Plan for an

IVHS Education Program

submitted to the

U.S. Department of Transportation

by

The Great Lakes Center for
Truck Transportation Research

The University of Michigan
Ann Arbor, Michigan 48109-2150

January 29, 1990

UMTRI The University of Michigan Transportation Research Institute

Great Lakes Center for Truck Transportation Research

Thomas D. Gillespie, Center Director (313) 936-1064

University of Michigan Transportation Research Institute, 2901 Baxter Road, Ann Arbor, MI 48109-2150

January 26, 1990

Mr. William Brown
University Transportation Centers
Office of the Secretary of Transportation
400 Seventh Street, S.W. Room 10309
Washington, D.C. 20590

Dear Bill:

Enclosed are fifteen (15) copies of a plan for an IVHS Education Program to be added to the Great Lakes Center for Truck Transportation Research. The proposed program responds to the Department's invitation to add an Advanced Institute to the Center's program funded from the additional $500,000 that will become available in the third year of the UTC program.

The Plan is intended to provide an advance description of the educational program that The University of Michigan will establish. It is submitted at this early date so that the USDOT can review the plan and provide feedback in time for students and faculty to be lined up for participation in the term beginning in September 1990. A detailed budget for the IVHS Education Program will be included in the Third Year Plan for the Great Lakes Center to be submitted to the Department on May 1, 1990.

Very truly yours,

Thomas D. Gillespie

Thomas D. Gillespie, Ph.D.
Center Director

xc: Patricia Waller
James Thomson
Robert Ervin
Joe Moore
Paul Cunningham

Enclosures (15)

Summary Page

Great Lakes Center for Truck Transportation Research: IVHS Education Program

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Date:	January 29, 1990
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Period:	October 1, 1990 - September 30, 1991
Amount:	$500,000

INTRODUCTION

BACKGROUND

The Great Lakes Center for Truck Transportation Research was established in October 1988 as one of the University Transportation Centers funded by the U.S. Department of Transportation as a provision of the Surface Transportation and Uniform Relocation Assistance Act of 1986. The Center is an association of six universities from Federal Region V and is based at The University of Michigan Transportation Research Institute (UMTRI). The current institutional partners in the Center are:

Central State University
Michigan State University
Michigan Technological University
Northwestern University
The University of Michigan
Wayne State University

The Center was founded to serve as a national resource for the application of science and technology to commercial (truck and bus) highway transport. It is a focal point for researchers and university faculty with expertise on the vehicle, driver, and roadway, and on the broader issues relating to economics, infrastructure, and regulation, to interact with leaders in the transportation community confronted with the challenging problems of maintaining mobility and safety in the coming decades.

During its first two years the Center recognized the importance of a concurrent initiative within The University of Michigan (UM) to develop a Research Program in Intelligent Vehicle-Highway Systems (IVHS). Though IVHS is in an embryonic state within this country, it is our belief that commercial vehicles represent one of the best proving grounds to develop, test and reduce to practice many of the IVHS technologies. Thus, in its first year program the Center sponsored a project under the IVHS title with the objective of identifying the commercial transport needs that could be met by IVHS technologies, and forming an IVHS sub-group within its sponsorship. Support is continuing during the Center's second year with a project to evaluate the potential payoff from applying IVHS technologies to prevention of truck collisions.

The University's Research Program in Intelligent Vehicle-Highway Systems began formally in May 1988. This Program emphasizes applied and basic research activities and has had the active support of the 22 sponsors shown in Appendix 1. Indirectly, the Urban Mass Transportation Administration has also been supporting the Research Program through its role as the funding source for the Great Lakes Center. An early planning study as part of the IVHS Research Program identified a shortage of engineers and scientists educated in the cross-disciplinary aspects of IVHS as a critical problem. Looking to the roots of this problem it is readily apparent that most engineering curricula give little or no attention to the large-scale systems research problems posed by technological developments in the vehicle-highway interface.

To meet this problem head on, UM has established educational goals stressing the acquisition of fundamental engineering knowledge relevant to IVHS with simultaneous emphasis on system design and integration at all levels. Additionally, the nurturing of a sensitivity to technological and institutional constraints is promoted.

As a first step toward fulfilling these goals UM has responded with a graduate level Special Topics Course in IVHS. This course was first taught during the Fall Term 1989 and is constructed as a cross-disciplinary cooperative effort interconnecting four engineering departments, four schools/colleges, and UMTRI. This course is comprised of approximately 40 faculty, staff, graduate students, and industrial and government experts. The outside professionals have participated through guest lectures, small group discussions, technology demonstrations on and off campus, and computer conferencing. It is based on the experience and insights gained in the Special Topics Course, and in conjunction with Michigan State University (MSU) and Wayne State University (WSU), that the IVHS Education Program is proposed here.

THEME

The Great Lakes Center for Truck Transportation Research was conceived in the recognition that commercial highway transportation is critical to the economic and social structure of the nation. It is accepted that large commercial vehicles are necessary for efficient transport of people and goods on the nation's highways. Yet their size places them at the focus of the looming concerns with highway congestion, deterioration, and safety. On a broader scale the environment, industrial productivity, and economic competitiveness are national concerns impacted by commercial transport.

The Center's objective is to capitalize on the broad opportunities for science and technology to help meet these challenges utilizing the considerable research capacity that can be found among the academic community of the Great Lakes region. With Federal support new research programs were established to address commercial vehicle problems over a broad range of topics including economics, human factors, vehicle dynamic behavior, highway wear, transit safety and operations, alternative fuels and more.

The application of intelligence to vehicle/highway systems offers methodologies for solving many of the problems mentioned above. IVHS is seen as one of the most hopeful means for easing the growing highway congestion problems, with associated enhancements to safety and productivity. Active (intelligent) steering and suspension systems on trucks and buses can ease the driver's work load, enhance safety, and reduce road wear. Similar benefits can be foreseen as intelligence is applied to the highway network to improve the management of traffic and provide information needed by the vehicle operator. Because of the direct economic benefits to be gained, commercial fleets are, and will be, the future test bed for many of the concepts developed under IVHS. Thus, there has been envisioned a close synergy between the focus of the Center and the IVHS research program.

The U.S. Department of Transportation's "Discussion Paper on Intelligent Vehicle-Highway Systems" (May 1989) has divided the area into four broad categories:

1) Advanced Traffic Management Systems (ATMS)

2) Advanced Driver Information Systems (ADIS)

3) Freight and Fleet Control Operations (FFC)

4) Automated Vehicle Control Systems (AVCS)

The UM IVHS Research Program has been focused on ADIS and FFC, the latter having received joint funding from the Great Lakes Center. Thus the proposed IVHS Education Program will emphasize ADIS and FFC although it will also give adequate coverage of those aspects of ATMS and AVCS that are synergistic with ADIS and FFC. Within ADIS and FFC, the proposed Education Program is intended to be quite comprehensive.

IVHS EDUCATION PROGRAM

The IVHS Education Program will cover:

- Engineering and non-engineering principles
- Modular technologies and system integration
- Applications to automobiles, trucks and transit systems
- Freeways, urban streets, and rural roads.

The IVHS Education Program is to be realized in three phases over a three-year period. The emphasis of each year is as follows:

- 1990-91 Formal Initiation: Initial courses
- 1991-92 Full-scale Implementation: Complete array of courses
- 1992-93 Education Derived Laboratory and Demonstrations Operational

The IVHS Education Program will proceed simultaneously along two tracks. The focus of each segment is as follows:

- University Education—to train the next generation of IVHS experts
- Continuing Education—to acquaint current transportation professionals with IVHS technology and policy issues

Including undergraduate, graduate, and continuing education, it is estimated that, by the end of the third year, this effort will affect approximately 200 students per year. In order to focus on the transportation needs of the U.S., special efforts will be made to recruit students whose intention is to enter or continue in the U.S. transportation community upon completion of their studies. An overview of the IVHS Education Program is shown in Figure 1 and described in the following.

