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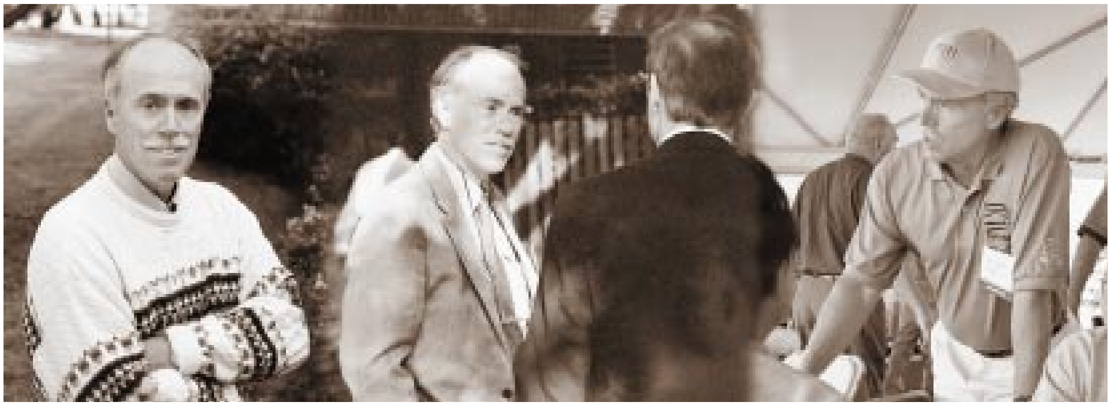
New Directions at PATH

PATH – Partners for Advanced Transit and Highways – is a joint venture of Caltrans, the University of California, other public and private academic institutions, and private industry, with the mission of applying advanced technology to increase highway capacity and safety and to reduce traffic congestion, air pollution, and energy consumption.

CALIFORNIA PATH



PATH Welcomes Karl Hedrick as New Director

I am very honored to become the Director of the California PATH Program. I came to UC Berkeley in 1988, when PATH was one year young. I came from MIT with a background in vehicle dynamics and control: in particular I had an ongoing research program with GM to look at powertrain dynamics, including electronic throttle control.

On my first day at Berkeley I received a memo from Bob Parsons, the first Director of PATH, asking the faculty for one-page proposals. One of the topics was automated longitudinal vehicle control. It seemed like a nice fit with my GM project so I submitted my one-pager and have been working for PATH in the AVCS area ever since.

My first several months as the new PATH Director were very pleasant: we were basking in the glory of our tremendously successful Demo '97 event. The NAHSC San Diego event was a showcase for many of the Consortium's partners, but to my mind PATH stole the show. We showed the world that the technology required to do close vehicle platooning, including vehicle following, lane keeping, and lane changing was here. Many people had thought the required technology was ten to twenty years off, but after taking a comfortable ride in our eight-car platoon they knew differently. Sure, there are many technical, social, and institutional issues to be solved before we will see an automated highway system in service (see Steve Shladover's article on page 2), but Demo '97 let it be known that we are closer than previously thought. Right after Demo '97, I began to plan PATH's tenth anniversary celebration. It was a wonderful occasion, with two of our previous Directors, Bob Parsons and Don Orne, returning to tell us how it was in the beginning (see page 6). PATH has accomplished so much in its first ten years of existence. It is now recognized around the world as the leading research program in advanced transportation technology, including both Advanced Vehicle Control and Safety Systems (AVCSS) and Advanced Transportation Management and Information Systems (ATMIS, see Joy Dahlgren's article on page 4).

I think we all knew that storm clouds were gathering on the horizon, but few of us anticipated their severity. Along with President Clinton's second term, came a new administration at the USDOT – an administration that doesn't believe in long-term research. They have decided to withdraw from the NAHSC and support only research into safety measures. This means the end of the program, and we are now in the process of dismantling the Consortium. To me, this seems a shame. If ever there were a role for federal support for transportation research, this is it. The program has the potential for solving both safety and congestion problems, but requires that many diverse groups collaborate. The anticipated rewards belong to the political realm – safety improvement, congestion relief, and emissions reduction.

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Future AVCSS Research Directions

Steven E. Shladover, Deputy Director, PATH

The National Automated Highway System Consortium Technical Feasibility Demonstration, Demo '97, was an important milestone for PATH as well as for the national program in Advanced Vehicle Control and Safety Systems and Automated Highway Systems (AVCSS/AHS). Researchers from around the country worked together to put together many of the technical developments that have been achieved within the past decade, and to showcase them for a wide audience. The afterglow of the Demo's success provides a good opportunity for us to take a retrospective look at our accomplishments, and then look ahead to see where we need to be heading.

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At Demo '97 we proved to a large audience that we can make an automated vehicle operate very smoothly and comfortably under normal operating conditions. We also showed animated simulations of a range of fully and partially automated vehicle operations under a wider variety of operating conditions. We are still a long way from being able to implement an operational AHS: at least 90 percent of the development effort remains ahead of us. In some ways our future work will be quite similar to what we have done before, but in other ways it will be different.

The following are some suggestions for directions we should pursue in the post-Demo period:

System definition and design tasks

• Define the performance requirements for a complete AHS, including its components and subsystems (such as sensors and actuators). This will need to be based on a series of analysis and testing cycles.

• Implement the coordination, link, and network layers of the AHS control hierarchy (in full-scale vehicles where possible), building on the extensive work that has already been accomplished in demonstrating regulation layer control.

• Develop an environment for testing and demonstrating the complete control hierarchy in a cost-effective fashion, perhaps by combining some real vehicles with simulated vehicles, analogous to hardware-in-the-loop simulation.

• Develop a good enough understanding of the human factors issues associated with driver workload and with loss of vigilance to be able to specify driver roles for both partially and fully automated systems, so that these systems can be made safer than today's driving conditions.

Application studies

• Define deployment sequences for advancing from today's transportation technology to fully automated systems. These sequences need to be verified for feasibility in terms of technology, costs, human factors, and institutional considerations at each stage of deployment.

• Design AHS systems for specific transportation applications in specific locations. This will provide opportunities to work on the interfaces between the AHS and the existing conventional transportation system in real case studies.

• Investigate impediments to AHS deployment from societal and institutional perspectives, and identify means for overcoming them.

• Estimate the benefits of the various kinds of AVCSS, ranging from warning to control assistance

to fully automated systems (AHS) in terms of efficiency, throughput, safety, energy, environment, driver comfort and convenience, etc.

Improving system robustness

The greatest technical challenges to come will probably involve improving the robustness of automated vehicle systems to safely accommodate the full range of abnormal operating conditions, including system malfunctions, that they might encounter. Research issues in this area are likely to be:

• Defining the system design requirements that must be met in order to reach system safety goals. This task has implications in terms of functional redundancy, hardware redundancy, and fault-tolerant system designs.

• Making both hardware and software more robust with respect to all abnormal operating conditions, including failures. This will require very substantial work: first to define potential failure modes and adverse conditions, and then to develop cost-effective strategies for addressing each one.

• Preparing for a new demonstration in which the automated vehicles will be robust enough that visitors can be put in the driver's seat.

