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PATH—Partners for Advanced Transit and Highways—is a collaboration between the California Department of Transportation (Caltrans), the University of California, other public and private academic institutions, and private industry.

PATH's mission: applying advanced technology to increase highway capacity and safety, and to reduce traffic congestion, air pollution and energy consumption.

CALIFORNIA PATH

Deploying the ITS Infrastructure in California

Hamed Benouar, PATH / CCIT

California recognized more than 30 years ago that it could not build itself out of congestion. Since 1971, when the first intelligent infrastructure was tested in the Los Angeles area, the California Department of Transportation (Caltrans) has been exploring the use of intelligent technology to improve the safety and efficiency of our transportation system. LA's first Transportation Management Center (TMC) was the foundation of what is now called Intelligent Transportation Systems (ITS). Inductive detectors (loops), cameras, and other surveillance methods were used to manage traffic and to respond quickly to incidents. The goal was to demonstrate that technology can improve the capacity utilization of the freeway system. This was an early success that unfortunately was undeveloped for many years.

Now, ITS is again seen as an avenue for enhancing the capacity utilization of existing facilities and for promoting efficient multi-modal transportation systems. California has seen a significant amount of success in its deployment of ITS, but still lacks important ITS elements to efficiently manage its transportation system. California still has a number of congested urban lane-miles of freeways without a complete intelligent infrastructure. Some of California's eight TMCs are still in the early stages of development. Vital elements of the intelligent infrastructure such as sensors (in or out of the pavement), cameras, etc. are necessary to use all modes of the transportation system to full capacity. There is also a need to better utilize the infrastructure already in place. Better and more equitable strategies for ramp metering must be developed, and better use made of the data that is collected. This requires continued research and development, such as the work that PATH is now doing statewide. Intelligent technology must also be applied to facilitating institutional processes, for more coordinated management of our multi-modal

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transportation system. Finally, the private sector must be given a much more important role in the management and operations of transportation systems, including transportation infrastructure.

***Figure 1.* Berkeley Highway Laboratory surveillance cameras atop a 40-story building next to Interstate 80 in Emeryville provide ground truth for Caltrans loop detectors.**

Defining ITS

ITS is the use of technological advances in computer and information technology to improve the efficiency of all new and existing modes of transportation systems, and to integrate and balance the various modes of our transportation system. The goal of ITS is to improve the mobility of people and goods, increase accessibility, and enhance safety, while meeting stringent environmental requirements. ITS offers new solutions to enhance transportation system interoperability, and provides such new mobility options as Bus Rapid Transit (BRT) and car-sharing tied to transit systems. ITS is a system of systems that includes the driver (behavioral characteristics, human machine interface, etc.), the vehicle (personal, transit, etc.), and the infrastructure.

ITS Benefits & Best Practices

ITS benefits are numerous: increase of throughput on the highway, reduction in crashes and their severity, reduction in delay and travel time, reduction in maintenance and operation costs, and reduction of energy waste. The insertion of ITS technologies into existing facilities results in the increase of the effective capacity of the facility, measured in terms of people or vehicles per segment of freeway per unit of time. Numerous studies and field operation tests have been performed to demonstrate the benefit of many ITS elements. Both the federal and the California Departments of Transportation have been compiling databases outlining the benefits of ITS investments through field operation tests and deployments. Since December 1994, the United States Department of Transportation's (USDOT) ITS Joint Program Office has been actively involved in collecting benefits and in other impacts of ITS projects. California, through its decision support effort, has also compiled a considerable amount of literature and field test results that document ITS benefit information.

Some early examples of successful ITS deployment in California, which can be found in these databases, include the Automated Traffic Surveillance and Control Program in Los Angeles (ATSAC) and the Freeway Service Patrol Program in San Francisco (FSP). ATSAC consists of a computerized signal control system that has been in operation since the 1984 LA Olympics. As of 1994, it reported a 13%

ITS is a system of systems that includes the driver (behavioral characteristics, human machine interface, etc.), the vehicle (personal, transit, etc.) and the infrastructure. The following tables summarize some ITS systems:

Elements that are	in the early deployment stage	ready for large-scale deployment
Intelligent Infrastructure for metropolitan areas		
Freeway Management Systems		■
Arterial Management Systems		■
Incident Management Systems		■
Emergency Management Systems		■
Transit Management Systems		■
Integrated System Management for all modes	■	
Integrated Traveler Information for all modes		■
Electronic Toll Collection Systems		■
Electronic Fare Systems for all modes	■	
Coordinated Highway/Rail Intersections	■	
Commercial Vehicle Electronic Screening/Safety		■
Intelligent Infrastructure for rural and inter-city areas		
Traveler Safety and Security	■	
Emergency Services		■
Traveler/Tourist Information		■
Commuter and Public Transportation		■
Commercial Vehicle Electronic Screening/Safety		■
Intelligent Vehicles for all modes		
Navigation Systems		■
Collision Warning/Avoidance	■	
In-Vehicle Signing	■	
Driver Assistance/Automation	■	

the models and issues discussed in a recent report on California's infrastructure policy for the 21st century by UC Berkeley professor of city and regional planning David Dowall. This report calls for "a dramatic shift in how California plans, executes, and finances infrastructure." It recommends that the state concentrate on policy and management rather than on the direct provision of infrastructure. Dowall proposes much more active participation from the private sector, the implementation of appropriate transportation service pricing policies, and the introduction of innovative multimodal mobility solutions. If such options are applied to the planning, implementation, and financing of ITS, California can without question accelerate its ITS deployment.

Figure 2.
Los Angeles' Automated Traffic Surveillance and Control Program (ATSAC) is a computerized signal control system that has been operating since the 1984 Olympics.

decrease in fuel consumption, a 14% decrease in emissions, a 41% reduction in vehicle stops, an 18% reduction in travel time, a 16% increase in average speed and a 44% decrease in delay to the motorists that use ATSAC's 1,170 controlled intersections. In San Francisco, the FSP aided more than 900,000 motorists from 1992 to 1997. In addition to reducing congestion, it also reduced an estimated 32 kilograms per day of hydrocarbon, 322 kilograms per day of CO emissions and 798 kilograms per day of NOx.