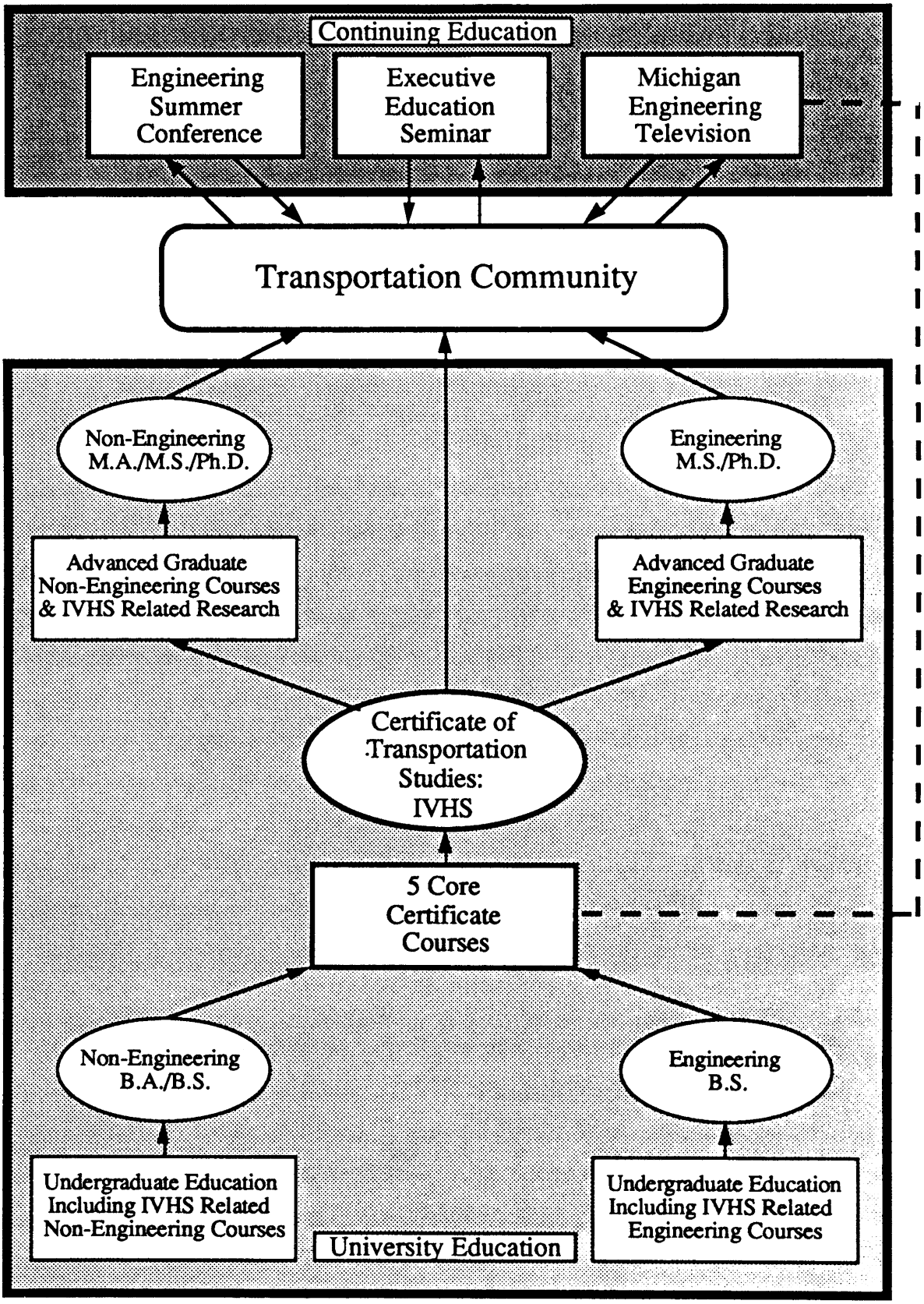

Fig. 1 Overview of the IVHS Education Program

UNIVERSITY EDUCATION

The purpose of this segment of the IVHS Education Program is to expose both graduate and undergraduate students to technological approaches for relieving the constraints on urban mobility and safety. Many existing courses offered by the College of Engineering, the College of Architecture & Urban Planning, the Law School, and the School of Business Administration are expected to be beneficial to, and enriched by, the IVHS Research and Education Programs. A representative sample of such courses which have been recently taught is given in Appendix 2. It is estimated that, by the end of the third year, 50 undergraduate students and 50 graduate students will take courses directly related to IVHS each year.

A number of graduate students are currently involved in IVHS studies through assistantships with one of the participating departments. In order to expand and deepen the reach of the education effort, the IVHS Education Program plans to establish graduate assistantships to provide 7 terms of support for students during the first year. This number is projected to increase by 7 during the second and 3 during the third year so that the total number of terms of graduate student research assistants (GSRAs) directly funded by the Program could reach 17 by the third year, for a total of 38 over the three-year period. These assistantships will be 50% appointments with remuneration, in the form of tuition waiver and stipend, at the rate of about $15,000/year. The students will work under the direction of faculty members responsible for IVHS research and course development projects. In addition to these resources, the assistance of the IVHS Program Sponsors is being sought to develop internships and fellowships to increase the level of support for students.

In an attempt to encourage undergraduate student participation and to identify a local pool of potential graduate students, an IVHS Scholars Program will be established. Each Spring semester during the three years, the junior level class will be solicited for nominations and 3 students will be selected as participants based on academic performance and student potential. We expect these "IVHS Scholars" to pick IVHS-related topics for their senior design projects. The selected students will receive a stipend as appropriate to the nature and level of the work done.

The current judgment is that a Masters or Ph.D. level program is not appropriate for a cross-disciplinary topic of the nature of IVHS. Rather, graduate students who seek to develop a working and comprehensive understanding in IVHS would benefit most by obtaining a non-degree Certificate of Transportation Studies: IVHS at UM. This Certificate is envisioned to form the keystone of IVHS education at UM.

Graduate Certificate

In order to establish a "Certificate of Transportation Studies: IVHS" within the next few months, the current program of Certificate of Transportation Studies is being amended to provide an IVHS focus. This design will allow the Certificate to complement existing departmental programs at both the Master's and Ph.D. levels. The Certificate Program will be governed by a committee chaired by Kan Chen (Electrical Engineering & Computer Science), and including, as Ex Officio, George Carignan (Associate Dean of Engineering for Research), and Robert Smith (Industrial & Operations Engineering), A. Galip Ulsoy (Mechanical Engineering & Applied Mechanics), John Nystuen (College of Architecture & Urban Planning), and Robert Ervin (UMTRI). The current estimate is that the Certificate Program will build up to 20-30 students within a couple of years. A total of 45 students (20 and 25 in the second and third years, respectively) are expected to have received the Certificate within three years.

The Certificate of Transportation Studies: IVHS will be awarded for the satisfactory completion of a program designed around the IVHS knowledge base and will require completion of 15 credit hours of graduate study. These requirements include one course (3 credits) within the student's home department, three courses (3 credits each) outside the student's home department, and a Research Seminar (3 credits) in IVHS-related topics. Each course will be developed as a series of 'modules' in order to facilitate cooperation between and exploit the strengths of UM, MSU and WSU, and guest lecturers. It is anticipated that students will apply the course offered by their home department toward fulfillment of the requirements in their Masters Program as well as toward the Certificate. Thus only 12 additional credits (or one additional term) will typically be needed to attain the Certificate.

The underlying philosophy of the Certificate concept is that graduate students in IVHS should have both breadth and depth in their skills and understanding. Although the specific distributional requirements are yet to be determined and approved by the faculty from the participating departments, the following mix of core courses to be developed will serve to illustrate the educational philosophy:

1) Driver-Highway Interactions: Traffic Analysis and Route Guidance (to be offered by the Department of Industrial & Operations Engineering with several course modules focusing on traffic modeling developed and supported by the Michigan State University's Department of Civil Engineering)

2) Driver-Vehicle Interactions: Vehicle Controls and Human Factors (to be offered by the Department of Mechanical Engineering & Applied Mechanics with substantial assistance from UMTRI)

3) Vehicle-Highway Interactions: IVHS Electronics Systems (to be offered by the Department of Electrical Engineering & Computer Science with several course modules focusing on Public Transit developed and supported by the Wayne State University's Department of Civil Engineering)

4) Socioeconomic Aspects of IVHS (to be offered by the College of Architecture & Urban Planning with cooperation from the Economics Department and the School of Law)

5) IVHS Research Seminar (to be offered in a cross-listed manner by participating departments in the College of Engineering and Urban Planning)

The IVHS Research Seminar has already been developed and taught in the form of a Special Topics Course in IVHS. This course, significant in itself, has also laid a solid foundation toward development of the remaining core courses.

Special Topics Course

The Special Topics Course in IVHS was first offered in the Fall Term of 1989 and is now scheduled into the yearly course roster. The course is a graduate-level cross-departmental seminar series which presents recent developments and future challenges in IVHS research. As a capstone to the seminar, students and faculty work to identify

possible improvements in UM's IVHS basic research directions. The objectives, format, content, and status of the course are as follows:

Objectives

- To provide an overview of the state of the art in IVHS technical developments.
- To familiarize students with ongoing research efforts.
- To facilitate systematic exchange of ideas among students, faculty, staff, industry and governmental representatives.
- To involve selected students who may become research assistants in IVHS.
- To develop the UM IVHS Education Program.
- To identify possible improvements in UM's IVHS basic research directions.

Format

- Each student participant is sponsored by a faculty member in order to avoid the ethereal nature that characterizes many such seminars. The faculty is responsible for the development of depth in the student's understanding of a certain area while the seminar provides for breadth.
- Each week all participants engage in a 2-hour plenary session structured around speaker presentations and related readings. Each session is videotaped for the use of those who either unavoidably miss a session or who desire to review a presentation or discussion. Viewing facilities are readily available in the engineering library.
- In addition to the plenary sessions, students participate in weekly small-group discussions between (a) individual students and their mentors, and (b) subsets of faculty, staff, students, and outside experts. Eight of the latter groups exist, each being focused on one of the specific technical areas to be introduced shortly.
- All participants, including those off campus, regularly participate in CONFER, a computer conferencing software program used at UM. (For access to the conference one signs onto the Merit Computing Network and runs the source program VHS:FORUM under the UB system.)

- Individual students pursue research in an IVHS area of interest to themselves and their mentor. The results are presented both during the plenary session and in written form.