Refining technologies

Although most of the required research is likely to be oriented toward the definition and development of a complete system, some more narrowly focused technological issues will still require attention:

• Selecting the best combination of sensors to serve each function, based on considerations of cost, complementary capabilities, and protection from common-mode faults.

• Defining the technical approaches for implementing the vehicle check-in and check-out functions at the entry to and exit from the AHS.

PATH engineers are currently working on providing magnetic sensor guidance for Caltrans snowplows, and on fully automating a heavy commercial tractor/trailer vehicle.

• Implementing high-performance vehicle control systems on trucks and buses, to show that good performance can be achieved on such vehicles, as well as on passenger cars.

• Developing user interfaces that will be safe and attractive to drivers.

As these suggestions for research topics show, there should now be more emphasis on specific real-world implementations and on operations under adverse conditions than in the past. This is the natural progression as we advance beyond the stage of theoretical studies and the design of systems for ideal operating conditions. We have proven that we can automate vehicles under favorable conditions. Now we need to show that they can be made to work under the harsher conditions of the real world.

The Future of PATH ATMIS Research

Joy Dahlgren, Interim ATMIS Program Manager, PATH

...the time has come to focus PATH resources on a few key research areas of great importance nationally and in California.

During PATH's first ten years, its Advanced Transportation Management and Information Systems (ATMIS) research covered a wide range of subjects. Projects included development of a national systems architecture, evaluation of advanced traveler information systems, development of machine vision systems, investigation of the value of traveler information, and research into the prospects for telecommuting. This comprehensive strategy has given PATH a broad understanding of the prospects for various types of ATMIS services, given the current state of ATMIS development. Key research still needed to support effective deployment of ATMIS has been identified.

The PATH ATMIS group believes the time has come to focus PATH resources on a few key research areas of great importance nationally and in California. We are therefore adopting two themes that will be the focus of the PATH RFP for 1998-99 projects, as well as for PATH staff research.

1. Benefits of ATMIS

The ITS community is being called upon by state and federal policy makers to demonstrate the benefits of ITS. The first step in determining ATMIS benefits is to evaluate ATMIS projects that have already been implemented. PATH has taken an active part in such research as the evaluator for the TravInfo project, the Transcal project, the Freeway Service Patrols in the San Francisco Bay Area and Los Angeles, and other ITS projects. Evaluation is one of PATH's greatest strengths, and we will be actively seeking opportunities to do more evaluations as more ITS projects are implemented.

The second step is to use this information to make inferences regarding future implementation. PATH has developed a web site that contains the results of actual implementations, along with a general discussion of ATMIS technologies and implementation considerations (www.path.berkeley.edu/~leap). Its purpose is to provide information to help potential implementers determine which ITS strategies would best suit their needs. A case-based reasoning tool is being developed, which will use the cases contained in the web site to help users estimate the effects of implementing a particular ITS service in their particular situation. New tools are needed to help project the effects of implementing the various ATMIS services in particular circumstances more accurately.

The last step is to develop methods of comparing anticipated benefits and costs of ITS projects to those of more traditional transportation improvements. This will better enable ITS projects to compete with traditional improvements for general transportation funding during the planning process. PATH is now embarking on a project to develop a benefit-cost framework for potential implementers to use in making such comparisons. Other decision support methods will be sought.

2. A Model Transportation Management Center (TMC)

TMCs are operated by Caltrans districts throughout the state, as well as by cities such as Los Angeles, Anaheim, and Irvine. The major functions of these TMCs are incident detection and management, signal control and ramp meter control, and in some cases, event management. Most TMCs pro-



vide information to travelers regarding road closures, traffic conditions, and travel options, using a variety of methods. PATH plans to support several lines of research to assist TMCs in optimizing their use of advanced technologies.

Few if any TMCs have adequate systems for collecting, processing, analyzing, and disseminating either real-time or historic traffic data. Research is needed regarding how much and what type of data is needed for different purposes under different conditions, and how this data can best be obtained and used.

Data from loop detectors, still the principal traffic surveillance method, are often missing or inaccurate. Methods for monitoring loop detector accuracy and adjusting for error are needed.

Even with good surveillance data, TMC effectiveness in reducing congestion could still be enhanced by integrating and optimizing strategies for incident management, ramp metering, and disseminating public information. Methods for improving and optimizing these control strategies are needed.

California is a cross-country rail terminus, the site of major air freight activity, and the hub of seaways to the Pacific Rim. The Ports of Los Angeles and Long Beach are the first and second largest container ports in North America, and Oakland is the fourth. These ports and terminals are also the focus of high truck volumes. Research is needed to determine what TMCs can do to facilitate this truck traffic and reduce its impacts on other traffic, or to otherwise facilitate intermodal freight movements.

Special Features of the Research

Just as PATH's experience and the current state of ITS development indicate that certain research areas

Houston's Transtar Facility, an example of city, county, and state agency cooperation.

particularly merit resources and attentions, so has a need become apparent for key features designed to move research closer to implementation. This year, PATH will be trying to integrate the following four features into its research (although not all are appropriate for all research projects).

1. Partnerships

We are encouraging PATH researchers to include potential implementers or users of the research as partners, either as part of the research team or in an advisory capacity. We hope that such partnerships will encourage research that is responsive to users' and implementers' needs, and will increase the likelihood that the research products will be implemented.

2. Benefit Assessment

Researchers are also encouraged to include in their research work plans the task of estimating the net benefits of their research's deployed products. Such estimates should utilize empirical data whenever possible. We expect these estimates to provide insights into the likelihood of implementation, and to suggest ways to change the research product to increase its net benefits. The estimates will also be useful in suggesting follow-up research.

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Past PATH Directors Address Program-Wide Meeting

Left to right:
Adib Kanafani, Bob Parsons, Don Orne, Steve Shladover, Pravin Varaiya

The 1997 PATH Program-Wide Meeting marked the program's tenth anniversary — or perhaps the eleventh. All four of PATH's past directors, plus its godfather, Adib Kanafani, Director of UC Berkeley's Institute of Transportation Studies, were present at a dinner marking the occasion, attended by over 100 PATH researchers and staff members. They reminisced about the program's early days and current accomplishments, and offered some thoughts about the future.

Adib Kanafani, Director
Institute of Transportation Studies, UC Berkeley

"It must be remembered that there is nothing more difficult to plan, more doubtful of success, nor more dangerous to manage than the creation of a new institution. For the initiator has the enmity of all of those who would profit by the preservation of the old institution, and merely the lukewarm defense of those who would gain by the new." That was our first PATH director, Machiavelli. And I tell you, you have to be Machiavellian at some points, as I'm sure you will hear from our past directors....

In 1986 we had a small but totally unusual project from Caltrans to work on a roadway powered electric vehicle. It had been developed for Santa Barbara, and Caltrans wanted further research on the feasibility of that technology. We found this was an opportunity not just to look at this new technology, but to launch a new program. We said to Caltrans that as we take this program on, we'll build around it a larger program that will advance the state of the art in transportation technology. We were talking about breaking new ground in transportation in two areas: the area of automation, and the other of information technology. These two areas are now the main functional areas of the PATH program, the main directional vectors in which we are headed.