More recently, PATH and Caltrans have given California the lead by developing a freeway performance measurement system (PeMS) that serves travelers as well as transportation professionals, planners, decision-makers, and researchers. PeMS makes better use of the intelligent infrastructure by providing information required for traveler information as well as ITS investment decision-making. Already on-line for some metropolitan areas, PeMS will soon provide California travelers statewide with accurate and timely travel-time information (www.dot.ca.gov/traffic). PeMS will enable the development of accurate models to help planners assess ITS benefits, and help accelerate the right ITS deployment.

California continues to explore ways to find an appropriate role for the private sector in providing many ITS user services. However, public-private partnerships still face obstacles and delay, due to the slow development of new institutional policies that can meet the need of both public and private sectors. The provision of ITS infrastructure is well suited to

Challenges To The Deployment of ITS

More and more decision makers, not just in the transportation sector but in the overall community, are realizing the value of ITS and its potential for enhancing mobility and accessibility. As a result, ITS is increasingly being incorporated in community planning processes. Many ITS projects have been successfully implemented, and many aspects of ITS could now be deployed on a large scale. Actual implementation of such large-scale deployment, however, still faces many challenges, these challenges often being institutional and not technical.

Figure 3.
The Bus Rapid Transit concept will combine buses' flexibility, convenience, and relatively low cost with light rail's speed, comfort, and environmental efficiency.

The transition of ITS from the development stage to the actual provision of services has been delayed by elements such as:

- Competing priority for scarce resources,
- Lack of definition of roles and responsibility between jurisdiction in the policy and operations aspects of ITS,
- Lack of wide recognition and understanding of ITS benefits,
- Lack of visibility of ITS projects (compared to, e. g., highway construction),
- Decision-makers' and politicians' preference for capital projects as short-term ribbon-cutting opportunities
- Traditional DOTs' lack of information technology expertise
- Difficulties in the determining credible benefit/cost ratios for ITS projects
- Limited private investments in ITS

The benefits realized from many successful projects clearly indicate that ITS solutions should receive a high priority for implementation to improve the operational efficiency and safety of transportation facilities. Yet many DOT's across the nation continue to use their scarce resources to build major new facilities without, at the same time, giving serious consideration to the deployment and mainstreaming of ITS. This is partly because decision makers fail to understand that ITS is capable of complementing both existing and new facilities in making them more efficient, that ITS is not necessarily meant to replace these facilities. Intelligent Transportation Systems are particularly helpful in facilitating coordination and integration across modes.

The high benefit/cost ratio of ITS projects currently in operation should promote investment in ITS capacity in the shorter term even if building physical capacity will ultimately be needed. ITS can be deployed quickly, and can provide incremental capacity that is needed while a new facility is planned, designed, and built. The determination of a credible benefit/cost ratio for ITS is still in the development process, given the complexity of ITS and the required system integration and operational policies.

Funding ITS

The Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991 dedicated funding to the development and deployment of ITS. However, most of the ITS funding in the Transportation Equity Act for the Twenty-First Century (TEA 21), the recent transportation legislation that superseded ISTEA, has been earmarked. TEA 21 calls for state, regional and local agencies to make decisions about investing in ITS in the same way they invest in other transportation projects. It also encourages the development of strategic plans that integrate ITS into the main transportation planning process. Unfortunately, as a result, ITS projects often have to compete with capital projects instead of complementing them. California has for many years opted not to participate in the earmarking process, which further hurts its ability to deploy ITS. The guidance for mainstreaming ITS in the planning and policy-making process that TEA 21 provides may be premature, since ITS is not yet mature and widely accepted by decision makers. In addition, technology expertise

Figure 4.
From 1992 to 1997, the Freeway Service Patrol aided more than 900,000 motorists in the San Francisco/East Bay area—getting almost a million stalled cars off the road.

and private markets have not yet developed the maturity level necessary to support such mainstreaming.

Public-Private Partnership

Technological innovation in transportation has historically proven successful as a collaboration between private industry, federal and state agencies, and universities. Successful deployment of such innovation requires that appropriate staff from the planning and operating agencies be involved early on. Deployment of ITS, as stated before, also relies heavily on private sector involvement. It is envisioned that anywhere from eighty percent to ninety-five percent of the ITS market will be in private markets, especially with the potential for infusion of venture capital in the development and commercialization of ITS. On February 7, 2002, the University of California, with support from Caltrans, launched a new enterprise, the Center for the Commercialization of ITS Technologies (CCIT), to bring together the best minds in an effort to facilitate and accelerate the introduction of ITS products and services to the marketplace (www.calccit.org). CCIT's mission is to facilitate the development, commercialization, and deployment of promising transportation technologies and systems.

Recommendations for Accelerating ITS Deployment

The enactment of TEA 21, with its mandate for integrating ITS in the planning process, was an important step in accelerating the deployment of ITS. Another is the development and maintenance of a national ITS architecture, to serve as a framework for defining, planning and integrating ITS. Other vital efforts include current work on ITS decision support and new ITS investment decision models, developing ITS industry standards, building professional capacity, and educating decision-makers about ITS. In the future, DOT's must buy into the mainstreaming of ITS as an integral part of the transportation system. This would include the revision of all plans and specifications to include ITS elements. ITS elements must be part of the planning, design, construction, operations, and maintenance of transportation facilities. In a similar manner, they must be an important element of the physical infrastructure.

