of collaborative consumption and stimulate interdisciplinary research and collaboration. The symposium, focusing on shared mobility, will begin with a research workshop featuring participants from a broad range of disciplines. The second day will be a public event and include talks and panel discussions by practitioners, entrepreneurs, government representatives, and other leading thinkers. Symposium sponsors are the U of M’s Initiative on the Sharing Economy and CTS. Further information will be available at SharingEconomy.umn.edu.
Minnesota leads the nation in biofuel use, in part due to a series of legislative acts designed to encourage ethanol production and consumption. Boies predicts, however, that biofuel consumption in the state is near saturation and that future shifts will likely be between biofuels. “These shifts may alter the routes of heavy-goods vehicles in the state as refineries shift from corn and soy to fuels derived from agriculture wastes and forest byproducts,” he says.

If the price of natural gas remains significantly lower than diesel fuel, natural gas vehicles will likely make up an increasing share of the heavy-duty vehicle fleet in Minnesota. A larger natural gas refueling infrastructure will need to be developed, most likely by private organizations that manage fleets of vehicles. “As this happens,” Boies says, “efforts must ensure that natural gas vehicles and refueling infrastructure do not emit significant quantities of methane, which has a high global warming potential.”

Minnesota electric vehicle sales have lagged behind the nation—winter temperatures are one factor—but Boies expects the numbers to rise. He estimates 16 percent of new cars sold in Minnesota in 2035, and 56 percent in 2050, will be electrified. The growing numbers will require a more robust charging infrastructure, likely supplied or subsidized by government agencies, he says.

In the long term, on-road charging systems are being investigated. In these systems, under study in several countries, charging coils embedded within the roadway transfer power wirelessly to vehicles. “The systems could make electric vehicles drastically more efficient by reducing vehicle battery size,” he says.

Better vehicle efficiency is likely to continue the trend of falling fuel tax revenues. “Minnesota will need a method for producing revenues from electric vehicles to maintain long-term funding for the transportation road network,” he says. “Currently the higher price of electric vehicles results in increased revenues during vehicle registration, which tends to offset the difference in fuel tax revenues. However, as the price differential between electric vehicles and traditional vehicles shrinks, there will be decreased funding for Minnesota roadways unless additional revenue sources are found.”

Finally, emphasis on fuel efficiency in the light-duty and heavy-duty vehicle fleets will drive the weight of these vehicle segments in opposite directions. “Light-duty vehicles will get lighter and heavy-duty vehicle fleet operators will lobby for increased weight limits on Minnesota roadways to reduce the energy intensity of goods deliveries,” Boies says. “This growing disparity in weight between the two vehicle classes may require increased safety measures to reduce the severity of crashes between vehicle classes.”

“The question of how alternative fuels and electric vehicles will impact the transportation system, ownership models, and operating costs, as well as vehicle and driver safety, are extremely important topics to study,” says Ken Buckeye, MnDOT program manager. “The potential for these trends to impact our revenue streams is also very significant. When you couple those trends with the federal mandate for a CAFE standard of 56 mpg by 2025, we are likely to see some profound impacts that reach across modes, jurisdictions, and funding mechanisms.”

Boies’s research is part of a multi-pronged study funded by MnDOT and the LRRB that analyzed the technological shifts altering surface transportation and the implications for Minnesota. Other contributors included CEGE professor and principal investigator David Levinson and associate professors Jason Cao and Yingling Fan of the Humphrey School of Public Affairs. Their high-level white papers are compiled in a final report: The Transportation Futures Project: Planning for Technology Change. Future issues of Catalyst will share findings from other chapters.
ALTERNATIVE FUELS will help shape Minnesota’s TRANSPORTATION FUTURE.

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Shrub willows offer promise for LIVING SNOW FENCES, biomass, and farm income.

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U OF M STUDENTS RECOMMEND SAFE ROUTES TO SCHOOL at busy Chaska intersection.

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Initiative on the Sharing Economy to stimulate leadership and research.

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