Contents

- Background

  Current needs and developments in highway transportation

  Competitive programs in Europe and Japan

  U.S. activities

- Technical

  Driver-Highway Interactions (e.g., traffic modeling, analysis, and simulation)

  Driver-Vehicle Interactions (e.g., human factors in driver information systems)

  Vehicle-Highway Interactions (e.g., computer/communication systems architecture)

  Collision Prevention (e.g., Near Obstacle Detection Systems)

  Subsystems & Components (e.g., sensors)

  System Reliability (e.g., diagnostics)

  Socioeconomic Aspects (e.g., user acceptance and legal liability)

  System Integration (e.g., comprehensive modeling and competitive strategy)

- Other

  Workshop

  Technology Demonstration

  Field trip

  Social

Status

During the Fall 1989 session of the Special Topics Course 18 students were enrolled, approximately 20 faculty, corporate, and governmental representatives participated each week, and in total over 70 people were involved. The course was cross-listed in the Departments of Electrical, Industrial, Civil, and Mechanical Engineering and also drew resources from the College of Architecture & Urban Planning, the School of Law, the College of Literature, Science, & the Arts, the Ph.D. Program in Urban, Technological, & Environmental Planning, and the University of Michigan Transportation Research Institute. The course participants are listed in Appendix 3. Note that a number of the students taking the course were supported by industry. It is anticipated that the IVHS Program Sponsors will continue to assist students in this manner.

It is felt that, in addition to the Certificate of Transportation Studies: IVHS, a number of students will pursue IVHS topics on the MS or Ph.D. level. In consideration of this, one of the computer conference items provided potential IVHS thesis/dissertation topics which were suggested by faculty and staff. This list is shown as Appendix 4 to provide an example of the kind of substance the UM education on IVHS will deal with.

Due to significant interests in continuation of the IVHS Seminar, an approximately weekly speaker and discussion series on IVHS topics is scheduled for the Winter Term 1990. The series will continue to develop the eight technical areas of the course and additionally will address public transit issues.

CONTINUING EDUCATION

Continuing education in IVHS will be provided by UM's College of Engineering and School of Business Administration.

The College of Engineering has a history of over thirty years of support for continuing education. This tradition is presently supported by two excellent facilities - the Chrysler Center for Continuing Engineering Education and the Michigan Engineering Television Network (METN).

Each year the Engineering Summer Conference (ESC) Program in the Chrysler Center offers from 30 to 40 intensive short courses for practicing engineers ranging in length from

three days to four weeks. The program serves as an educational resource for high technology industries and has attracted a national and international audience. We plan to hold an ESC on IVHS every summer beginning in 1990 (the initial course being July 23-26, 1990 as indicated in Appendix 5) as an effective means to convey our research results to practicing engineers and to interested faculty from other universities. It is estimated that 20 engineers and faculty will participate in the ESC each year.

The METN broadcasts live, interactive courses to several industrial sites in the greater Detroit area, especially to the automobile companies. The courses offered include regular graduate and undergraduate credit courses from the College of Engineering as well as workshops, lectures, and mini-courses. It is our plan to have all the required courses in the Certificate Program be available to practicing engineers through the METN. Thus, practicing engineers already having a Masters degree will be able to fulfill the Certificate requirements off campus. It is estimated that, by the end of the third year, 20 engineers will take advantage of the METN broadcasts each year. In addition to broadcasts, METN has produced and sold a number of videotape courses to other universities and to industry. The IVHS courses are also to be made available in this format and it is estimated that another 20 people per year will participate through this media. The concept of using METN to link UM, MSU, and WSU is under discussion.

In addition to these College of Engineering activities, a Seminar on IVHS is to be offered through the UM School of Business Administration Executive Education Program, which, in terms of yearly enrollment, has recently become the largest program of its type in an American university. The first seminar is planned for late 1990 or early 1991 and is targeted on the opportunities and policy implications arising from IVHS in both the public and private sectors. It is estimated that 40 executives from government and industry will participate in the seminar each year.

MANAGEMENT PLAN

CENTER DIRECTION

The Center organization is structured around a Center Director, Dr. Thomas D. Gillespie, who takes responsibility for day-to-day direction and administration. A resumé for Dr. Gillespie is provided in Appendix 6. A Center Executive Committee, comprised of Principal Investigators, advises the Director on matters of policy, as well as providing a review and critique of the annual research plan. Additional guidance on the research program is provided by an Advisory Committee representing heavy vehicle manufacturers, truck and bus fleet operators, a drivers union, state highway and transportation agencies, and trade organizations.

With the addition of the IVHS Education Program the organizational structure will assume the form shown in Figure 2. For purposes of directing the two main activities the Center will be organized along a research and an educational line even though the same universities and principals are involved in each. The Center Director, supported by the Executive and Advisory committees, will retain responsibility for both activities. As before the Center Director has primary responsibility for organization and administration of the research program. Those responsibilities for the education program will be handled by personnel directly involved in the program. The IVHS Program Advisory Committee, consisting of the current co-sponsors of the research program, will advise the Education Director on needs and directions for the educational component.

EDUCATION DIRECTION

The educational initiatives will be directed by Dr. Kan Chen, Professor in the Electrical Engineering & Computer Science Department and former Director of the cross-disciplinary Ph.D. Program in Urban, Technological, & Environmental Planning (see resumé in Appendix 6). Robert Ervin (see resumé in Appendix 6) will act as the Associate Education Director in support of Professor Chen. Additional advice will be provided by the Dean's Office of the College of Engineering and by faculty, industry, and government sponsors. Dr. William Taylor, Chairman and Professor of Civil and Environmental Engineering at MSU, and Dr. Snehamay Khasnabis, Professor of Civil Engineering at WSU, will lead the cooperative efforts from their respective universities.

Great Lakes Center for Truck Transportation Research

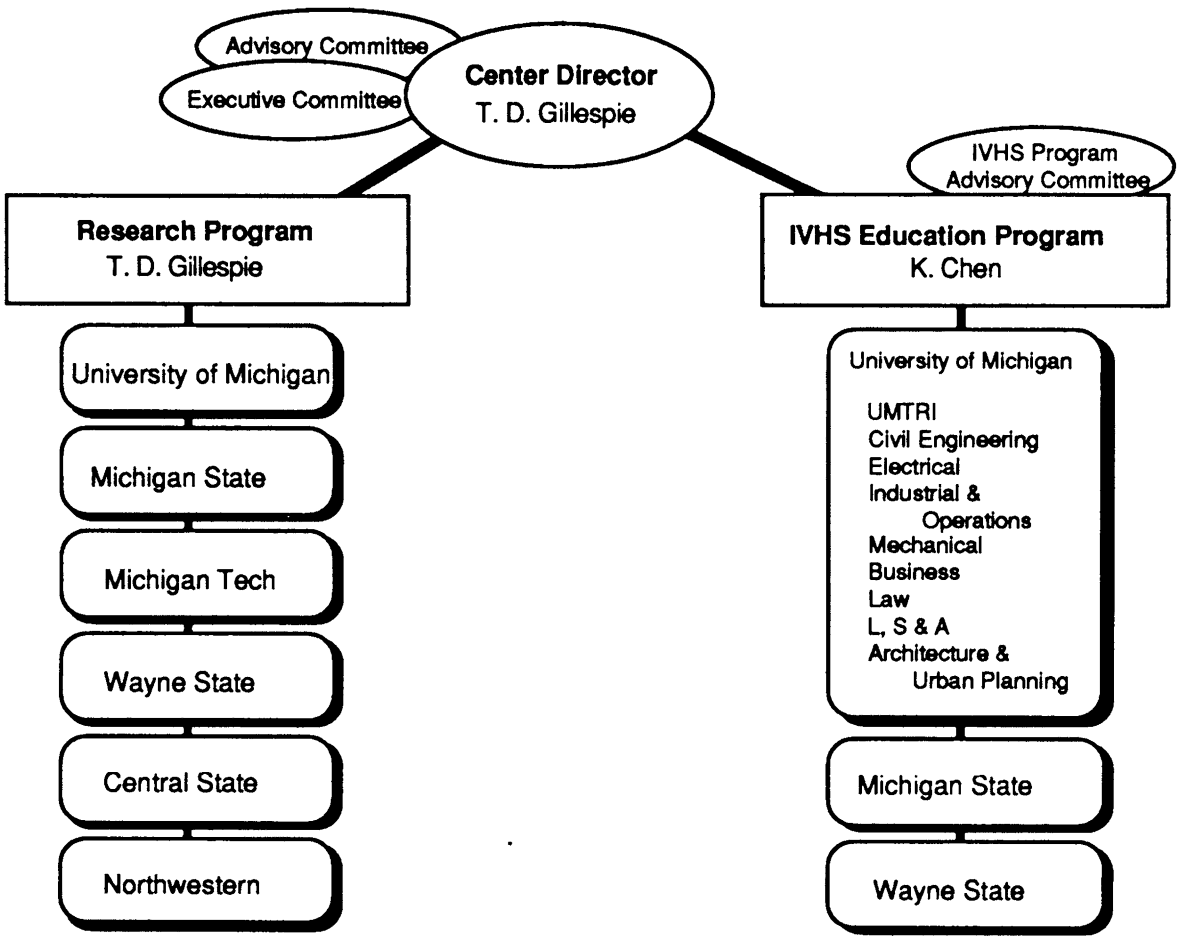

Fig. 2 Organizational chart

INSTITUTIONAL SUPPORT (UNIVERSITY OF MICHIGAN)

The University provides many services which support the management of enterprises such as the Center. In addition to office, classroom, and laboratory facilities, the Center is supported by university procurement, contract, and accounting services.

The newly-formed IVHS Education Program will have strong support from within the University community. Vertically, the Program has solid support from Dean Daniel E. Atkins III of the College of Engineering and from University Provost Charles M. Vest. In addition, the Academic Policy Group, a high-level UM body composed of selected vice presidents and deans and chaired by the Provost, recently evaluated the IVHS Research Program and determined it to have significant long-term education and basic research values deserving strategic support from UM. Quoting from a memo from William Kelly, Vice President for Research at UM, ". . . the Academic Policy Group was favorably impressed by the broad base of faculty interest and potential student involvement in the IVHS initiative, and they recommended that these academic ties continue to be emphasized and cultivated as this enterprise is pursued." Horizontally, the Program has been pledged the help of the administration and faculty of the various engineering departments and has encountered enthusiastic interest from other parts of the University, in particular the College of Literature, Science, & the Arts, the School of Law, the College of Architecture & Urban Planning, and the School of Business Administration.