The long-range strategic planning process should be used as a forum for stakeholder buy-in. In the short term, specification and project study reports must incorporate the most promising elements of ITS in

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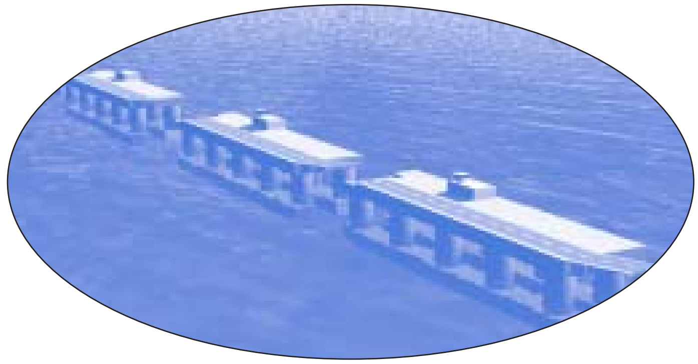
Figure 5.
Headquarters of PATH's new Center for the Commercialization of ITS Technologies stands one block from the UC Berkeley campus, at the Berkeley BART station.

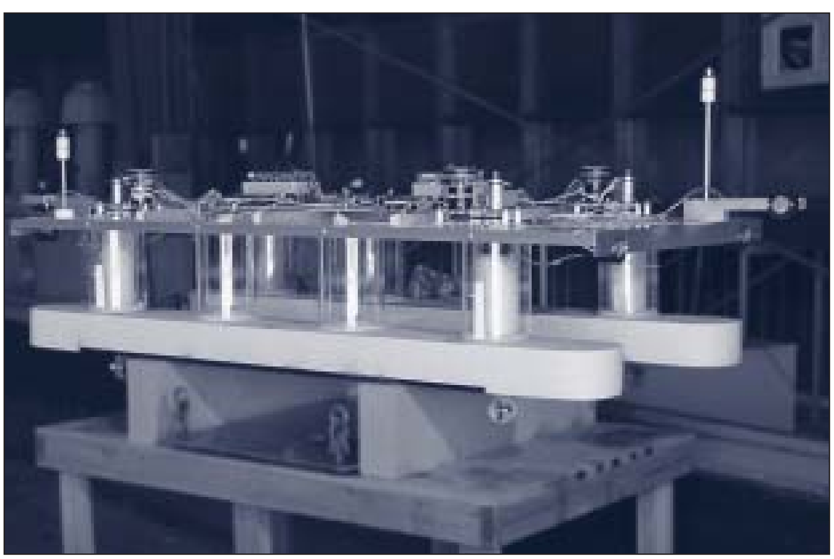
PATH's Experimental Testbed for Mobile Offshore Base Control Concepts

Anouck Girard, Daniel Empey, João Sousa, Stephen Spry, Gerald Stone, William Webster, and Karl Hedrick, PATH / UC Berkeley



As presently envisioned by Office of Naval Research planners, a Mobile Offshore Base (MOB) is a very large, self-propelled, floating air base that could accept cargo from aircraft and container ships and discharge resources to the shore via a variety of surface vessels and aircraft (Remmers and Taylor, 1998). A MOB could provide forward presence anywhere in the world. It would serve as the equivalent of land-based assets, but situated closer to the area of conflict and capable of being relocated. In operation, it would be stationed far enough out to sea to be easily defended (Taylor and Palo, 2000). A MOB would comprise three or more independently operable deep-sea going semi-submersible platforms, used in conjunction with one another to create a stable sea-based runway for large cargo and other aircraft. MOB platforms would provide personnel housing, equipment maintenance functions, vessel and cargo transfer, and logistic support for rotary wing and short take-off aircraft. The longest MOB configuration envisioned (nominally 2 kilometers or 1.2 miles in length) would also accommodate conventional take-off and landing aircraft, including the Boeing C-17 cargo transporter (Polky, 1999). Because a mile-long structure would be subjected to great loads in the ocean, and because existing shipbuilding facilities can only build ships about one-third to one-quarter of a mile long, a MOB would be built out of several modules, which must be aligned using thrusters, connectors or both. The modules forming the MOB must be able to perform long-term station keeping at sea, in the presence of waves, winds and currents. This is usually referred to as Dynamic Positioning (DP).

***Figure 1.* One of the three 6-foot long, 2.5-foot wide (1.8m x 0.68m) independent floating modules that make up PATH's 1:150 scale MOB physical model.**



PATH and UC Berkeley researchers are part of the Office of Naval Research (ONR) MOB technical base effort devoted to determining the feasibility of dynamic positioning of multiple MOB platforms (Remmers and Taylor, 1998). We have developed an automated multi-module dynamic positioning control system for the MOB, and a simulation template to uniformly support DP control systems testing and evaluation. Part of the project was a virtual demonstration that simulated several different MOB control methods under a set of environmental conditions. We also compared control system performances using an evaluation tool kit developed

