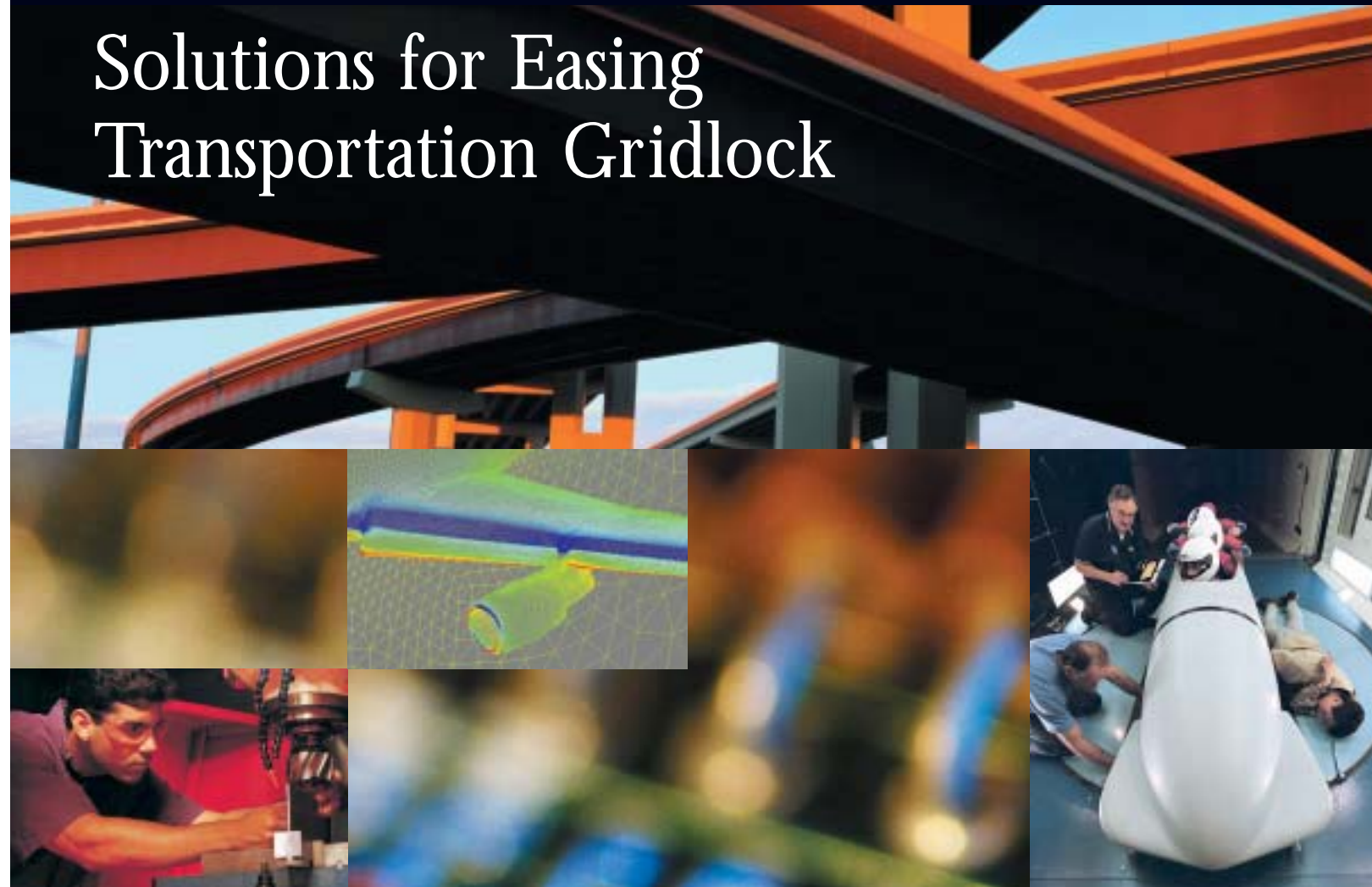


# Solutions for Easing Transportation Gridlock



**INSIDE**

The Thrill of Discovery

Transforming Innovations  
into Hard-Driving Results



New Technologies Hold Promise  
for *Faster* and *Easier*  
Transportation Systems



story by Paul Adams



**M**ore than a century after the Wright Brothers successfully piloted the first engine-powered airplane, they would barely recognize their own invention. Nor would they fully comprehend how their crude flying machine spawned the creation of a complex, interdependent transportation system that has taken mankind to the far corners of the Earth and to the moon and back.