It wasn't called PATH at first. Bob Parsons and I were scratching our heads to find a name for the program once we realized it would be really big, trying all kinds of permutations and combinations and acronyms. Finally we came up with the word "path," and we fit words to it: Program on Advanced Technology for the Highway. A few years later partnering became a very important thing so we changed it again and it became Partners for Advanced Transit and Highways. I really can't tell you what the program will be called next year, but it still will be called PATH as an acronym.

We started with a half-million a year contract; today we're up over $10 million a year. We started with three people; today we have scores of faculty and researchers and students and staff members. It's been a hard journey, it's not over yet, we're still struggling. It's not a thankless job, but sometimes we're too busy to say thank you.

PATH has expanded the field of transportation beyond its traditional domain of civil engineering and traffic engineering and has brought in a tremendous amount of intellectual power into the transportation field. It has turned the University into a much better place for educating and training young people to go out and work in the field. It has helped the UC Berkeley Institute of Transportation Studies become much more relevant. It has expanded the student body in transportation to at least half a dozen departments where there are students who are seriously studying transportation.

Bob Parsons, PATH Founding Director
August 1986-April 1990

It wasn't easy in the early days. There was no money when we started. I was managing the MagLev study out in Las Vegas when Adib called me back. Caltrans insisted I come back from Las

Vegas to manage it because they didn't trust any of these professors (Caltrans really pinched pennies). That's why we started out with non-professors as Directors.

The University brass at that time wasn't very accommodating to PATH. They didn't know we were going to make it. University guys are pretty good at putting technical things together, but Caltrans is good at disasters. I want to thank Caltrans. I think we had five experiments and three of them bombed, and they were able to smooth things over so that nobody knew they'd bombed but us. At our 1989 open house, the electric bus crapped out, everything went wrong, but no one knew but us.

Don Orne, PATH Director
July 1991–November 1993

I spent my early career in state government—came here, had a taste of the academic environment, moved on to the space and defense environment for a while, and am now working in the large consulting engineering environment. From all of those perspectives, all of those points of view, and all of those cultures, it's abundantly clear to me that the premier ITS program in the whole world is PATH. We focus on the AHS, we focus on the San Diego Demo, but that's the tip of the iceberg, what's most visible right now. But all of the rest of what you're doing in ITS, and in all of the advanced technology...everyone in the world, all the academic institutions, all the government agencies, are looking for ways in which they can emulate what you're doing, ways in which they can pick up what you're doing and utilize it in real-world applications.

Steve Shladover, PATH Acting Director
May 1990-June 1991, December 1993-June 1994

In 1986, Caltrans had the foresight to look ahead and see the need to apply some advanced technology to our transportation problems. There was nothing happening on the Federal level. In 1986-89 Bob Parsons and Howard Ross traveled around the country recruiting interest in other states. They had a traveling road show going around, preaching the gospel of advanced transportation technology. They got the state DOTs and universities and some of the industrial leaders to see that there was something real here, something worth paying attention to. And that gradually turned into a group called Mobility 2000 that would meet at different places around the country every few months to put together some outlines of what a national program ought to be. About 1991, it turned into something called IVHS America, and two years after that IVHS America morphed into ITS America.

There was no Federal money coming into this area until 1991, when ISTEA [the Intermodal Surface Transportation Efficiency Act] was passed. The USDOT was pretty much invisible. The seed from which the national ITS program grew started right here...a product of Bob's and Adib's initiative. Now, everybody takes ITS as an accepted part of the transportation world. The ITS America annual meeting is a big deal. I remember a meeting in Berkeley in March 1988 where we had about twenty-five people. That was the whole body of people in the United States who were interested in this topic. We've come a long way since then, especially looking at what happened this past August in San Diego. It was something we dreamed of, going back 10 years. Now we've got the challenge of keeping that momentum going so that it turns into something real, and not just a demonstration.

Pravin Varaiya, PATH Director
July 1994–August 1997

Caltrans has requirements... filling out quarterly reports, and final reports, and they want their money's worth. At the end of my first year as Director even the University couldn't figure out if we were plus $1 million or minus $1 million. It was a real mystery. You'd think that money is money, and that at any time people would be able to tell you what you have in the bank. It took two days to settle the budget matters. That was the first year. But the last budget meeting we had, in July, it took exactly two hours. So that's a huge improvement, with Caltrans. And the reason is that Caltrans trusts us, that people in PATH do work that is outstanding...that they're getting a bargain for the money they're spending.

But most important of all is the continuing trust that has been established, the continuing communication...the dialogue has become such that it is no longer just a relationship between contractor and contractee, where they are giving us money and we are doing the job and their job is to see that they're getting their money's worth, but rather that we are working together to solve California's transportation problems.

Saving Energy with LED-Based Traffic Signals

Theodore E. Cohn, School of Optometry, UC Berkeley

On a clear evening, sightseers gazing down at the lights of the San Francisco Bay area from the surrounding hills would not see traffic signals as a predominant source of lighting, or as a large energy burden. But these incandescent lamps are an important economic cost to the government agencies that purchase and maintain them. As urban sprawl and increased crowding lead to more traffic and to the need for more vigorous traffic control capability, the number of signals and their burden is increasing.

As of 1996, about a quarter of a million intersections in the US had been fitted with traffic control signals. Each intersection has an average of 40 signals, using either 69 or 150 watt incandescent lamps. Half of these are on at any given time, and due to the existence of protected left turns, the red lights are on 55-60 percent of the time. In addition to their energy cost, these ten million incandescent lamps have an inherent maintenance cost, requiring preventative replacement annually.

Professor Cohn preparing LED-based signal for field test.

Increasing economic pressure on governmental agencies is requiring them to explore all available avenues of cost savings. Efficiency has become not only a desirable but often a requisite product of day-to-day operations. For example, Executive Order W-83-94 by California Governor Pete Wilson prescribed a cumulative state government energy savings goal of $500 million by the year 2004.

Energy-efficient alternatives

The 1990s have seen the emergence of a number of solutions to the energy problem posed by those ten million lamps. For example, vendors have developed neon tube replacements for incandescent lamps, a reflectorized incandescent bulb is now available for purchase, and a fiber-optic fixture using a halogen bulb can also be obtained. These technologies each promise some meaningful energy savings, and possibly maintenance savings as well. The most promising technology, however, is actually a family of technologies resting upon the light emission properties of semiconductor materials, the so-called light emitting diodes (LEDs). LEDs are familiar to most consumers as the tiny red light on the electric razor, or the flickering lamps embedded in the heels of some current children's sport shoes. But LEDs are available in other colors, including yellow, orange, and green.

A number of different semiconductor materials have been tried as light sources, with a premium placed on obtaining sufficient light output to match that available with the existing incandescent technology. The threshold appears to have been crossed several years ago based on advances by Hewlett Packard in developing first AlInGaP (Aluminum Indium Germanium Phosphate), then later TsAlInGaP (Transparent Substrate AlInGaP) semiconductor technology. Single forms of these devices are so bright that they can now be used on key chains to replace small flashlights. Arrays of several hundred appear to be able to serve the purpose of signaling a motorist as to whether to stop or go at an intersection. Such devices use as little as one-sixth the energy of the incandescent lamp. This saving, coupled with an expected life exceeding seven years, is large enough that the high initial capital cost can be absorbed with net savings.