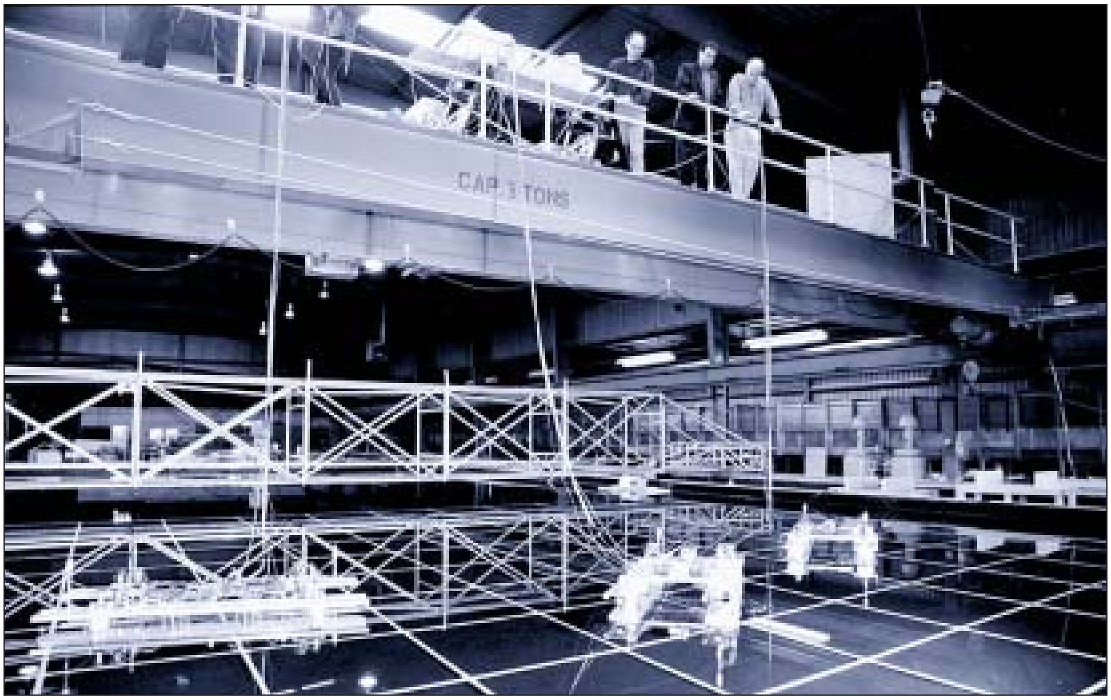


Figure 4.
Three modules are being operated from the bridge. The central computer is located on the bridge, and the umbilical cables that connect the central computer to the modules are visible on the picture. The umbilicals communicate power and control signals to the modules.

during the project. (Sousa et al., 1998; Girard et al., 2001). Our team was also tasked to physically validate the key design issues using scale models of the MOB. This article describes these physical experiments.

MOB Control Testbed

PATH has developed a 1:150 scale physical model of a generic Mobile Offshore Base (MOB) concept. The heart of the MOB physical model consists of three 6 foot x 2.5 foot (1.8m x 0.68m) independent floating modules, constructed from closed cell foam, acrylic plastic and aluminum tubing, and weighing about 200 pounds (90 kilograms). Each module is equipped with four controllable thrusters (azimuth and thrust) plus sensors that provide both inertial and relative position information. One module is shown in Figure 1. The modules are operated in a 50' x 100' x 2.5' (15m x 30m x 0.68m) tank, located at PATH headquarters at the Richmond Field Station. The large indoor tank allows the testing of the scale models in the absence of disturbances such as wind, and also provides the opportunity to inject known disturbances into the system and measure the response. The system is controlled by a real-time computer system located at the side of the tank.

Scaled MOB Modules

Each module is equipped with four variable thrust, dirigible, ducted propellers, one mounted at each corner. These thrusters were designed and fabricated at UC Berkeley and provide a true scale representation of the actual thrusters that would actually be used on a full-scale, mile-long MOB. The thrusters are electrically powered: dc servomotors provide the variable thrust while stepper motors control the azimuth.

The modules are equipped with both absolute and relative position sensors. The absolute sensor system consists of a laser beacon/position transponder system using two "shore" mounted rotating laser beacons and two position transponders on each module. The relative position measuring system consists of six ultrasonic sensors, three for each "gap" between the modules, which measure both longitudinal and lateral separation of the modules. The accuracy of this system is about ±2 mm.

Control concepts for the MOB

To support air and sea operations, the MOB is required to:

- assemble at sea,
- remain aligned and assembled to allow for landing of aircraft and cargo transfer from ships,
- align headed into in the wind to facilitate the takeoff and landing of aircraft,
- and disassemble if the environmental conditions become too severe, or in an emergency.

The Mobile Offshore Base can be viewed as a string of modules that must be kept aligned. The modules are homogeneous, that is, they are all assumed to

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PATH Vehicles Will Roll at Demo 2003