The thrust of detailed efforts toward development and implementation of the Education Program stem from the participating departments. These efforts include preparations which focus on the five core courses of the Certificate Program, as well as on the closely associated senior design seminar in the College of Engineering. Currently a number of faculty and staff facilitators are actively moving ahead with foundational work. The relevant personnel are introduced in the following and the appropriate resumés are included in Appendix 6.

Robert Smith of Industrial & Operations Engineering is heading the effort to develop the course Driver-Highway Interactions: Traffic Analysis and Route Guidance. Steve Underwood of Electrical Engineering & Computer Science is assisting in this effort. In collaboration with their work, William Taylor of the Michigan State University Department of Civil Engineering is providing several course modules.

A. Gallip Ulsoy of Mechanical Engineering & Applied Mechanics is in charge of the effort to create the course Driver-Vehicle Interactions: Vehicle Controls and Human Factors. Robert Ervin and Paul Green of UMTRI are supporting this effort.

Bernard Galler of Electrical Engineering & Computer Science is leading the work to produce the course Vehicle-Highway Interactions: IVHS Electronics Systems. Three other faculty from Electrical Engineering & Computer Science—Kan Chen, Marlin Ristenbatt, and Giorgio Rizzoni—are assisting in this process. In collaboration with their work, Snehamay Khasnabis of the Wayne State University Department of Civil Engineering is producing several course modules which focus on public transit .

John Nystuen of Architecture & Urban Planning is coordinating the effort to establish the course Socioeconomic Aspects of IVHS. Robert Marans of the Institute for Social Research, Frank Stafford of Economics, and Kent Syverud of Law will be working with him to produce the course.

The IVHS Research Seminar has already been developed and taught in the form of a Special Topics Course in IVHS. Bernard Galler of Electrical Engineering & Computer Science has agreed to take responsibility for the continuance and expansion of this Seminar.

The Senior Design Course in the College of Engineering is an ongoing educational effort aimed at helping students learn engineering design principles and creative thinking. Giorgio Rizzoni of Electrical Engineering & Computer Science is responsible for the effort of refocusing this course onto IVHS issues.

Rounding out the UM Faculty team, Stuart Hart of Corporate Strategy in the School of Business Administration is directing the effort to develop the Executive Education Seminar in IVHS. Kan Chen of Electrical Engineering & Computer Science is assisting in this effort.

OTHER SUPPORT

Michigan State University (MSU) and Wayne State University (WSU) will be participants in the IVHS Education Program. This involvement will include development and support of course modules on IVHS topics and, potentially, the exchange of students and faculty and the sharing of resources. The strengths that MSU will bring to the Program are focused in the area of IVHS and Traffic Modelling. This includes study of Car Following Models (lane capacity and safety issues), Traffic Flow Models, Traffic Assignment Models, Traffic Control (Urban and Freeway), and Street Network Models. The strengths that WSU will bring to the Program are focused in the area of IVHS and Public Transit. This includes study of Transportation Engineering, Civil Engineering Decision Processes, Urban Transportation Planning, and Mass Transportation Systems. Thus, the interests and strengths of MSU and WSU in IVHS complement those at UM.

The MSU effort will be coordinated through:

Dr. William Taylor
Chairman, Department of Civil and Environmental Engineering
Michigan State University
382 Communications Arts Building
Lansing, Michigan 48824-1212
(517) 355-5107

The WSU effort will be coordinated through:

Dr. Snehamay Khasnabis
Professor, Department of Civil Engineering
Wayne State University
Detroit, Michigan 48202
(313) 577-3915

Resumés of these staff members are included in Appendix 6. Appendix 7 contains a letter of commitment and proposed plan of action from each of these universities.

PRELIMINARY BUDGET

For planning purposes a preliminary budget for the first three years of the Education Program has been prepared. The following table shows how Federal support would be utilized as it becomes available.

	Federal Contribution (total direct and indirect)					
	1st yr		2nd yr		3rd yr	
Administration	$75,000		$75,000		$75,000	
Clerical & technicians	17,056		13,879		14,362	
Planning & counseling	34,589		36,664		38,864	
Core courses	145,958		77,358		82,000	
Grad. Student Research Assts.	60,019	(7)	127,238	(14)	163,774	(17)
Continuing ed & ad courses	41,378		43,861		0	
Other direct costs	26,000		26,000		26,000	
Subcontracts	100,000		100,000		100,000	
Total	$500,000		$500,000		$500,000	

The matching support from the Michigan consortium will exceed $500,000 per year. In fact, the matching support will increase further after the first year as all the core courses developed during the first year will be taught as regular courses beginning the second year, and thus be supported by the universities' general funds.

An annual increase of 6% is assumed for faculty /staff salary and student stipend. As indicated in the above table for the three-year budget, the number of graduate student research assistants (GSRAs) will begin as 7 in the first year, and will increase to 14 and 17 for the second and third years, respectively. Program planning and student counseling will be at the level of 2 person-months per year. A total of 10.5 person-months is budgeted to develop the 5 graduate-level core courses and the senior design course in the first year. Half of that amount of person-months will be needed for course improvement during the second year and for educational material documentation and dissemination in the third year. The budget also includes 2.75 person-months for IVHS continuing education development in the first year, and the same amount for advanced course development in the second year. These courses will become self-supporting in the second and third years, respectively. Other direct costs are for publication, travel, and communications. The subcontracts in

each of the three years are to support cooperative efforts at Michigan State University and Wayne State University.

Matching Support

During the first year matching funds in amounts easily exceeding $500,000, will be available from a number of potential sources as described below.

1) Tuition waiver of graduate student research assistants (GSRAs)—The College of Engineering will provide full-tution support for GSRAs having 50% or higher-fractional time appointment at the College. The GSRAs will provide assistance to the faculty/staff in course development and improvement.

2) Undergraduate scholarship—A number of outstanding undergraduate students at the senior level will be given a scholarship to take the senior design course conducting projects related to IVHS. We expect this to be one of several ways of attracting bright undergraduate engineering students to enroll in the IVHS Certificate Program.

3) Tuition from core courses—Two of the five core courses are expected to be offered even during the first year of the proposed program; viz., the IVHS Research Seminar, and Socioeconomic Aspects of IVHS. The number of 20 students in each course is a conservative estimate.

4) Tuition from continuing education—The Engineering Summer Conference in IVHS will be offered once, and the Executive Education Seminar on IVHS will be offered twice during the first year. Again, the number of 20 professionals in each session is a conservative estimate.

5) Faculty time—The School of Business Administration and the Urban Planning Program will provide a one-to-one match in support of their faculty members preparing for the Executive Education Seminar on IVHS, and for the core course in Socioeconomic Aspects of IVHS, respectively.

6) Equipment —Three units of the University of Michigan (Office of Vice President for Research, College of Engineering, and UMTRI) are potential sources for support equipment to be used for IVHS core course laboratories, and several co-

sponsors from industry have expressed a willingness to consider contributing IVHS equipment for the educational program.

7) Internships—Based on the result of a survey, it is estimated that 10 internships are likely to be provided to support IVHS students, mostly in the summer, by both the private and public sector co-sponsors each year.

8) Basic Research—Four basic research projects are supported by five co-sponsors, with a total funding of $250,000 in the current year. UM has contributed through waiving indirect costs associated with funding from the three co-sponsors from private industry, as well as a special cost share of $25,000 this year, and $15,000 next year. We expect this to continue during the first year of the proposed program. All the basic research results are expected to help core course development.

9) Subcontractors' Match—As indicated in Appendix 7, Michigan State University and Wayne State University have each committed a match of up to $50,000 for the first year of the proposed program.

In recognition of the educational and basic research values in IVHS, the UM administration, through the Office of the Vice President for Research as well as through the College of Engineering, has already committed over $300,000 in the last two years to support the IVHS Program through cost sharing. Industrial sponsors of IVHS have also recognized the need and the value of IVHS education. The most recent example of this is the recent gift of $10,000 gift from Motorola to the UM College of Engineering for support of IVHS education. Additional corporate gifts of this nature are anticipated.

LONG-RANGE PLANS

PROGRAM EVALUATION

In order for the program to endure for the long term, it must be relevant to IVHS needs and effective in producing professionals with the necessary skills. The best way to ensure this is to conduct a periodic review of the program, evaluating the progress in meeting its objectives.

Annual reviews of the program are planned. At the end of the first year, three University faculty members (who are not associated with the Program) along with two industry representatives will be convened as a Review Panel to evaluate the operation of the program and provide feedback to the Director and University administration on its progress. In subsequent years similar reviews will be conducted, although the makeup of the Panel and procedures may be expected to evolve as experience is gained with the review process.

FACULTY EVALUATION

It is standard practice within the University to conduct annual evaluations of faculty performance for tenure, promotion, and merit salary purposes. Inputs to this process include student evaluations of specific courses. This practice will apply to all UM faculty/staff participating in the IVHS Education Program. In this procedure, evaluations are the responsibility of the faculty or staff member's academic department and chair-person. However, UM explicitly recognizes that cross-disciplinary work requires extra efforts and skills that may interfere with publication of the type and quantity required of university faculty. The administration of the College of Engineering is determined to see that the operational incentives for the faculty and staff in the College will reflect this recognition. This is considered a critical feature for attracting and retaining faculty in this new field.