A number of cities have experimented with the earliest versions of this technology. (All alternative technology devices available for purchase are offered in configurations that allow for ready installation in existing fixtures.) The conclusion is that predicted life and costs estimates are realizable.

Visual effectiveness of alternatives

If it is accepted that one can readily replace an incandescent fixture with a solid-state one that will last longer and consume a fraction of the energy, all that remains is to ascertain whether motorists who once stopped at an incandescent-powered signal will stop as often and with the same certainty at an LED-based fixture. It was with this question in mind that the Caltrans Traffic Operations Program, a major traffic signal operator in California, approached PATH to arrange for an experimental test to verify the visual suitability of the new technology. The question was not a trivial one, because there are significant differences between the spectral composition of the LED fixture and also of the spatial distribution of its intensity. Both parameters are well known to vision scientists to affect visibility.

Under usual circumstances, an instrument known as a photometer can imitate the human eye and provide a quantitative estimate of the equivalence of two fixtures. But in the case of red traffic signals, the red end of the spectrum presses such a device to its limits of accuracy. Moreover, spatial inhomogeneity in a target (an uneven intensity profile), which can affect visibility, cannot be accounted for. Hence, the so-called "44-point test" is not necessarily able to supply an indication of the ultimate visual effect of a candidate traffic light. (The 44-point test is described in "Vehicle Traffic Control Signal Heads," ITE Journal, May 1984, pp. 13-19. It requires, among other things, photometric quantification of light output in 44 different directions spanning a range of 17.5 degrees down and 27.5 degrees side-to-side.) If one is prudent, one requires more direct evidence than a photometer can provide as regards the visual equivalence of incandescent and LED devices.

PATH Human Factors Project test technique

Scientists in the Visual Detection Laboratory (VDL) at the School of Optometry worked with Caltrans Traffic Operations and State and Local Project Development (the office with cognizance for department-wide energy savings) personnel to plan a PATH project that would provide an authoritative answer to the question of whether alternatives to incandescent lamps would function as well as standard lamps. The approach taken was conceived by Daniel Greenhouse, an engineer/scientist who had worked for a number of years with the Lawrence Berkeley Laboratory Lighting Lab. He proposed the adoption of a variant of a traditional technique for measuring light effects, that of heterochromatic flicker photometry (HFP). In HFP, one arranges for the silent replacement of a test light with a comparison light many times (perhaps 20) per second, while maintaining the spatial integrity of the scene viewed by an observer. Usually in HFP, the lights in question are of small size and this can be accomplished with suitable use of mirrors and prisms on a laboratory bench. But in this case, the lights were 12-inch diameter, ponderous, four-foot tall fixtures (.3 m diameter, 1.2 m tall).

Richard Knowles, senior technician at VDL, created a special purpose instrument that enabled an observer to view alternately one fixture, then the other, 20 times per second, without moving, and without knowing which fixture was before the eye at any given moment. Taking advantage of a very long hallway, and through the use of mirrors at one end, observers were placed at a distance from the fixtures (300 ft = 91.5 m) that corresponds to the stopping distance of interest to Caltrans engineers. By adjusting a knob that controlled the intensity available from each fixture, the observer could minimize the flicker, thus rendering the two fixtures visually equivalent. The level at which this equivalence was achieved told us whether the LED-based fixture could be counted on to do the visual task set for it.

Caltrans approached PATH to arrange for an experimental test to verify the visual suitability of the new technology.

Results for TsAlInGaP LED-based red fixtures

We express the results of our tests in terms of a *usability factor*, which can be thought of as a correction factor to be used with the measurement that would be obtained using photometry. Here's how the LEDs fared. Viewed straight on, with the highly acute central area of the eye, the LED fixture was measured to have on average a usability of 99%. This means that it was within 1% of the incandescent, that 1% more intensity would leave it equivalent. Seen in the peripheral visual field, the usability increases by 3% to over 100%. This improvement isn't surprising (though the amount of improvement is) because the peripheral visual system has little acuity and would be insensitive to the spatial variation that can be seen in the central field and which leads, we think, to a small advantage in visibility for the incandescent fixture. More important is that statistically speaking, these usability numbers differ little if at all from 100%. Accordingly, we were able to conclude that the 44-point test would adequately quantify the visibility of the fixtures we tested.

A simple field test was used to verify this result. We placed two fixtures, the incandescent and the LED, side by side. We adjusted their intensities according to the usability factor so that they should appear equally bright. We then arranged for observers

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to drive toward the twin lights and to note the distance at which they became visible, and whether any visibility difference was noted. Both the LED and the incandescent proved to be equally visible and both, despite severe attenuation of intensity (about 7-10 times), were visible at distances over three times the stopping distance, when seen against a very bright background.

Colorblindness and aging eyes

Recent proposals to adjust the allowable spectral content of traffic signals so that persons who may confuse some shades of red and green do not confuse red and green traffic lights make it clear that the colorblind segment of the driving population has very special needs (CIE Technical Report, "Review of the official recommendations of the CIE for the colours of signal lights," Publication # CIE 107-1994). So do the aging: with increasing age comes a variety of age-related visual deficiencies, many of which are not grounds for exclusion from licensure. And mean driver age is rising as the elderly segment of the population expands.

...Caltrans may save $3 million a year in energy costs.

What can we expect of LED devices in the eyes of these beholders? Preliminary indications are that the picture is fairly rosy. One can calculate that people whose eyes are insensitive to the long wavelengths of the visible spectrum (reds) would actually exhibit an improved usability for TsAlInGaP LEDs (though not so for the longer wavelength TsAlGaS LED which has also been introduced) because these LEDs have a slightly lower peak wavelength than the incandescent lamp. Measurements on one such individual did show a usability factor meaningfully different from unity. We expect no difference at all for people whose insensitivity is toward the middle wavelengths (yellow-green).

In the case of the aging eye, the main meaningful difference that might be expected to affect traffic signal visibility is lower acuity, and this would favor the LED device (resulting in a predicted usability of unity) as described above. Measurements on one such individual bore out this prediction.

Other features of LED technology

A variety of issues and problems must be considered in evaluating the suitability of a new technology for traffic signals. For some of these, the LED fixture offers surprising and significant advantages. One problem that engineers have noted, and which is mentioned in the ITE standard, is that of the "sun phantom," the apparent illumination of a fixture when it is off but directly faces the rising or setting sun. Our measurements show that the LED fixture reflects 50% less light than does the incandescent fixture (due mainly to the incandescent's built-in reflector). We would thus expect superior performance by the LED under conditions that can lead to sun phantom.

A final note relates this new technology, which might otherwise be viewed as pedestrian by planners engaged in ITS studies, to its potential for inclusion as a component in advanced ITS features. LED fixtures, unlike the incandescent lamps they replace, can be modulated at frequencies far in excess of the flicker fusion limit of the human eye. This modulation would thus not be detectable by the driver, but could be used as part of the ITS infrastructure to convey locally important information (e.g., the identity of a cross-street, or the existence of minimally visible pedestrians in the intersection) to an oncoming vehicle through light sensors installed on the vehicle.