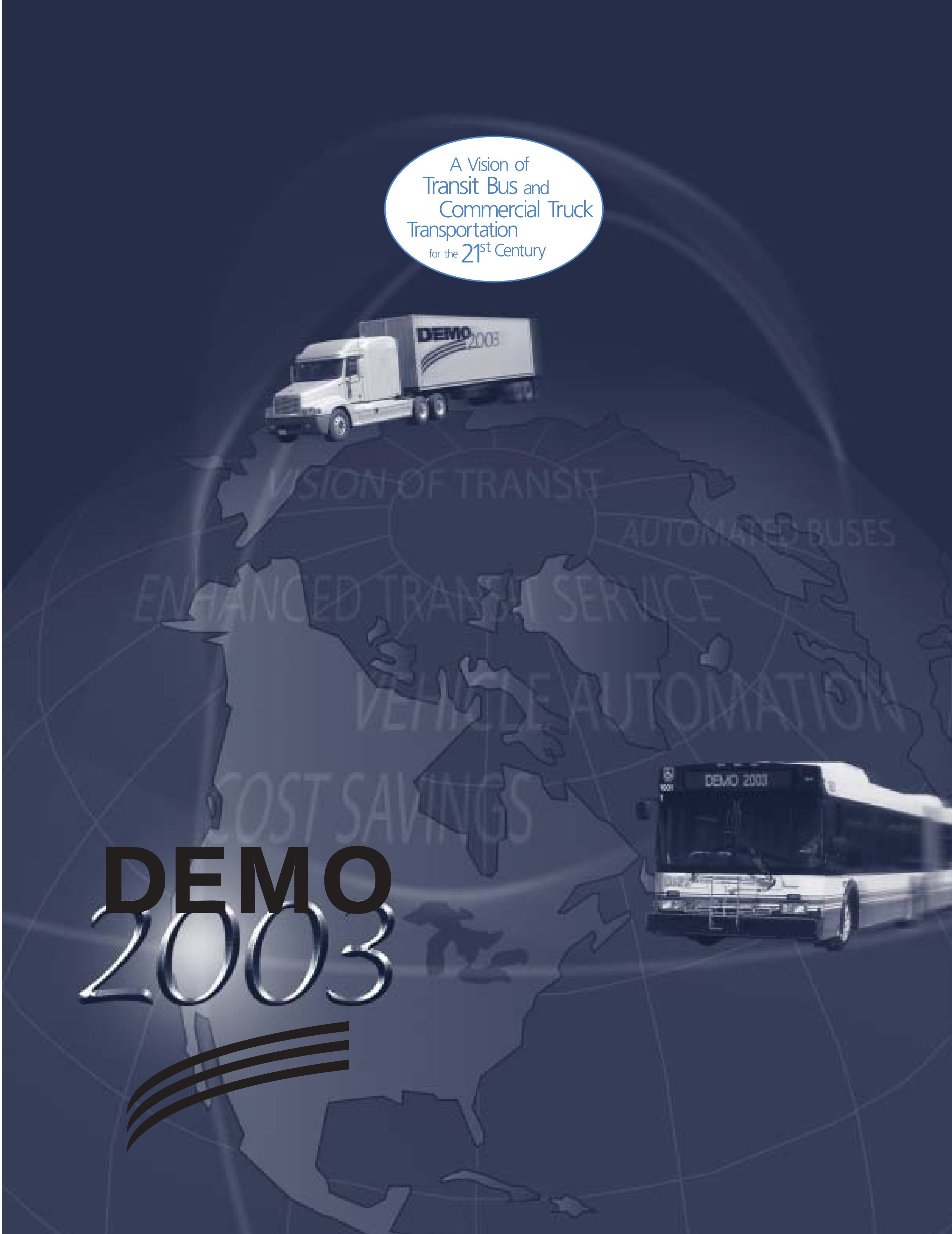
Dan Empey, PATH

SAN DIEGO, CALIFORNIA, site of the very successful Demo '97, where PATH conclusively demonstrated the technical feasibility of completely automated vehicles, will see the future of ITS vehicle automation again next year. From August 16–20, 2003 PATH and Caltrans will host Demo 2003, a demonstration and conference showcasing the benefits of heavy truck and transit bus automation. Demo 2003 offers the opportunity to advance the state of the art in the control of heavy vehicles while at the same time giving PATH and Caltrans the chance to present recent technological developments to possible early adopters of vehicle automation. Potential benefits of the technology include better delivery time and reduced fuel costs, reduced congestion, enhanced quality of service, safer vehicles, and lower insurance costs.

Featured will be on-the-road, in-the-cab rides in PATH's three Class 8 trucks (eighteen wheelers) and three transit buses (one 60-foot articulated and two 40-foot), operating in platoons and performing a variety of automated maneuvers. PATH researchers are developing the control algorithms, software structure, computer hardware, vehicle-to-vehicle and vehicle-to-roadside communications systems, and steering, brake, and fueling actuators for all six vehicles. PATH is fully responsible for the development and integration of the automation systems on all the vehicles, which presents some unique challenges. Fortunately, we have several partners in this venture. NSK in Japan is designing and building the steering actuators to PATH specifications, and the University of Porto in Portugal is working with PATH engineers on the design and integration of computer systems for the vehicles.

Hardware development is providing its share of challenges, but the real research lies in developing the control algorithms for longitudinal and lateral control of the heavy vehicles. Especially interesting is longitudinal control, which must take into account the vehicles' low power to weight ratio, potential large differences in loading, and relatively large braking delays (due to pneumatic brake systems). We also plan to demonstrate automated bus docking and automated truck backing, two maneuvers that require additional research in lateral control.

Demo 2003 will take place on the reversible HOT (High Occupancy and Toll) lanes on Interstate 15 just north of San Diego, which offer seven miles of protected two-lane freeway. The lanes are still instrumented with the magnetic markers installed for Demo '97, but additional fiber-optic and wireless communication systems will be installed to enhance vehicle-to-roadside communication capabilities.


A Vision of
Transit Bus and
Commercial Truck
Transportation
for the 21st Century
DEMO 2003
VISION OF TRANSIT
AUTOMATED BUSES
ENHANCED TRANSIT SERVICE
VEHICLE AUTOMATION
COST SAVINGS
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2003

Mobile Offshore Testbed

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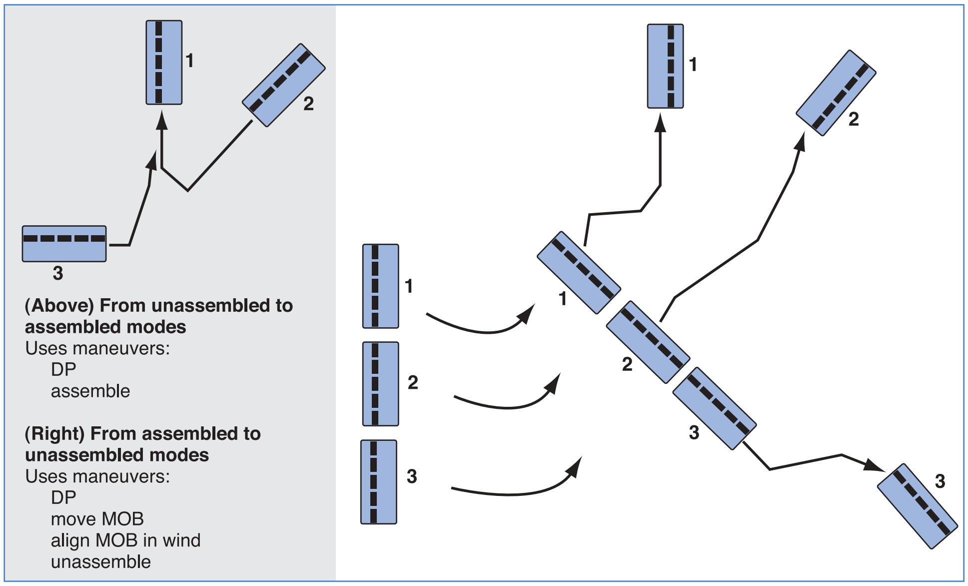