Researchers at the A. James Clark School of Engineering are moving us into yet another era of transportation — one that relies on massive communications systems and sophisticated software and electronic sensors. Their far-reaching work touches all major modes of transportation and is designed to improve access, enhance safety and increase convenience and speed both in the air and on the ground.

### The Friendly Skies

Building on the Wright Brothers' dream of personal air travel, faculty and alumni of the Clark School are working with government and corporate partners to reinvent the way small airplanes are used in today's transportation system, while at the same time easing the headaches of commercial air travel.

Norris J. Krone Jr., B.S. '55, Ph.D. '72, is aiding NASA's efforts to develop a small aircraft transportation system that will make general aviation a viable alternative to transportation on commercial airlines. Krone's work involves developing high-tech, single-pilot aircraft capable of operating in all kinds of weather without the assistance of airport radar and control towers, which are often absent at small community airports.

"The idea is to make general aviation more efficient as part of a larger transportation system, which means using smaller airports and avoiding the big, congested hubs," says Krone, whose doctoral thesis provided the technical foundation for the development of the U.S. Department of Defense x-29 experimental aircraft.

Krone, who heads the University Research Foundation and its subsidiary, the Maryland Advanced Development Laboratory, has equipped a twin-engine Cessna 402 with the same sophisticated avionics and communications equipment that jetliners and military fighter planes use to navigate under difficult conditions. He believes much of this high-priced technology will become more affordable in the decade ahead, making it possible for general aviation pilots to fly safely in difficult weather without using airport landing aids.

Aviation experts suggest another way to reduce congestion on major airport runways is to use more small planes that can take off and land on shorter, underutilized runways. Doing so would change air traffic patterns and noise levels over many residential communities, but Ella Atkins, assistant professor of aerospace

engineering, is working on software to mitigate that problem.

"We are looking at noise models for various types of rotorcraft and small aircraft so that the noise generated on the ground is minimized," offers Atkins.

"Years from now, our work could open air space previously not used by commercial aircraft and increase passenger throughput to major metropolitan airports."

Amr M. Baz, professor of mechanical engineering, is also exploring new methods of noise reduction. Baz uses sensitive electronic sensors to measure noise-causing vibrations in everything from aircraft to power tools. "We measure the vibration and acoustics and then provide control actions to reduce noise," Baz explains, noting that his technique is patented and has been employed to reduce cabin noise in small planes and helicopters.

Baz's work complements research conducted at the Clark School's internationally recognized Alfred Gessow Rotorcraft Center, honored with last year's Grover E. Bell Award from the American Helicopter Society for its pioneering contributions in smart structure technologies that successfully transition into full-scale helicopter systems. The center is at the forefront of research on rotorcraft aerodynamics, composite structures, flight mechanics, acoustics and other aspects of rotorcraft engineering.

Darryll Pines, associate professor of aerospace engineering, uses the resources of the Rotorcraft Center to advance his research, particularly with large unmanned aircraft and micro unmanned air vehicles (UAVs), which fit in the palm of the hand. "The physics of flight at the micro scale has not been studied significantly," says Pines. "The propulsion and power, structure and material, and aerodynamic needs and the whole spectrum of design and configuration for these vehicles is open to research."