Conclusion

Caltrans is now hard at work gearing up to buy 48,000 LED TS fixtures, with an additional 24,000 being made available to local governments who are sharing intersection operational expenses. Vendor unit pre-qualification testing is currently in progress at Caltrans' Sacramento lab facilities. The Traffic Operations Program's LED traffic signal Web page includes performance specifications for the purchase of LED-based traffic signals, including red lights, red arrows, and orange hand pedestrian signals, (as well as the final version of the PATH human factors study report: – http://www.dot.ca.gov/hq/traffops/elecsys/led/index.htm).

Caltrans Maintenance intends to have all qualifying intersections installed within 12 months from the date of acceptance of the qualified LED fixtures by its Quality Assurance (QA) Lab. Stephen Prey, Coordinator of Caltrans Energy Conservation Programs, estimates that Caltrans may save $3 million a year in energy costs. Since Caltrans operates just 7 percent of California's signaled intersections, the changes in existing fixtures now underway throughout the state and the nation will result in a considerable savings to the public in energy and maintenance costs, with no apparent degradation in the purpose that these devices are intended to serve.

PATH Welcomes Karl Hedrick as New Director

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The termination of the NAHSC will be hard on PATH, but we are determined not only to survive this blow but also to continue our leadership in AHS. Fortunately for PATH (and the nation), California has the vision to tackle hard problems that require a long-term commitment. Caltrans' New Technology and Research Program, our close partner, is committed to providing the technology required to alleviate California's growing congestion crisis. Caltrans and PATH are currently in the process of formulating a California-led AHS initiative. We will need to form a new partnership of private industry, government, and academic institutions that are committed to providing California with a transportation system for the twenty-first century, one that can increase capacity, improve safety, and at the same time not damage our environmental or social institutions. Solving a problem of this magnitude requires long-term vision; I believe the PATH/Caltrans partnership has this vision and will find a way to achieve it.

PATH's previous Director, Pravin Varaiya, was fortunate to have been Director during PATH's "Camelot" period. The beginning of the NAHSC brought a period of unprecedented growth. The end of the NAHSC will mean that PATH must seek new opportunities and reassess its future directions. The "retreat" held by PATH and Caltrans the day before this year's Program-Wide Meeting addressed exactly this issue, and resulted in a refocusing of PATH's goals in AHS, ATMIS and AVCSS. Some of the results of the retreat can be seen in the current PATH Request for Proposals (RFP) (on the Web at http://www.path.berkeley.edu/PATH/General/WhatsNew/98_99RFP.htm), which defines research areas that PATH feels are critical to the future of ITS.

The three "thrust" areas to which research needs to be guided in the immediate future are:

AHS

PATH feels that full highway automation may be the only means by which we can solve not only congestion problems but also reduce traffic accidents, emissions and energy consumption. Improved mobility for both people and goods is crucial to California's growing economy. I hope that 1998 brings a new California AHS program so that the NAHSC demise will not derail the future of AHS.

AVCSS

PATH has established an international reputation in advanced vehicle control systems, including software, hardware design, and prototype testing. In the past we have established cooperative research relationships with American, Asian, and European automotive manufacturers and suppliers. I see these relationships increasing as new products such as adaptive cruise control and collision avoidance systems begin to enter the marketplace.

ATMIS

PATH has always had a world-renowned ATMIS research reputation (see Joy Dahlgren's article on page 4). Although the AHS area has been on a roller-coaster ride, the ATMIS area has been consistently on an upward trend. The recent emphasis on ITS deployment has found PATH well positioned to act as an evaluator on several current high profile projects. PATH is also very strong in the area of cost/benefit analysis. This area is clearly going to become crucial when the nation begins to consider choosing between ITS and more conventional options. I look for continued growth in PATH's ATMIS program. It is a truly multidisciplinary area that is ideal for an academic setting; however it is also one that has an important role to play in future ITS deployment and development.

In conclusion, I look forward to being PATH's new director and playing a part in its future. Although my tenure as the Director may not be known as the "Camelot" period, hopefully it won't be the Armageddon either. I hope that it will be period of intellectual accomplishments and important contributions to transportation productivity in California, the nation, and the world.

PATH Database

The PATH Database, the world's largest on Intelligent Transportation Systems, is now accessible at:

http://sunsite.berkeley.edu/PATH.

It currently lists over 10,000 bibliographic records with abstracts.

Also available is the monthly PATH Recent Additions list, a collection of 150-200 recent citations to the Database, at:

http://www.lib.berkeley.edu/~path.

PATH Presentations

Recent and Upcoming Presentations of PATH Sponsored Research

AATT 5th International Conference on Applications of Advanced Technologies in Transportation Engineering, Newport Beach, California, April 26-29, 1998.
• Seungmin Kang, Stephen G. Ritchie, R. Jayakrishnan. "Prediction of Short-term Freeway Traffic Volume Using Least Squares and Lattice Filtering."

American Control Conference, Albuquerque, New Mexico, June 1997.
• Diana Yanakiev, Jennifer Eyre, Ioannis Kanellakopoulos, "Longitudinal Control Of Heavy Vehicles With Air Brake Actuation Delays."
• Jacob Tsao, R.W. Hall, "Capacity of Automated Highway Systems: Merging Efficiency," Proceedings, pp. 2046-2050.
•Datta N. Godbole and John Lygeros, "Safety and Throughput Evaluation of Automated Highway Systems."

ASME International Mechanical Engineering Congress and Exposition, Dallas, Texas, November 16-21, 1997.
• C. Chen and M. Tomizuka, "Vehicle Lateral Control on Automated Highways: a Backstepping Approach," Proceedings, pp. 693-700.
• S. Saraf and M. Tomizuka, "Lateral Control of Vehicles Using Non-Linear Sliding Surfaces," Proceedings, pp. 701-706.
• P. Hingwe and M. Tomizuka, "Robust and Gain Scheduled H-inf Controllers for Lateral Guidance of Passenger Vehicles in AHS."

Distinguished Lecture in Mechanical Engineering, Pennsylvania State University, October 23, 1997.
• Pravin Varaiya, "The Automated Highway System: A Transportation Technology For The 21st Century."

Hybrid Systems '97 - Fifth International Conference, University of Notre Dame, Indiana, September 1997.
• Aleks Göllü, Mikhail Kourjanski, Pravin Varaiya, "The SHIFT Simulation Framework: Language, Model And Implementation." Invited talk.

IEEE International Symposium on Industrial Electronics, Guimarães, Portugal, July 1997.
• Masayoshi Tomizuka, "Automated Highway Systems - An Intelligent Transportation System for the Next Century," Plenary Lecture.