Specifically, the Education Director will be formally involved in the faculty/staff evaluations. The Director will provide input to the Dean of Engineering (and other school

deans in the case of non-engineering faculty) at the appropriate time on these matters. The input will be sent to the department chair and departmental review committees as well. Because the Dean and College Executive Committee make the final decision within the College of Engineering (and likewise for non-engineering schools), they will resolve any differences of opinion concerning the merits of the IVHS faculty.

INTEGRATION WITH OTHER PROGRAMS

In the previous sections we have attempted to show that the IVHS Education Program is valued as an addition to the educational curriculum at The University of Michigan, and that it is a natural complement to the commercial vehicle research programs underway at the Great Lakes Center. However, there are several other existing (or potential) activities within the Federal Region 5 which the Education Program will also complement.

The Domestic Automotive Industry

IVHS has the potential to exert one of the most revolutionary influences on automotive design in the nearly 100-year history of the industry. The Michigan program is physically located in the heart of the U.S. domestic automotive industry. As the momentum builds and education in IVHS becomes more essential to industry professionals, both the universities and industry will benefit from the close association. The industry will provide a reservoir of demand for IVHS training that can be easily accessed through enrollment on campus, at remote campuses, or through the television network (METN).

Michigan Mobility Center

The Michigan Mobility Center (MMC) is an organization proposed for meeting the growing demand for real-time traffic management services in metropolitan Detroit while also enabling the use of the metropolitan road system for experiments and demonstrations with IVHS technology. Beyond traffic management services, the essential need to which it responds is that of providing an infrastructure for field testing the usefulness of prototype IVHS packages and related systems in the actual urban

traffic environment. Ready access to an IVHS field laboratory is desirable to this State because of the presence of the automotive manufacturing industry in this area.

As currently envisioned, the MMC will incorporate an Operations Division which implements the current infrastructure to provide traffic services to the metropolitan area's road users in real time. A "first phase" of this management role is already in place, having been established twelve years ago when the Michigan Department of Transportation set up the "Surveillance, Control and Driver Information" (SCANDI) system which services the over 30 miles of expressway links in the central portion of the city. The impending plans to refurbish the SCANDI system and relocate its central facility have been put on hold in order to consider how to integrate the IVHS field laboratory mission.

An Experimental Division of the MMC will provide a "test bed" plus support services for the field evaluation and demonstration of IVHS technology. This division would be "used" by government, industry, and academia in the conduct of research, development, and demonstration of IVHS components and systems. The Division would have access to the installed system of sensors, cables, transmitters, and central computers which are in place for the operations functions, plus additional equipment as needed to carry out the exclusively experimental functions.

We expect that as MMC becomes operational by 1992-93, both its Operations Division and its Experimental Division will have a synergistic relationship with the IVHS Education Program. This is the basis on which we anticipate "education derived laboratory and demonstration operational" as the highlight of the proposed IVHS Education Program in 1992-93.

Michigan Truck Safety Commission

Michigan is unique as the only state to have established a Truck Safety Commission. The Commission, established in 1989 by the Michigan Legislature, includes Dr. Gillespie as one of the Commissioners. One of the goals of the Commission is to emphasize safety in the training and re-training of truck drivers. With the impending shortage of drivers, new requirements of the Commercial Driver's License, competitive pressures on the trucking industry and other factors, there is

concern that experienced drivers are being lost only to be replaced by drivers with less training and fewer skills. Although universities do not train drivers directly, the Commission is looking to Michigan universities to aid in development and evaluation of training methods that will elevate the skills of professional drivers. Discussions have been held between the faculty of The University of Michigan, Michigan State University and Oakland Community College to locate the resources required for this task. Driven by the charge from the Commission, it is anticipated that there will be renewed interest within the academic community in the driving function—what are the skills and knowledge required, how can these be instilled in drivers, can driving simulators provide this training, what evaluation methods are effective, etc. The questions raised here overlap those which will be faced as IVHS systems develop, because many IVHS functions are concerned with the information that should be presented to the driver, and the assumption of some of the driving tasks.

Driving Simulator

Within the Federal establishment there is recent interest in sponsoring development of a National Driving Simulator. The Simulator will be a multi-million dollar facility utilizing state-of-the-art technology in moving base hardware and computer generated graphics to achieve the most realistic driving simulator possible for research on the driver-vehicle-highway system. This action is motivated by the recognized need for a better understanding of the driving task. Timely issues related to drugs and alcohol, the aging driver population, and the potential human factors impact of IVHS technologies have brought this need into focus.

There has been broad support from public and private sectors within the State of Michigan for an initiative to attract the facility to this region. For example, the Michigan Transportation Commission and the Michigan Truck Safety Commission have both sent resolutions to the governor and legislature asking support of the initiative. Within The University of Michigan there has been strong interest expressed by faculty from many of the colleges and institutes to participate in research that could be conducted with such a facility. Overall, we believe Michigan will be a strong contender as a site for the facility, should it be funded; and if established here the

existence of a National Driving Simulator will stimulate research that will significantly augment the IVHS Education Program.

Taken together the many new developments described above provide a broad base of science and technology in highway transportation that will complement the IVHS Education Program. The goals of the Great Lakes Center and the IVHS Education Program interface with Michigan Mobility Center and the National Driving Simulator in complementary ways. Figure 3 illustrates some of the interrelationship that will exist between the programs.

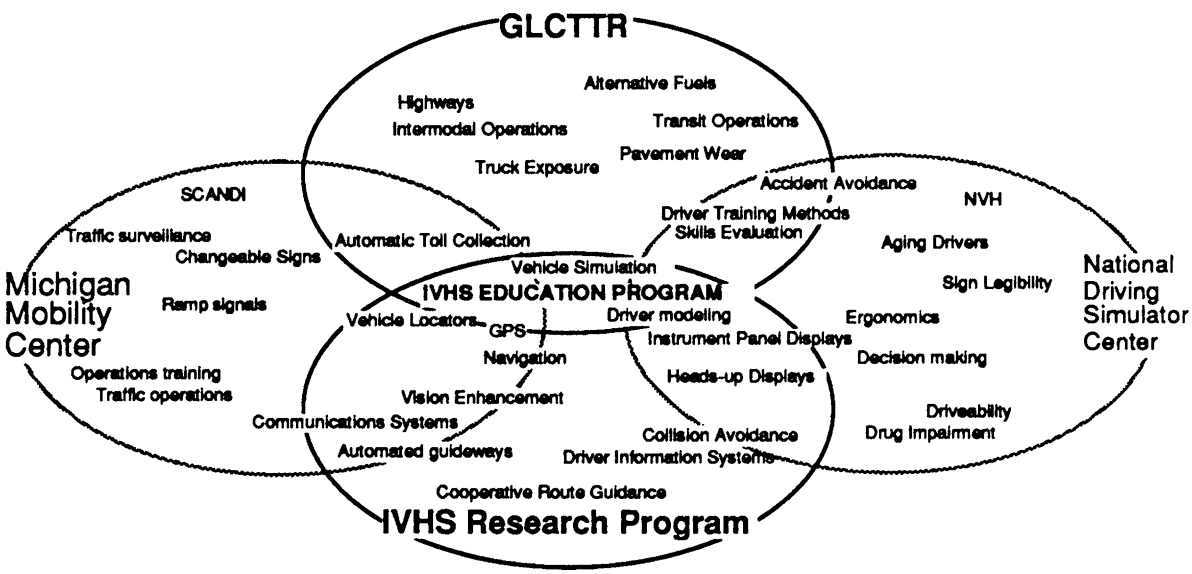

Fig. 3 Relationship of IVHS Education Program to complementary programs

At this time the GLCTTR and IVHS Program are both in place and active. Among these programs there is a commonality of interests in areas such as driver modeling and vehicle simulation. The IVHS Education Program will bring the two progams together formally, while addressing the need for stronger educational programs to augment the research in each area. The Michigan Mobility Center, now under consideration by the Michigan Department of Transportation, is viewed as an important adjunct to each program. With an on-highway testbed new opportunities will open for development of

advanced systems needed by both the commercial vehicle industry and IVHS technologies. With realization of a National Driving Simulator (whether or not in Region 5), new opportunities for research into the driver function and driver behavior will become possible that will impact both the commercial vehicle industry and IVHS systems.

Overall, we are optimistic that infrastructure and facilities will materialize in the near future that will greatly enhance our ability to apply science and technology to solution of the problems threatening our highway transportation system.