***Figure 3.* Mission Scenarios for the MOB.**

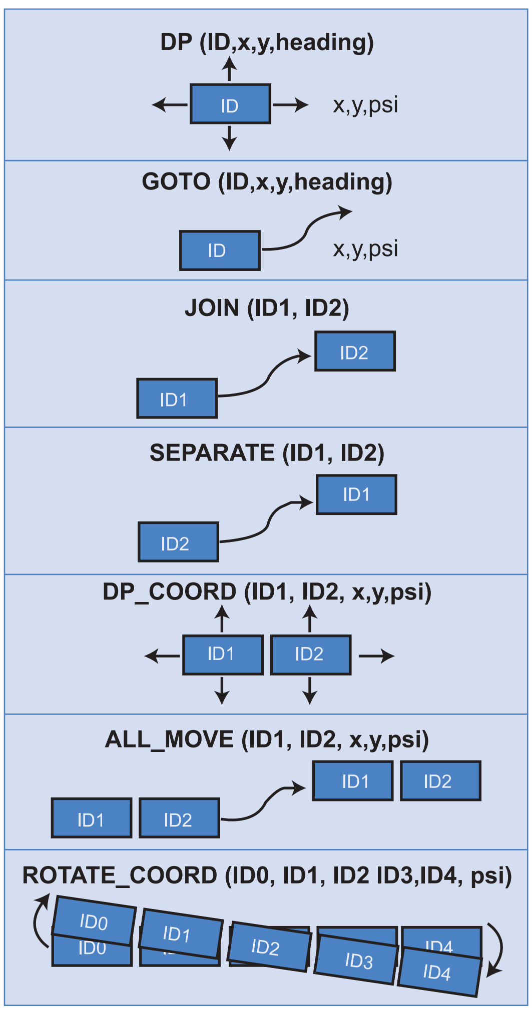

***Figure 4.* Legal maneuvers in the experimental setup.**

have the same dynamics and properties. It is possible, however, to have heterogeneous modules within the MOB. This allows us to reconfigure the string dynamically if problems arise. Ships can position themselves side by side with the MOB to transfer cargo. Another case in which we might have a heterogeneous module in the MOB is if there were a major failure in one of the modules, for instance if all thrusters on one platform. were to fail. In this case limited operations could still occur, by having the functioning modules follow the one with the failures. If two of the modules were to have major failures, however, the MOB would cease to be functional and some of its modules would have to separate.

The most significant requirement is that the modules must have good relative position control with respect to each other. The relative position requirements are quite tight. These very large, very slow modules must be within ±5 meters of each other in the sway and surge directions, and within ±1 degree of relative alignment, in disturbances up to sea state 6 (5-meter significant wave height, 17 m/s wind, 1 m/s currents). The string, however, may be allowed to drift in terms of its global position. This allows for a reduction in the power consumption (cost) in lower sea states, and focuses all the control effort on maintaining the relative alignment in high sea states. The environment in which the modules "live" (the ocean) is assumed to be unconstrained, that is, at this time we do not envision obstacle avoidance other than collision prevention between modules.

Experimental Results

The user interface for the experiment is formed by a menu offering a choice of several maneuvers. A maneuver coordinates the motion of one or several modules: legal maneuvers are shown in Figure 4. Such legal maneuvers include moving one module to a new position and heading, assembling modules to form a bigger MOB, separating assembled modules, moving a string of modules to a new position and heading, and rotating a string of modules into the wind.

A typical mission scenario would include: dynamic positioning at an initial location; bringing the modules into a straight line, but still far apart; dock-

ing the modules to form a string; performing coordinated station keeping (DP); rotating the string 10 degrees and bringing it back; performing a coordinated lateral maneuver; and separating the modules. Running a complete scenario takes about 20 to 30 minutes in the tank. Video showing all these maneuvers can be downloaded from the PATH web page:
http://www.path.berkeley.edu
under the Publications and Video heading or from the author's home page:
http://path.berkeley.edu/~anouck

What we will present next is logged data from an actual experiment. The data from the complete scenario is difficult to interpret visually, so we will concentrate on the station-keeping, docking, and coordinated rotation parts of the scenario.

Figure 5 is an x/y plot of a module station-keeping in the tank. It shows the motions of the center of gravity of the module in the x and y directions. The x and y position are given in meters, so the movements of the center of gravity of the boat are on the order of ±2 cm in either the x or y directions, which is about the accuracy of the absolute measurement system.

Usually, at the start of a mission the modules station-keep for some time, then assemble. The assembly maneuver is split into two parts: first, the modules align, far away from each other. Then the two end modules move in toward the middle one and dock precisely. Figure 7 (on the following page) shows the x locations of the three modules forming the experiment during a precision docking maneuver. Module 1 is shown on top, module 2 in the center and module 3 in the lower plot. The desired positions are shown in blue and the actual positions in black. Initially, modules 1 and 3 are not exactly at their desired position because of umbilical forces. Module 2 station-keeps during the whole maneuver.

Finally, Figure 8 (on the following page) shows the actual and desired heading angles for all three modules during a coordinated rotation maneuver. The heading angle is shown in degrees (vs. time in seconds). The desired maneuver called for a rotation from 0 to 5 degrees. The actual response lags behind the desired heading angle, but the alignment between all modules is kept closely at all times.