IEEE-ITSC, Boston, November 9-12, 1997.
• Jim Misener, organizer & chair. "Modeling, Simulation and Analysis Tools for AHS."
• Aleks Göllü, Mikhail Kourjanski, "Object-Oriented Design of Automated Highway Simulations Using the SHIFT Programming Language."
• Akash Deshpande, Alan Girault, "Microsimulation Analysis of Multiple Merge Junctions Under Different ITS/ AHS Policies."
• Luis Alvarez, "Activity Based Highway Capacity Analysis: A Case Study."
• Raja Sengupta, Datta Godbole, "Tools for Design of Fault Management Systems."
• Farokh Eskafi, "Dynamic Channel Allocation for Vehicle-to-Vehicle Communications in Automated Highway Systems."
• Pravin Varaiya, "Driver Assistance Technologies."

IEEE Conference on Decision and Control, San Diego, California, December 10-13, 1997.
• John Lygeros, Claire Tomlin and Shankar Sastry, "Multi-objective Hybrid Controller Synthesis: Least Restrictive Controls."
• John Lygeros, Nancy Lynch, "On the Formal Verification of the TCAS Conflict Resolution Algorithms."
• Shankar Sastry, "Plenary Talk."
• Diana Yanakiev and Ioannis Kanellakopoulos, "Longitudinal Control Of Automated CHVs With Significant Actuator Delays," (Finalist in the Best Student Paper Competition of the conference).
• Datta N. Godbole, Veit HagenMeyer, Raja Sengupta, D. Swaroop, "Design of Emergency Maneuvers for Automated Highway System: Obstacle Avoidance Problem," presented by Raja Sengupta.

8th IFAC / IFIP / IFORS Symposium on Transportation Systems, Chania, Greece, June 1997.
• Jennifer Eyre, Diana Yanakiev, and Ioannis Kanellakopoulos, "String Stability Properties Of AHS Longitudinal Vehicle Controllers."

INFORMS Spring Meeting, San Diego, CA, May 1997.
• Jacob Tsao, S.-C. Fang, J.R. Rajasekera, "Entropy Optimization and Mathematical Programming."

International Association of Travel Behavior Research (IATBR) 8th Meeting, Austin, Texas, Sept. 21, 1997.
• Patricia Mokhtarian, Debbie Niemeier, Ilan Salomon, "The Costs and Benefits of Telecommuting: An Evaluation of Macro-Scale Literature."

International Joint Conference on Artificial Intelligence, Nagoya, Japan, August 1997.
• Tim Huang and Stuart Russell, "Object identification in a Bayesian context" (won best paper award).

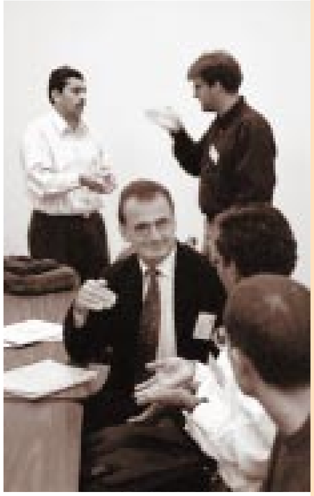
ITS Enabling Technologies Meeting, Volpe National Transportation Systems Center, Cambridge, Massachusetts, September 1997.
• Ioannis Kanellakopoulos, "Intelligent Sensors And Control For Commercial Vehicle Automation."

Korea Society of Mechanical Engineers Workshop on Automated Highway Systems, Kwangju, Korea, September 1997.
• Masayoshi Tomizuka, "Intelligent Vehicle Control for AHS," (Keynote speech).

Royal Swedish Institute of Technology, Stockholm (invited mini-course), June 1997.
• Shankar Sastry, "Safety Proofs for Automated Highways; the PATH Architecture."

continued on page 15

PATH Program-Wide Meeting Presentations



Thursday, October 9

Welcome Address
Adib Kanafani Director, ITS, UCB, and John West, Program Manager, New Technology & Research, Caltrans

ISTEA Reauthorization – Implications for PATH
Steve Shladover, Deputy Director, PATH

Vehicle Control I
Chair: Ioannis Kanellakopoulos, UCLA
• Design of Longitudinal Control for AHS Demo Vehicles–Rajesh Rajamani, PATH • Vision Based Lateral and Longitudinal Control Algorithms–Jitendra Malik/Jana Kosecka, UC Berkeley • Development of Robust Lateral Control Algorithms Based on Front & Rear Magnetometer Displacement Measurements– Han-Shue Tan, PATH

System Integration
Chair: Mohamed Al-Kadri, Caltrans
• California System Architecture–Jesse Glazer, Claremont Graduate School • ITS Evaluation Website Update and Demonstration–Joy Dahlgren, PATH • Beyond Telecommuting: A Broader Empirical Look at the Relationships Between Telecommunications and Travel Activities–Patricia Mokhtarian, UC Davis

AHS Safety
Chair: Datta Godbole, PATH
• A Complete Fault Diagnostic System for Longitudinal Control of Automated Vehicles–Rajesh Rajamani, PATH • Fault Detection and Identification for Automated Vehicle Control Systems–Jason Speyer, UCLA • Safety Spacing Requirements and Approaches for Lane Changing–Petros Ioannou, USC

Communications
Chair: Chin-Woo Tan, PATH
• AHS Wireless Communication Architecture–Farokh Eskafi, PATH • Mobile Networks on Our Mobile Highways–Robert Schultz, MobilConnect Software • Network Layer Design for Intervehicle Communications–Pravin Varaiya/Bradley Younge, UC Berkeley

Advanced Traveler Information Systems
Chair: Robert Tam, PATH
•TravInfo Field Operational Test–Y.B. Yim/Mark Miller, PATH • TransCal Field Operational Test–Aram Stein, UC Davis • YATI Field Operational Test–Ken Kurani, UC Davis

Modeling and Simulation Tools for AHS
Chair: Jim Misener, PATH
• AHS System Modeling, Analysis, and Simulation–Akash Deshpande, PATH • Development of Vehicle Dynamic Models and Regulation Layer Controllers Using SHIFT–Karl Hedrick/Adam Howell, UC Berkeley • A SHIFT Application Program Interface–Mikhail Kourjanski, PATH

Transit
Chair: Robert Tam, PATH
• Impacts of ITS on Transit Productivity–Randolph Hall, USC • Talking Signs for the Visually Impaired–Reginald Golledge, UC Santa Barbara • ATMS Testbed and Transit Modeling–R. Jayakrishnan, UC Irvine

Friday, October 10

Inertial Sensors and Vehicle Navigation
Chair: Raja Sengupta, PATH
• Inertial Sensors for Automotive Applications – Bernhard Boser, UC Berkeley • Economical Navigation System Design Methods – Pravin Varaiya/Kirill Mostov, UC Berkeley • Differential GPS Aided Inertial Navigation for Vehicle Control – Jay Farrell, UC Riverside

Surveillance
Chair: Joe Palen, Caltrans
• Algorithm Development for Section-Related Measures of Traffic System Performance –Stephen Ritchie, UC Irvine • Video Vehicle Signature Analysis and Tracking - Proof of Concept Results – Art MacCarley, Cal Poly San Luis Obispo • Laser-Based Non-Intrusive Detection of Delineations of Vehicles for Measurement of True Travel Time on the Highway – Harry Cheng, UC Davis