Technology aside, one of the biggest challenges is how to integrate large and even the smallest unmanned aircraft into the traditional Federal Aviation Administration-regulated infrastructure. "Right now, the technology of unmanned air vehicles is used primarily by the military to observe ground operations," adds Pines. "But, there are hundreds of civilian applications, including the capability for these vehicles to act as their own wireless cellular networks, but the FAA must first wrestle with all of the policy issues, such as air space, landing and take-off restrictions."

Pines, along with colleagues Norman Wereley and Inderjit Chopra, are also looking to implement "morphing wings" as a characteristic of the new unmanned aircraft. He predicts that morphing aircraft structures will become part of a formalized flight test program in the next five years. "We are looking at using advanced materials to change the shape of the vehicle and its



ability to carry weight,” asserts Pines, who explains that morphing structure technology could address future military mission needs, potentially enabling an actual vehicle to morph into a weapon.

While research on aviation alternatives of the future is charting the course for commercial and unmanned air travel, many new technologies are currently being applied to make daily travel on the ground easier and more convenient.

## On the Road Again

The Clark School is gaining momentum in developing intelligent transport systems, which provide traffic managers, emergency responders and motorists with everyday traffic information that could eliminate much of the guesswork in the workday commute. Armed with the very latest facts about traffic conditions, motorists can also make better decisions so that, ultimately, congestion will be eased on the most heavily traveled routes.

“The key issue here is real-time information — that is the theme that runs through much of our work,” says Hani Mahmassani, the Charles A. Irish, Sr., Chair in Civil and Environmental Engineering; and head of the Maryland Transportation Initiative, the umbrella organization for the university’s various transportation research centers.

In his own work, Mahmassani is developing computer programs to predict how motorists will respond when presented with real-time information about traffic conditions, such as accidents. State and federal traffic managers may be able to influence driver behavior and keep traffic running more smoothly using his modeling software.

Another rapidly emerging tool will provide travelers with data using electronic message boards, radio, the Internet, or a cell phone equipped with a global positioning chip. With a cell phone, motorists could dial into the Internet, learn their exact location and download maps, directions, real-time traffic information and travel advice as they are selecting their routes.

“All of these converging technologies are helping to feed the concept of intelligent traffic systems,” Mahmassani notes.

In addition to easing commuter congestion, Mahmassani’s research has numerous commercial applications. For example, trucking companies or delivery services could use traffic data and complex modeling software to plan their routes or determine pricing strategies.

But first, traffic managers must determine the best way to make the information available to users. To that end, Clark School researchers are working with state transportation officials to outfit Maryland’s highways with a network of traffic sensors and video monitors to provide real-time information about accidents and general traffic conditions as part of the Maryland State Highway Administration’s Coordinated Highways Action Response Team (CHART) program.

Phil Tarnoff, director of the Clark School’s Center for

Advanced Transportation, imagines the coming decade when state traffic managers can quickly detect accidents or traffic backups and use road signs or wireless communication to immediately advise travelers to take alternate routes. Today, Tarnoff’s group is helping to design the system and develop computer simulations to guide transportation officials on the best method of response to traffic incidents.

The Clark School is also leading an effort to develop a wireless communication system to allow transportation managers, rescue workers and public safety agencies to coordinate their responses to everything from traffic accidents to major disasters. The federally funded Capital Wireless Integrated Network (CapWIN), a partnership between the state of Maryland, Virginia and the District of Columbia, is coordinated through Tarnoff’s group at the Clark School.

Using the network, a highway trooper responding to a vehicle accident would activate a specially-equipped laptop in his cruiser, type in the relevant information, exit the car and take control of the scene. The global positioning system-equipped computer would automatically notify authorities of the trooper’s location and use wireless communication to begin alerting the appropriate emergency response agencies, saving critical time. The system could even incorporate video, allowing public safety officials to view the incident site.

“We would like to become a national model with the idea that every urban area in the country would have something like this,” explains Tarnoff, who says interest in the project has grown since the 2001 terrorist attacks, which exposed the need for better coordination among emergency responders.