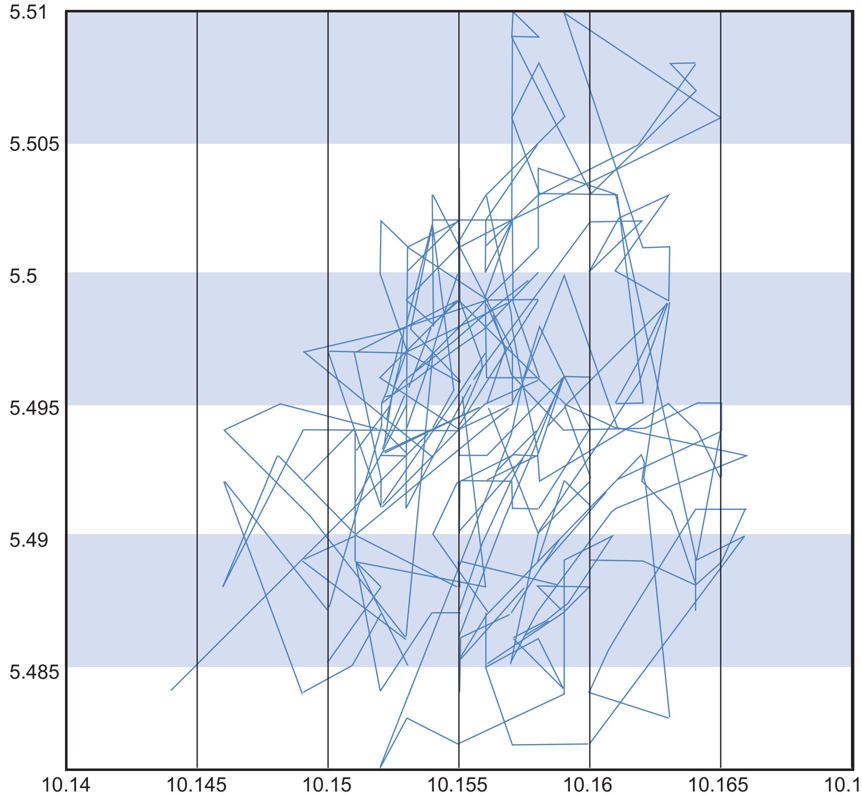

Figure 5. x position vs. y position of the center of gravity of one module while performing dynamic positioning at setpoint (10.15, 5.5).

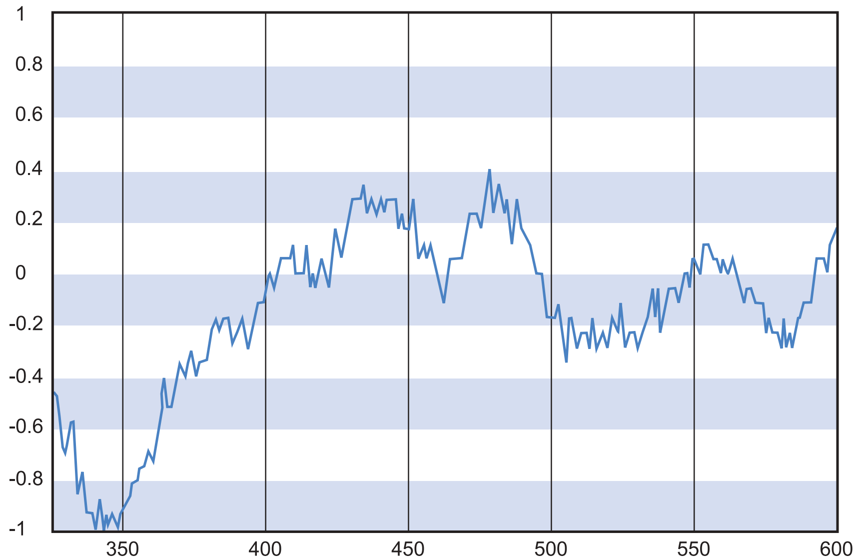

Figure 6. Heading angle of the module shown in figure 5 (in degrees), vs. time (in seconds), also while performing dynamic positioning. The angle is maintained within ±1 degree of its desired value.

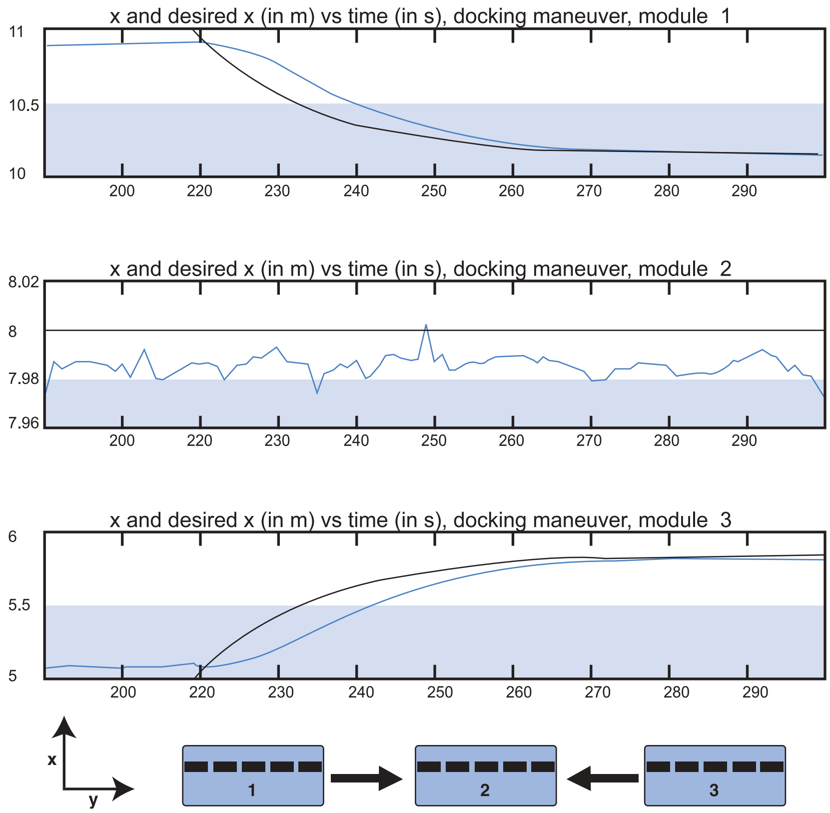

Figure 7. x position of the modules (in meters) vs. time (in seconds), while performing a precision docking maneuver. The desired positions are shown in blue and the actual positions in black.