Vehicle Control II
Chair: Luis Alvarez, UC Berkeley
• Design of Safe Switched Maneuvers for Vehicle Control Systems – Shankar Sastry, UC Berkeley • Software Integration in AVCS – Akash Deshpande, PATH • Link and Emergency Vehicle Maneuvers and Control Laws for AHS – Roberto Horowitz, UC Berkeley

Platoon Dynamics and Aerodynamics
Chair: Rajesh Rajamani, PATH
• MEDUSA: A New Capability for Simulating Platoon Dynamics – Oliver O'Reilly/Panayiotis Papadopoulos, UC Berkeley • Wind Tunnel Measurements of Transient Aerodynamic Vehicle Interaction During a Lane Change Maneuver – Omer Savas/Amy Chen, UC Berkeley • Aerodynamic Drag Reduction and Reduced Cooling Flow for Two Full-Scale, Close-Following Vehicles • Aerodynamic Interactions Among Three Closely-Spaced Vehicles: Wind Tunnel Tests – Fred Browand/Patrick Hong/Bogdan Marcu/Aaron Tucker/Chris Sharpe, USC

Traffic Management
Chair: Richard Macaluso, Caltrans
• Anaheim SCOOT and Video Traffic Detection System FOT Evaluation – Art MacCarley, Cal Poly San Luis Obispo • Video-Based Traffic Signal Control – Michael Cassidy, UC Berkeley • FSP as Probes – Jim Moore, USC

Vehicle Control III
Chair: Jay Kniffen, PATH
• Integrated Brake/Throttle Switching Control Algorithms – Karl Hedrick/Michael Uchanski, UC Berkeley • Intelligent Cruise Control Systems and Traffic Flow Stability – D. Swaroop, UC Berkeley • Longitudinal Control Design for Automated Commercial Heavy Vehicles – Ioannis Kanellakopoulos, UCLA • Lateral Control of Heavy Vehicles (Tractor/Trailer) for Automated Highway Systems – Masayoshi Tomizuka/Chieh Chen/Pushkar Hingwe/Mei-Hua Tai/Jeng-Yu Wang, PATH/UC Berkeley

Performance Measures
Chair: Robert Tam, PATH
• An Exploration of the Market for Traffic Information – Matthew Malchow, UC Berkeley • A Performance Measure Framework - How Does ITS Fit? – Joy Dahlgren, PATH • Performance Measurement for Traffic Management Systems – James Banks, CSU San Diego

PATH on Paper

An Updated List of Recent PATH Sponsored Research Publications

A complete list of PATH publications that includes research reports, working papers, technical memoranda, and technical notes can be obtained from the:

Institute of
Transportation Studies
Publications Office
University of California
109 McLaughlin Hall
Berkeley, CA 94720

http://www.its.berkeley.edu/publications.html

510-642-3558,
FAX: 510-642-1246.

Abstracts for most PATH research publications can also be obtained via the PATH World Wide Web site at: http://www.path.berkeley.edu

FMCW MMW Radar for Automotive Longitudinal Control, William David, May 1997, $10.00
UCB-ITS-PRR-97-19

Longitudinal Control Development for IVHS Fully Automated and Semi-Automated System Phase III, J.K. Hedrick, V. Garg, J.C. Gerdes, D.B Maciuca, D. Swaroop, May 1997, $15.00
UCB-ITS-PRR-97-20

Brake System Modeling, Control and Integrated Brake/Throttle Switching: Phase I, J.K. Hedrick, J.C. Gerdes, D.B. Maciuca, D. Swaroop, May 1997, $15.00
UCB-ITS-PRR-97-21

A Vehicle Collision Model for Platoon Controller Development, Benson H. Tongue, Andrew Packard, Douglas Harriman, May 1997, $10.00
UCB-ITS-PRR-97-22

The NETCELL Simulation Package: Technical Description, Randall Cayford, Wei-Hua Lin, Carlos F. Daganzo, May 1997, $15.00
UCB-ITS-PRR-97-23

A Design Framework for Hierarchical, Hybrid Control, John Lygeros, Datta N. Godbole, Shankar Sastry, May 1997, $10.00
UCB-ITS-PRR-97-24

Development of Vehicle Simulation Capability, James W. Stoner, Douglas F. Evans, Daniel McGehee, June 1997, $20.00
UCB-ITS-PRR-97-25

National Automated Highway System Consortium: Modeling Stakeholder Preferences Project, John Lathrop, June 1997, $20.00
UCB-ITS-PRR-97-26

A Combined Approach to Stereopsis and Lane-Finding, Jitendra Malik, Camillo J. Taylor, Joseph Weber, Dieter Koller, Quang-Tuan Luong, July 1997, $20.00
UCB-ITS-PRR-97-27

Integrated Maneuvering Control for Automated Highway Systems Based on a Magnetic Reference/Sensing System, Hung Pham, Masayoshi Tomizuka, J. Karl Hedrick, July 1997, $20.00
UCB-ITS-PRR-97-28

Unified Lateral Motion Control of Vehicles for Lane Change Maneuvers in Automated Highway Systems, Wonshik Chee, Masayoshi Tomizuka, July 1997, $15.00
UCB-ITS-PRR-97-29

Integrated Maneuvering Control Design and Experiments: Report for Phase III, J.K. Hedrick, T. Yoshioka, Y.H. Chen, T. Connolly, L.R. Shen, July 1997, $15.00
UCB-ITS-PRR-97-30

Intelligent Sensor Validation and Fusion for Vehicle Guidance Using Probabilistic and Fuzzy Methods, Alice Agogino, Kai Goebel, Satnam Alag, July 1997, $30.00
UCB-ITS-PRR-97-31

Smart Call Box Field Operational Test Evaluation: Subtest Reports, James H. Banks, Patrick A. Powell, July 1997, $30.00
UCB-ITS-PRR-97-32

Improved Modeling Environment for ATMIS, Alexander Skabardonis, Edward Lieberman, Paul Menaker, August 1997, $20.00
UCB-ITS-PRR-97-33

Models of Vehicular Collision: Development and Simulation with Emphasis on Safety II: On the Modeling of Collision between Vehicles in a Platoon System, Oliver M. O'Reilly, Panayiotis Papadopoulos, Gwo-Jeng Lo, Peter C. Varadi, August 1997, $10.00
UCB-ITS-PRR-97-34

An Exploration of the Market for Traffic Information, Shirley Chan, Matthew Malchow, Adib Kanafani, October 1997, $10.00
UCB-ITS-PRR-97-35

Safety Analysis of Automated Highway Systems, Nancy G. Leveson, October 1997, $25.00
UCB-ITS-PRR-97-36

Evaluation of ITS Technology for Bus Timed Transfers, Randolph Hall, Maged Dessouky, Ali Nowroozi, Ali Singh, October 1997, $5.00
UCB-ITS-PRR-97-37

Case Study: Road Pricing in Practice, David Levinson, November 1997, $10.00
UCB-ITS-PRR-97-38

Light Rail System Safety Improvements Using ITS Technologies, Ted Chira-Chavala, Ben Coifman, Dan Empey, Mark Hansen, Ed Lechner, Chris Porter, November 1997, $25.00
UCB-ITS-PRR-97-39