Wireless communication also is the foundation for efforts to monitor traffic conditions by pinpointing cell-phone transmissions. David Lovell, assistant professor of transportation engineering, says that by anonymously tracking cell phone transmissions originating from the beltway, researchers can gauge the speed and density of traffic and allow transportation officials to pinpoint trouble spots.

Since motorists are more likely to use a phone to call home or check their voice mail when they are stuck in traffic, such a system would theoretically turn every cell phone user into an unwitting traffic reporter.

“One advantage of a cell phone system is that you are likely to receive data from anywhere where there is a true traffic problem,” notes Lovell.

One of the biggest contributors to traffic tie-ups is summer roadwork. Clark School faculty are testing innovations in pavement design that could make roads last longer, resulting in fewer construction delays.

Dimitrios G. Goulias and Charles Schwartz, associate profes-





sors of civil and environmental engineering, are studying high-performance concrete pavements with funding from the Federal Highway Administration and the Maryland State Highway Authority. Their study involves laboratory evaluation of several fiber-reinforced concrete mixtures, which have been used to construct portions of a highly trafficked Maryland bypass to determine the material's performance under real-world conditions. A variety of sensors were built into the concrete test sections to record data on the pavement's durability.

"The results will directly impact the design charts and construction practice of concrete highway pavements in Maryland," contends Goulias.

The two researchers are also studying asphalt pavements as part of two national studies. Through the Superpave project, researchers are investigating new material behavior models for asphalt concrete that capture its complex dependence on temperature, loading rate and stress level. The second study involves developing a new national guide for highway pavement design to replace the current empirical methodology with a more rigorous theoretical approach.

Both of the projects "will allow us to capture the benefits of today's improved paving materials as well as the damage caused by today's higher traffic loads in ways that simply are not possible using existing empirical design procedures," relates Schwartz.

Researchers at the Clark School's Bridge Engineering Software and Technology (BEST) Center are working to improve the safety and efficiency of bridges. Chung Fu, center director, is looking at the use of fiber-reinforced polymer (FRP)

## Technologies for Trains

For those travelers looking for a more convenient alternative to driving or flying, train travel remains a viable option. A 1994 Clark School Innovation Hall of Fame inductee, Emilio A. Fernandez, '69, is developing electronic braking systems that reduce train stopping distance by 40 percent and cut fuel costs by nearly five percent.

Founded by inventor and industrialist George Westinghouse, Fernandez's company, Pennsylvania-based WABTEC Corporation, pioneered air brake systems that have been the industry standard for generations. More than a century later, the company is marketing the new electronic equipment as an alternative to traditional pneumatic systems that rely on air to deploy brakes on passenger and freight trains.

"With electronic brakes, the signal is sent to all the cars and applied consistently and rapidly, so the whole train comes to a very gradual and very quick stop," explains Fernandez.

The company is also working on positive train control (PTC) systems that allow railroad dispatchers to control train movements by computer. While never a replacement for an engineer, Fernandez believes the system can be used to make train movements more efficient without compromising safety.

"Through PTC, we could reduce the distance between trains in a very safe manner and could move more goods over time," he adds.

Fernandez's work, like that of his Clark School peers, could help to ease bottlenecks on the road and in the air by diverting cargo and passenger traffic to the rails.



From intelligent transportation systems and the highly accessible technology of cellular phones to the concepts and blueprints for micro-

composites as an alternative to traditional steel-reinforced concrete on bridge decks. "Composites have an advantage over steel-reinforced concrete in that they take less time to construct and do not corrode when exposed to water and salt," describes Fu, who is currently field testing a newly placed FRP composite bridge deck in Harford County, MD.

FRP road surfaces cost considerably more than but far outlast their conventional counterparts, says Fu. In the long run, by considering the life-cycle cost and increasing the longevity of road surfaces, researchers hope to eventually reduce construction delays and make highways less costly to build, he adds.

sized unmanned air vehicles, researchers are clearly searching for transportation solutions to meet the challenges posed by today's complex world—a world very much on the move.

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