Appendix 1: UM IVHS Research Program Sponsors (1988-1989)

Category	Organization
State	Michigan Department of Transportation
Federal	Federal Highway Administration National Highway Traffic Safety Administration Transport Canada (Canadian DOT)
Automotive Industry	General Motors Ford Chrysler Motor Vehicle Manufacturers Association
Automotive Suppliers	Allied Signal/Bendix General Electric Rockwell International Westinghouse
Communications	Motorola
Computer	Digital Equipment Corp.
Materials	DuPont Automotive 3M
Defense	Martin Marietta Robotics Vision Systems
Highway Users	Automobile Association of America (AAA) United Parcels Service/II-Morrow Yellow Freight Systems
Research	Environmental Research Institute of Michigan

Appendix 2: Courses Affected By The IVHS Education Program

UNIVERSITY OF MICHIGAN

College of Engineering

Department of Electrical Engineering & Computer Science

EECS	442	Introduction to Computer Vision
EECS	489	Computer Networks
EECS	492	Introduction to Artificial Intelligence
EECS	497	Analysis and Design Project
EECS	506	Computing System Evaluation
EECS	543	Knowledge-based Computer Vision
EECS	558	Stochastic Control
EECS	582	Advanced Operating Systems
EECS	584	Advanced Database Concepts
EECS	597	Technology Planning and Assessment
EECS	598A	Discrete Event Systems
EECS	598B	Failure Detection in Dynamic Systems

Department of Industrial & Operations Engineering

IOE	315	Stochastic Industrial Processes
IOE	416	Queueing Systems
IOE	436	Human Factors in Computer Systems
IOE	499	Senior Design Project
IOE	503	Social Decision Making
IOE	512	Dynamic Programming
IOE	591	Special Topics in Human Factors
IOE	616	Queueing Theory
IOE	640	Concepts in Mathematical Modeling of Large Scale Systems

Department of Civil Engineering

CE	430	Special Problems in Construction Engineering
CE	470	Transportation Engineering
CE	516	Bridge Structures
CE	551	Rehabilitation of Constructed Facilities
CE	571	Traffic Engineering
CE	572	Transportation Evaluation Methods
CE	574	Public Transportation Systems
CE	576	Disaggregate Transportation Demand Models
CE	577	Traffic Flow I
CE	578	Transportation Planning
CE	579	Special Problems in Transportation

Appendix 2 continued: Courses Affected By The IVHS Education Program

UNIVERSITY OF MICHIGAN continued

College of Engineering continued

Department of Mechanical Engineering & Applied Mechanics

MEAM	484	Robot Applications
MEAM	490	Experimental Research in Mechanical Engineering
MEAM	496	Internal-Combustion Engines I
MEAM	497	Automotive Laboratory
MEAM	498	Automotive Engineering
MEAM	560	Modeling Dynamic Systems
MEAM	594	Internal-Combustion Engines II
MEAM	598	Vehicle Dynamics
MEAM	661	Adaptive Control Systems

College of Architecture & Urban Planning

UP	571	Urban Transportation System Planning
UP	576	Urban Geography
UP	671	Research Seminar in Transportation

School of Law

Law	800	Automobile Accident Insurance & Litigation in the 21st Century

School of Business Administration (Corporate Strategy)

CS	601	Corporate Strategy
CS	617	Industry and Competitive Analysis

College of Literature, Science, and the Arts

Economics

ECON	487	Urban Economics
ECON	573	Cost/Benefit Analysis

Appendix 2 continued: Courses Affected By The IVHS Education Program

MICHIGAN STATE UNIVERSITY

College of Engineering

Department of Civil Engineering

(course module)	Car Following Models
(course module)	Traffic Flow Models
(course module)	Traffic Assignment Models
(course module)	Traffic Control Models: Urban
(course module)	Traffic Control Models: Freeway
(course module)	Street Network Models

WAYNE STATE UNIVERSITY

College of Engineering

Department of Civil Engineering

CE	460	Transportation Engineering
CE	701	Civil Engineering Decision Processes
CE	763	Urban Transportation Planning
CE	765	Mass Transportation System
CE	790	Directed Study
CE	795	Special Topics

Appendix 3: Participants in the Special Topics Course in IVHS

UM FACULTY

Name	Affiliation
K. Chen*	Electrical Engineering & Computer Science
S. Crary	Electrical Engineering & Computer Science
R. Ervin	University of Michigan Transportation Research Institute
P. Fancher	University of Michigan Transportation Research Institute
B. Galler	Electrical Engineering & Computer Science
P. Green	University of Michigan Transportation Research Institute Industrial & Operations Engineering
Y. Koren*	Mechanical Engineering & Applied Mechanics
S. Lafortune	Electrical Engineering & Computer Science
R. Marans	Urban, Technological, & Environmental Planning Institue for Social Research
N. McClamroch	Electrical Engineering & Computer Science
J. Meyer	Electrical Engineering & Computer Science
A. Nowak*	Civil Engineering
J. Nystuen	Architecture & Urban Planning
A. Prakash	Electrical Engineering & Computer Science
W. Ribbens	Electrical Engineering & Computer Science
M. Ristenbatt	Electrical Engineering & Computer Science
G. Rizzoni	Electrical Engineering & Computer Science
R. Smith*	Industrial & Operations Engineering
F. Stafford	Economics
F. Streff	University of Michigan Transportation Research Institute
K. Syverud	Law
T. Weymouth	Electrical Engineering & Computer Science

* Departmental coordinators

CONSULTANTS

Name	Affiliation
M. Bair	Environmental Research Institute of Michigan
R. Rothery	University of Texas at Austin

Appendix 3 continued: Participants in the Special Topics Course in IVHS

GUEST SPEAKERS

Name	Affiliation
P. Acito	3M
D. Florence	Chrysler
N. Rees	Transport and Road Research Laboratory (UK)
J. Rillings	General Motors
R. Rothery	University of Texas at Austin
K. Russam	Transport and Road Research Laboratory (UK)
B. Spreitzer	General Motors

STUDENTS

Name	Affiliation
H. Abi-Nassif	Civil Engineering
Z. Bareket	Mechanical Engineering & Applied Mechanics
S. Chung	Electrical Engineering & Computer Science
K. Deboo	Electrical Engineering & Computer Science
T. Himmelspach*	Electrical Engineering & Computer Science
D. Kaufman	Industrial & Operations Engineering
J. Lee*	Industrial & Operations Engineering
L. Mellis*	Electrical Engineering & Computer Science
J. Nackach	Mechanical Engineering & Applied Mechanics
M. Navvab	Urban, Technological, & Environmental Planning
T. Pilutti	Mechanical Engineering & Applied Mechanics
U. Raschke	Mechanical Engineering & Applied Mechanics
T. Reed	Urban, Technological, & Environmental Planning
G. Shahin	Electrical Engineering & Computer Science
J. Simon*	Electrical Engineering & Computer Science
B. Stone	Urban, Technological, & Environmental Planning
J. Yedid	Mechanical Engineering & Applied Mechanics
Y. Zhao	Electrical Engineering & Computer Science

*Sponsored by a Michigan based industry

Appendix 3 continued: Participants in the Special Topics Course in IVHS

VISITORS

Name	Affiliation
K. Abraham	Urban, Technological, & Environmental Planning
D. Anderson	Electrical Engineering & Computer Science
R. Arbanas	Electrical Engineering & Computer Science
A. Boneh	Industrial & Operations Engineering
S. Devlin	Ford
R. Doi	Motorola
K. Gilbert	Environmental Research Institute of Michigan
B. Heinrich	Chrysler
E. Johnson	Chrysler
A. Khurana	School of Business
C. Kolenda	Electronic Data Systems/General Motors
A. Kirson	Motorola
R. Lin	Mechanical Engineering & Applied Mechanics
C. Martell	Ford
L. Oberdier	General Motors
J. Queen	Ford
A. Rubin	Electrical Engineering & Computer Science
M. Sheldrick	Automotive Electronics Journal
D. Teneketzis	Electrical Engineering & Computer Science
W. Toperzer	Motorola
P. Waller	UM Transportation Research Institute

COMPUTER CONFERENCING FACILITATORS

Name	Affiliation
J. Haswell	Computing Center
I. Porat	Urban, Technological, & Environmental Planning

Appendix 4: Potential Thesis/Dissertation Topics in IVHS

ENGINEERING

Kan Chen (Electrical Engineering & Computer Science)

- Decision Theoretic Approach to IVHS Communications Systems
- Pareto Optimality in Traffic Control
- Gaming Simulation of IVHS Globalization
- The Value of Information in IVHS

Selden Crary (Electrical Engineering & Computer Science)

- A Fiber-Optic Serial Bus-Organized Network
- Optimal Design of Experiments for Traffic Modeling and Simulation
- Phase Transitions and Criticality in Highway Traffic Modeling
- A Yaw-Rate Microsensor

Bernard Galler (Electrical Engineering & Computer Science)

- Data Integrity in Large Distributed Systems with Nodes Constantly Leaving and Returning to the System
- Real-Time Management of Distributed Databases in a Cellular Model
- Real-Time Coordination of Process Execution in a Cellular Model
- Performance Evaluation in Large Distributed Systems with Nodes Constantly Leaving and Returning to the System

Yoram Koren (Mechanical Engineering & Applied Mechanics)

- Decision Support System for Safe Driving
- Real-Time Defensive Driving Rule-Based System
- Real-Time Collision Avoidance System
- Integration of Decision Support and Defensive Driving Systems with Collision Avoidance

Stephane Lafortune (Electrical Engineering & Computer Science)

- Distributed Information and Distributed Control: Case Studies from IVHS
- Supervisory Control of an IVHS
- Uncontrollability Issues in Controlled IVHS
- Efficient Distributed Simulation of IVHS
- Distributed Database Design for an IVHS

Andrzej Nowak (Civil Engineering)

- Load Spectra on Highway Bridges: Measurements of Truck Weights, Configurations, Static and Dynamic Loads
- Sensors for Monitoring Highway Infrastructure Performance
- Signal Processing Systems for Infrastructure Monitoring
- Overweight Truck Systems Using IVHS Technologies

Appendix 4 continued: Potential Thesis/Dissertation Topics in IVHS

ENGINEERING

Giorgio Rizzoni (Electrical Engineering & Computer Science)