A Conceptual Simulation Framework for Mobile Radio Communications: A Flexilevel Approach, John A. Silvester, November 1997, $10.00
UCB-ITS-PRR-97-40

Development of Binocular Stereopsis for Vehicle Lateral Control, Longitudinal Control and Obstacle Detection, Jitendra Malik, Camillo J. Taylor, Philip McLauchlan, Jana Kosecka, November 1997, $10.00
UCB-ITS-PRR-97-41

Modeling and Control of Articulated Vehicles, Chieh Chen, Masayoshi Tomizuka, November 1997, $15.00
UCB-ITS-PRR-97-42

Lateral Control of Single Unit Heavy Vehicles, Pushkar Hingwe, Masayoshi Tomizuka, November 1997, $10.00
UCB-ITS-PRR-97-43

Design and Evaluation of an Automated Highway System with Optimized Lane Assignment, Randolph W. Hall, Cenk Caliskan, November 1997, $10.00
UCB-ITS-PRR-97-44

The Los Angeles Freeway Service Patrol (FSP) Evaluation: Site Selection and Database Development, Robert Bertini, Karl Petty, Alexander Skabardonis, Pravin Varaiya, May 1997, $15.00
UCB-ITS-PWP-97-16

The Los Angeles Freeway Service Patrol (FSP) Evaluation: Study Methodology and Preliminary Findings, Karl Petty, Robert L. Bertini, Alexander Skabardonis, Pravin Varaiya, May 1997, $10.00
UCB-ITS-PWP-97-17

Consumer Research on Advanced Traveler Information Systems: TravInfo Field Operational Test, Youngbin Yim, July 1997, $5.00
UCB-ITS-PWP-97-18

A Survey of Value Added Resellers: Private Sector Views on Advanced Traveler Information Markets, Jean-Luc Ygnace, Youngbin Yim, Stein Weissenberger, July 1997, $5.00
UCB-ITS-PWP-97-19

Supply Side Evaluation of Radio Traffic Information, Youngbin Yim, Brian Pfeifle, Paul Hellman, July 1997, $5.00
UCB-ITS-PWP-97-20

Integrated Traffic and Communications Modeling Environment for ATMIS, P. Varaiya, J. Walrand, F.F. Wu, A. Polydoros, J. Sylvester, July 1997, $10.00
UCB-ITS-PWP-97-21

Development Testing and Evaluation of Advanced Techniques for Freeway Incident Detection, Stephen G. Ritchie, Baher Abdulhai, July 1997, $10.00
UCB-ITS-PWP-97-22

A Focus Group Study of Automated Highway Systems & Related Technologies, Youngbin Yim, July 1997, $10.00
UCB-ITS-PWP-97-23

Robust Automatic Steering Control for Look-Down Reference Systems with Front and Rear Sensors, Jürgen Guldner, Wolfgang Sienel, Han-Shue Tan, Jürgen Ackermann, Satyajit Patwardhan, Tilman Bünte, September 1997, $5.00
UCB-ITS-PWP-97-24

The Impact of Intelligent Transportation Systems on Bus Driver Effectiveness, Diane E. Bailey, Randolph Hall, October 1997, $10.00
UCB-ITS-PWP-97-25

Transit ITS Simulator (TRANS-ITS): Design Document, Maged Dessouky, Ajay Singh, Randolph Hall, October 1997, $10.00
UCB-ITS-PWP-97-26

Evaluation Framework for Commercial Vehicle Responses to Congestion Pricing, Martin Wachs, Kazuya Kawamura, November 1997, $5.00
UCB-ITS-PWP-97-27

Queue Spillovers in Transportation Networks with a Route Choice, Carlos F. Daganzo, October 1997
Tech Note 97-1

PATH Presentations

continued from page 12

SAE International Congress, Detroit, Michigan, February 1998.
• Patrick Hong, Bogdan Marcu, Fred Browand, Aaron Tucker, "Drag Forces Experienced by Two Full-Scale Vehicles at Close Spacing," (paper number 98B-175).

SAE Future Transportation Technology Conference, San Diego, California, August 1997.
• Jacob Tsao, Bart van Arem, "The Development of Automated Vehicle Guidance Systems - Commonalties and Differences Between the State of California and the Netherlands."

SPIE ISAM'97 (ITS session), Pittsburgh, Pennsylvania, October 1997.
• M. Kourjanski, A. Göllü, F. Hertschuh "Implementation of the SmartAHS Using SHIFT Simulation Environment."

13th World Congress, IFAC '96, San Francisco, California, July 1996.
• Zvi Shiller, S. Sundar, "Emergency Maneuvers of Autonomous Vehicles."

49th University of California Transportation Symposium, Anaheim, California, October 2-3, 1997.
• Jim Moore "Evaluation of the City of Anaheim SCOOT (Split, Cycle, Offset, Optimization Technique) Deployment, Session on ITS Advanced Traffic Signal Control Field Operational Tests.
• Joy Dahlgren, "Presentation On LEAP, Learning From The Evaluation And Analysis Of Performance, PATH's Website On Evaluations Of ITS."

University of Maryland (invited talk), January 1997.
• Shankar Sastry, "Verification of AHS Architectures."

University of Michigan (invited talk), September 1997.
• Shankar Sastry, "Decentralized Distributed Control."

Michigan State University (invited talk), November 1997.
• Shankar Sastry, "Safety Proofs for AHS."

Winter Simulation Conference, Atlanta, Georgia, December 1997.
• Farokh Eskafi, "A General Framework For Large Scale Systems Development."

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The Future of PATH ATMIS Research

continued from page 5

3. Technology Transfer

PATH encourages researchers to develop plans to transfer usable results of their research to professional practice. Researchers benefit by seeing their research from a new perspective, and practitioners benefit by being kept abreast of new ITS research. The Technology Transfer Program of the Institute of Transportation Studies can provide both researchers and practicing professionals with advice on designing and preparing material to move research into practice. The Program's mission is to support the development and implementation of advanced transportation systems by facilitating exchanges of information between research and practice.

4. The California Advanced Traffic Management Testbed

This laboratory, located at the Institute of Transportation Studies at the University of California at Irvine, provides access to real-time loop detector and video data from the Caltrans District 12 TMC. The ATMIS Testbed offers the opportunity to test models and theories with empirical data. It also allows researchers to observe real traffic conditions in order to develop new theories regarding traffic flow and behavior. PATH researchers will be encouraged to utilize this opportunity to base their research on empirical observation, rather than only on models.

Prospects for the Future

Because ITS provides the means for obtaining large quantities of traffic data at relatively low cost, we may be entering a golden age of transportation research. With volume and occupancy data, video surveillance, and probe surveillance we can actually *see* how traffic and travel times are affected by various ramp metering or traffic signal strategies. We can study the causes of traffic disturbances; we can look for new strategies to smooth and increase traffic flow. We will have the information that researchers have long needed to test models and theories.

Intellimotion

Intellimotion is a quarterly newsletter edited and designed by the California PATH Publications Department.

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For more information or comments about this newsletter, please write, call, fax, or e-mail the address below.

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Partners for Advanced Transit and Highways

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