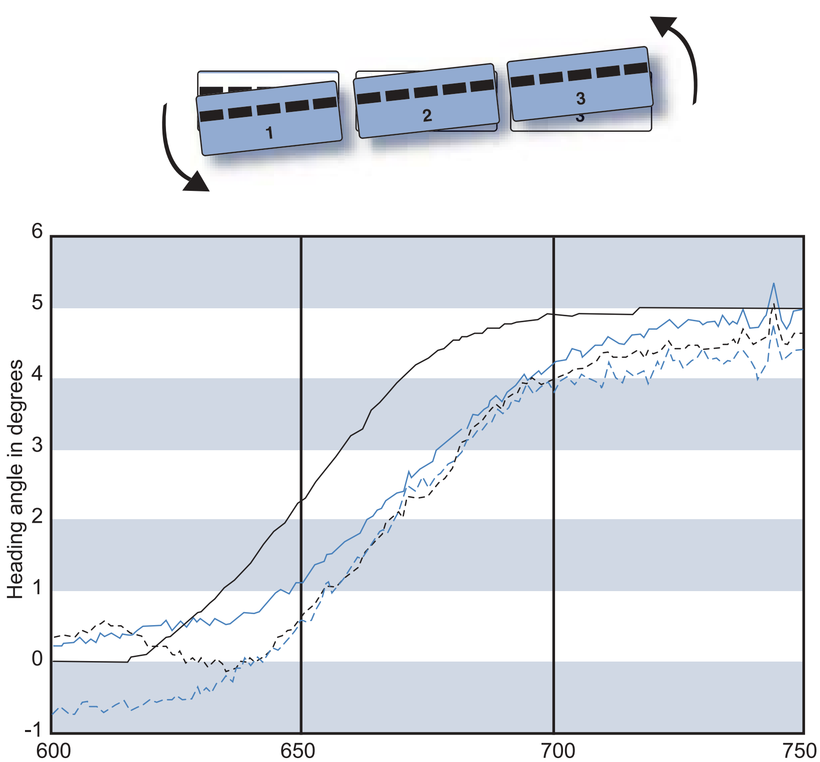

Figure 8. Heading angles of all three modules (in degrees) vs. time (in seconds) during a coordinated rotation maneuver from 0 to 5 degrees.

Conclusions

Early experimental results obtained using PATH's MOB testbed have been encouraging. Improvements to the testbed could be made in two directions: the modules should be made wireless to extend their range and get rid of the forces produced by the umbilical cables on the modules; also, the testbed would greatly benefit from an improved absolute position system.

Acknowledgments

The material is based upon work supported by the US Office of Naval Research's MOB Program under grant N00014-98-1-0744. The authors would like to thank the Link Foundation, the Fundação Luso-Americana para o Desenvolvimento, and the Ministério da Defesa, Portugal for their support.

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Deploying ITS

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the design of new facilities, as well as in retrofitting existing ones. The role that ITS offers for the private sector should not be undermined: government should encourage and facilitate private provision of intelligent products, services and infrastructure. Current involvement from the private sector includes providing traveler information services to the public for a fee. Automotive manufacturers are also providing in-vehicle ITS products, including safety and personal security services such as route guidance, vehicle location, and systems such as GM's OnStar in-vehicle safety, security, and information service. The successful deployment of ITS will depend on the degree in which private markets are successful in the provision of ITS products and services. The success of these markets will be contingent upon the extent to which public policy facilitates their development.

Conclusion

The deployment of ITS requires strong policy support and new institutional processes that facilitate collaboration between jurisdictions, with strong participation from the private sector. This includes the development of new private markets in transportation.

In general, the deployment of ITS requires the following:

- Focusing on institutional processes and stakeholder involvement
- Educating decision-makers about the benefits of ITS
- Using public policy to facilitate private involvement
- Continuing support of research and development
- Facilitating commercialization of research ideas
- Capitalizing on ITS advances
- Attracting venture capital investments
- Strengthening the role of the private sector in ITS deployment

The creation of new public-private entities as well as new private transportation markets is vital to the successful deployment of ITS. The public sector must recognize the benefit of ITS, and require its mainstreaming through the planning process. ITS must be an integral part of the planning, design, construction, and operations of a facility. In addition, the private sector must be given a better opportunity to play an active role in the provision and operation of transportation infrastructure.

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***Figure 6.* Port of Oakland: cross-country rail terminal, hub of seaways to the Pacific Rim, major freeway interchange. ITS technology facilitates coordination across modes.**

PATH on Paper

An Updated List of Recent PATH Sponsored Research Publications

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Improving Operations Using Advanced Surveillance Metrics and Existing Traffic Detectors, Benjamin Coifman, Pravin Varaiya, January 2002, 65 pp., $15
UCB-ITS-PRR-2002-2*

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Correction. Juan Carlos Muñoz' article in Intellimotion 9.4, Putting the Microscope on Freeway Traffic Data, contains the sentence: "Subtle but important features, such as slight changes in the rate at which vehicles are being counted—that is, speed—are obscured by the large scale required to display the data." "Speed" should have been "flow." Our apologies to the author.

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Transportation Secretary Visits PATH

Maria Contreras-Sweet, California's Secretary of Business, Transportation, and Housing, visited PATH on April 18, accompanied by members of her staff. UC Berkeley Institute of Transportation Studies Director Marty Wachs, PATH Director Karl Hedrick, Deputy Director Steve Shladover, and CCIT Director Hamed Benouar briefed the Secretary on PATH's effort to improve California's transportation systems using advanced intelligent technology. PATH staff were on hand to provide automated vehicle demonstrations, and displays of the new Freightliners and buses that will be automated for Demo 2003 (see pp. 8-9).

Secretary Contreras-Sweet, appointed in 1999, helped Governor Davis put forward the largest transportation augmentations in the state's history —$6.8 billion. This major program that she manages is aimed at traffic congestion relief.

Secretary Contreras-Sweet tries her hand at PATH's snowplow guidance system demonstration.

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MOB graphic on p.6 by Jay Sullivan
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