- Failure Detection and Isolation in Integrated Vehicle Control Systems for Improved Safety and Reliability
- Improved Performance of Radar Braking for Passenger Vehicle Applications through Advanced Signal Processing
- Improved Land Navigation through Optimum Integration of Radio and Dead-Reckoning Methods with Digital Geography

Robert L. Smith (Industrial & Operations Engineering)

- Optimal Routing in a Network User Stochastic Control with Applications to Traffic Networks
- Optimal Multicommodity Flows under Partial Observability and Control
- Planning Horizons in the Presence of Surprise with Applications to Traffic Incidents

NON-ENGINEERING

Robert Marans (Urban, Technological, & Environmental Planning)

- Regional Differences in Perceptions of Travel Distance
- Alternative Scenarios for Development Patterns for Metropolitan Areas
- Alternative Scenarios for Development Patterns for Land Adjacent to Highways and Intersections
- Socioeconomic and Psychological Determinants of Acceptance and No Rejection of New Technologies
- Applicability of IVHS Technology to Office Building Design

John Nystuen (Urban Planning)

- Institutional Requirements, Social Value and Equity Issues by Stages of IVHS Technology Adoptions
- Navigational Aid Effects on Learning Rates of Beginning Drivers in Fleet Operations
- Conditions for Pioneer Use, Mass Use and Mandatory Use of Navigational Aid and Automatic Vehicle Locator Technologies
- Potential User Response to Improvements in Mobility due to Congestion Relief through IVHS Applications
- Changes in Business and Residential Activities and Locations in Response to IVHS Applications
- Parking Strategies and Behavior under Improved Information about Parking Opportunities in Central Business Districts and Hospital Districts

Frank Stafford (Economics)

- Highway Network Investments & Their Impact on Residential & Work Location Choices
- Systemwide Toll Structures and Optimal Utilization of Urban Roads
- Travel Time Patterns of Two-Earner Families in Detroit's Smart Freeway Corridor
- Financing Highway and Public Transit in Urban Areas

Kent Syverud (Law)

- Automobile Accident Litigation in the 21st Century
- Liability Risk management for New Transportation Technology

Automotive Engineering

Intelligent Vehicle-Highway Systems

July 23-25, 1990

Course Number: 9023 C.E.U. Credits: 2.0 Fee: $575

Intelligent Vehicle-Highway Systems (IVHS) is the next generation of smart cars and smart highways attracting national attention due to personal and social concerns of urban congestion, highway safety, and international competition. Professionals in the automotive and electronics industries, and in the transportation departments at all governmental levels, will find it useful to have an understanding of the technical and institutional issues underlying IVHS.

Objectives

- to present an overview of IVHS development
- to survey both technical and institutional issues in IVHS
- to provide some direct observations of IVHS technologies

Content

Introduction
- Overview of highway travel trends
- Overview of U.S. and international IVHS programs

Survey of Current Technologies
- Automatic vehicle identification
- Navigation systems
- Traffic surveillance and control
- Driver information & communications systems
- Collision warning systems
- Diagnostic systems

Survey of Selected Research Issues
- Traffic modeling & simulation
- Human factors
- System architecture
- Advanced vehicle control
- Socioeconomic aspects

Demonstration and Field Trip
- In-vehicle technologies
- Traffic control center technologies

Staff

Kan Chen, Sc.D., Co-Chair
(313) 764-4332, FAX (313) 763-1503
E-mail: Kan_Chen@ub.cc.umich.edu
Professor, Department of Electrical Engineering & Computer Science, and IVHS Co-Director

Robert D. Ervin, Co-Chair
(313) 936-1066
E-mail: Bob_Ervin@um.cc.umich.edu
Research Scientist, The University of Michigan Transportation Research Institute, and IVHS Co-Director

Guest speakers from The University of Michigan faculty and staff, and from participating industry and government organizations

Format and Materials

The course will include lectures, demonstrations, and discussions. Workshops will include hands-on experience with traffic simulation, as well as a visit to a human factors laboratory. A field trip will include visits to private and public research facilities and installations. A set of course notes will be provided.

Prerequisites

Bachelor's degree in either engineering or a physical science, or the equivalent experience. Minimum mathematical tools will be used in the presentations.

Thomas D. Gillespie

Research Scientist
University of Michigan Transportation Research Institute

Ph.D., Pennsylvania State University, 1970

RESEARCH EXPERIENCE

Dr. Gillespie's professional career has been concerned primarily with advanced engineering and research in the automotive and highway areas. From the beginning, his career spanned the breadth of these areas, ranging from applied research during the 1960's at the Pennsylvania State University in pavement friction test methods, to responsibilities as a Project Officer with the U.S. Army Corps of Engineers directing engineering and service tests on military construction equipment. In 1973 he joined the Ford Motor Company serving as a group leader in development testing of new heavy truck products. He joined the University of Michigan in 1976, where his work on road roughness and vehicle dynamic interactions led to direction of the international experiment from which a standard – the International Roughness Index – was developed for measurement of road roughness worldwide. In 1985 he received the L. Ray Buckendale Award from the Society of Automotive Engineers. During the 1987 academic year Dr. Gillespie took leave from the University to serve on the White House staff as a Senior Policy Analyst in the Office of Science and Technology Policy, working with Dr. William R. Graham, Science Adviser to President Reagan. He still serves as a consultant to that office working with Dr. D. Allan Bromley, Assistant to the President for Science and Technology.

CURRENT PROJECTS

"The Great Lakes Center for Truck Transportation Research," Center Director, multi-disciplinary research, $2,000,000 per year over 4 years, started September 1988.

"Effects of Heavy Vehicle Characteristics on Pavement Response and Performance," Project Director, $400,000 over 3 years, started September 1988.

SELECTED PUBLICATIONS

"Comparison of the Turning and Braking Performance of a U.S. and a European Heavy Vehicle," Proceedings of the 1988 FISITA Congress, Dearborn, MI, September 25-29, 1988.

"Developments in Road Roughness Measurement and Calibration Procedures," invited paper, 13th ARRB/5h REAA Conference, Adelaide, Australia, August 1986.

Measuring Road Roughness and Its Effects on User Cost and Comfort, (co-editor), American Society for Testing and Materials, Special Technical Publication 884, 1985.

HONORS

SAE Fellow, Office of Science and Technology Policy
L. Ray Buckendale Award

Kan Chen

Professor
Department of Electrical Engineering & Computer Science
College of Engineering, University of Michigan

Sc.D., Massachusetts Institute of Technology, 1954

RESEARCH EXPERIENCE

Directed 7 research projects funded by NSF in the areas of technology planning and assessment, including 3 system theory projects and 4 cross-disciplinary projects

Integrative corporate planning, combining technology with strategic planning

Value-Oriented Social Decision Analysis (VOSDA) and negotiation research

CURRENT PROJECTS

Intelligent Vehicle-Highway Systems Research Program (multiple sponsors)

Causes and Consequences of the Internationalization of U.S. Manufacturing (sponsored by the National Research Council's Manufacturing Studies Board)

SELECTED PUBLICATIONS

Interdisciplinary Planning: A Perspective for the Future, (co-edited with M. J. Dluhy), Center for Urban Policy Research, Rutgers University, 1986.

"Employment and Organization Aspects of High Technology: A Case Study of Machine Vision," (with F. P. Stafford), Human Systems Management, Vol. 7, 1988, pp. 233-242.

"Integrative Analytical Assessment: A Hybrid Method for Facilitating Negotiation," (with S. E. Underwood), Negotiation Journal, Vol. 4, No. 2, 1988, pp. 183-197.

"Toward Motoring Smart," (with R. D. Ervin), Issues in Science and Technology, Winter 1988-89, Vol. 5, No. 2, pp. 92-97.

MANAGEMENT AND INDUSTRIAL EXPERIENCE

Director, Ph.D. Program in Urban, Technological, and Environmental Planning, University of Michigan, 1980-87

Program Director, Systems Science, SRI International, 1966-70

Manager of System Technology R&D, Westinghouse Electric Corp., 1960-65

HONORS

Paul G. Goebel Professor of Advanced Technology, University of Michigan, 1971-72
Fellow of IEEE and AAAS

Robert D. Ervin

Research Scientist
University of Michigan Transportation Research Institute
University of Michigan

M.S., Engineering, Cornell University, 1968

RESEARCH EXPERIENCE

Mr. Ervin's research at UMTRI has focused upon the mechanical performance of motor vehicles, from motorcycles to heavy-duty truck combinations. This work has dealt with the investigation of the response of vehicles to steering and braking inputs, with particular interest in the conditions leading to loss of control. Mr. Ervin has directed the design of various apparatuses and test methodologies for use in measuring vehicle performance. Also, he has directed numerous studies employing computerized simulations to examine vehicle behavior and to evaluate its sensitivity to design and operating variables. Since 1976, the major emphasis of this research has been in the area of heavy commercial vehicles.

CURRENT RESEARCH

Intelligent Vehicle-Highway Systems Research Program

SELECTED PUBLICATIONS

"The Influence of Size and Weight Variables on the Roll Stability of Heavy-Duty Trucks," SAE Paper No. 831163, August 1983.

"Influence of Specific Geometric Features on Truck Operations and Safety at Interchanges," (co-author), Final Report, Contract No. DTFH61-82-C-0054, University of Michigan Transportation Research Institute, University of Michigan, August 1985.

"The Influence of Braking Efficiency on the Probability of Wheel Lockup," (co-author), SAE Paper No. 870334, February 1987.

"Truck Control Problems Posed by the Design of Highway Ramps," (co-author), SAE Paper No. 870071, February 1987.

"Toward Motoring Smart," (co-author), Issues in Science and Technology, Winter 1988-89, Vol. 5, No. 2, pp. 92-97.

MANAGEMENT EXPERIENCE

Acting Director, University of Michigan Transportation Research Institute, 1986-89

Bernard A. Galler

Professor
Department of Electrical Engineering & Computer Science
College of Engineering
University of Michigan

Ph.D., Mathematics, University of Chicago, 1955

RESEARCH EXPERIENCE

Pioneering work on mainframe computer operating systems for the University of Michigan computing center.

Directed major word processing software projects at the University of Michigan in conjunction with IBM.

CURRENT RESEARCH

Intelligent Vehicle-Highway Systems Research Program: System Architecture

Very Large Scale Distributed Systems

SELECTED PUBLICATIONS

"Thoughts on Software Engineering," Proceedings, 112th International Conference on Software Engineering, May 1989, Pittsburgh, PA, p. 97.

"The History of the Computer, Part One," Humanities Education, Vol. IV, No. 1, 1987, pp. 23-27.

"The Influence of the United States and Japan on Knowledge Systems of the Future," Proceedings of IEEE International Conference on Systems, Man, and Cybernetics, p. 1024, Atlanta, GA, Oct. 1986.

"A View of Artificial Intelligence," New Generation Computing, Vol. 3, No. 3, 1985, pp. 235-236.

MANAGEMENT AND INDUSTRIAL EXPERIENCE

Chairman, CSNET Executive Committee, 1988-90.
Member, Board of Directors, Charles Babbage Foundation, 1982-1990.
Category Editor, ACM Computing Reviews, 1982-1990.
Founding Editor-in-Chief, Annals of the History of Computing, AFIPS Press, 1978-87.

HONORS

AFIPS Distinguished Service Award, 1984
ACM Distinguished Service Award, 1980
IBM Triangle Fellow in the History of Technology, 1980

Paul A. Green

Associate Research Scientist

UM Transportation Research Institute
University of Michigan

Adjunct Assistant Professor
Dept. of Industrial & Operations Engineering
College of Engineering
University of Michigan

Ph.D., Industrial & Operations Engineering / Psychology, University of Michigan, 1979

RESEARCH EXPERIENCE

Dr. Green has been working on human factors problems relating to automobile instrument panel design for over 15 years and user interfaces to computer systems for over 10. His studies have concerned the design of symbols, driver understanding of displays, the legibility of speedometers, driver preferences for controls, and so forth.

CURRENT PROJECTS

"Automobile Driver Controls - Human Factors Considerations," $100,000, Chrysler, started September, 1988, 9 months.

"Human Factors and Interface Design," started 1986, annual gift, NCR, about $20,000/year.

SELECTED PUBLICATIONS

"Human Factors Research on Automobile Secondary Controls: A Literature Review," (with C. Turner), (technical report UMTRI-87-20), 1987.

"Driver Preferences for Secondary Controls," (with D. Ottens, J. Kerst, S. Goldstein, and S. Adams), (technical report UMTRI-87-49), 1987.

"Legibility of Text on Instrument Panels: A Literature Review," (with S. Goldstein, K. Zeltner, and S. Adams), (technical report UMTRI-88-34), 1988.

"How Should Instrument Panel Legibility be Tested?" (with T. Bos and J. Kerst), (technical report UMTRI-88-35), 1988.

Boreczky, J., "Effects of Contrast, Illumination, and Color on the Legibility of Numeric Speedometers," (with J. Boreczky, T. Bos, and J. Kerst), (technical report UMTRI-88-36), 1988.

"Human Factors and Gauge Design: A Literature Review," (technical report UMTRI-88-37), 1988.

Stuart L. Hart

Assistant Professor
Corporate Strategy
School of Business Administration
University of Michigan

Ph.D., University of Michigan, 1983

RESEARCH EXPERIENCE

Dr. Hart has directed or been involved in a number of large-scale research projects over the past ten years, including an NSF funded project exploring industry-university cooperation as a means for economic development. He also co-directed an NSF-sponsored project examining ways to improve the quality and utility of scientific and technical information in environmental impact assessment. At present, he is co-principal investigator on a study of business firms in the "Automation Alley" area of southeastern Michigan, focusing on issues of new firm creation and economic development.

His interdisciplinary training emphasizing socioeconomic as well as technological dimensions, combined with his current position in the area of strategic management make him well qualified for work on this project.

CURRENT PROJECTS

"Oakland County Business Survey," five year panel study of firms, up to $125,000.

"Ford Leadership Education and Development Project," a multi-year training and research project geared toward organizational change.

SELECTED PUBLICATIONS

"A contingency approach to firm location: The influence of industry sector and level of technology," (with D. Denison and D. Henderson), Policy Studies Journal, 1989.

"The creation of new technology-based organizations: A system dynamics model," (with D. Denison), Policy Studies Review, 6, 1987, pp. 512-528.

"Revival in the rustbelt: Tracking the evolution of an urban industrial region," (with D. Denison), Ann Arbor: Institute for Social Research, 1987.

"An eight step approach to strategic problem solving," (with G. Enk), Human Systems Management, 5, 1985, pp. 245-258.

Improving impact assessment, (co-edited with G. Enk and W. Hornick), Boulder: Westview Press, 1984.

Robert W. Marans

Director
Urban Environmental Research Program
Institute for Social Research
University of Michigan

Professor

College of Architecture & Urban Planning
University of Michigan

Director
Ph.D. Program in Urban, Technological,
& Environmental Planning
University of Michigan

Ph.D., Urban & Regional Planning, University of Michigan, 1971

RESEARCH EXPERIENCE

Survey research
Evaluation research
Environmental and behavioral research

SELECTED PUBLICATIONS

Methods in Environmental and Behavioral Research, (co-edited with R. Bechtel and W. Michelson), New York: Van Nostrand Reinhold, 1987.

"Developments in Research Design, Data Collection, and Analysis: Quantitative," (with S. Ahrentzen), in Advances in Environment, Behavior, and Design, Vol. 1, G. Moore and E. Zube (Editors), Plenum Press, 1987.

"Generative Evaluation Using Quantitative Methods: A Case Study," in Advances in POE: Theory and Methods, W. Preiser (Editor), Plenum Press, forthcoming.

Environmental Simulation: Research and Policy Issues, (co-edited with D. Stokols), New York: Plenum Press, forthcoming.

John D. Nysteun

Professor
Geography & Urban Planning
College of Architecture & Urban Planning, The University of Michigan

Ph.D., University of Washington, 1959.

RESEARCH EXPERIENCE

Professor Nystuen has been on the faculty of the University of Michigan since 1959. He has had a long association with transportation planning. He is currently Director of the Certificate of Transportation Studies, and interdisciplinary program providing training in transportation planning to graduate students pursuing other post baccalaureate degrees. He has conducted research on: urban travel behavior, especially related to customer travel behavior and the location of retail facilities; on environmental conditions affecting bus maintenance and operations and; on spatial theory in the context of abstract and analytical geography. He teaches Transportation Planning, Urban Geography and Quantitative Methods for Urban Planners. He has been the chairman of 9 doctoral dissertations on transportation related topics and 16 doctoral dissertations on urban land use topics.

The link between the technology vehicles and highways and the institutional context of urban travel and urban land use patterns is travel behavior. The value of any changes in vehicle or highway technology will be realized primarily through changes in travel behavior and adjustments in the operations and arrangements of urban institutions. Research on travel behavior is therefore a primary component of the IVHS research strategy. Professor Nystuen has extensive experience in analysis of both urban travel behavior and urban land use development.

SELECTED PUBLICATIONS

"A Cartographic Perspective on the Security of an Urban Water Supply Network," (with S. Arlinghaus), Perspectives in Biology and Medicine, vol. 32, no. 1, University of Chicago Press, Autumn, 1988, pp. 91-102.

"Terrain Effects of Bus Maintenance and Performance," (with S. Arlinghaus), Transit Bus Maintenance, Transportation Research Record #1440, National Research Council, Washington, D. C., 1987, 00. 45-51.

"Climatic Effects on Bus Durability," (with S. Arlinghaus), Transportation Research Record #1066, National Research Council, Washington, D.C., 1986, pp. 29-39.

"De Facto Redlining: A Geographic View," (with A. C. Kantor), Economic Geography, vol. 58, no. 4, 1982, pp. 309-328.

Human Geography: Spatial Design in World Society, (with John Kolars), New York: McGraw-Hill, 1974, 344 pages.

"A Theory and Simulation of Interurban Travel," Quantitative Geography Part I: Economic and Cultural Topics, Studies in Geography, no. 13, Northwestern University Press, Evanston, Illinois, 1967, pp. 54-83.

Marlin P. Ristenbatt

Research Scientist and Lecturer
Department of Electrical Engineering & Computer Science
College of Engineering, The University of Michigan

Ph.D., Electrical Engineering, University of Michigan, 1961

RESEARCH EXPERIENCE

Devised and evaluated new digital communication, spread spectrum, and position fixing systems and techniques, using concepts and models of communication theory, decision theory, and estimation theory, along with simulation and laboratory experimentation. Was one of earliest investigators of pseudo random sequences; analyzed the effect of ignition noise on narrowband FM mobile communication systems; worked directly with the Air Force Chief Scientist in selecting and developing an antijam communication system; devised and prototyped a new trapped miner communication system; originated a comprehensive Motorist Information System that included position location, and worked with the Highway Research Board (in 1972/73); was basic architect for and edge-of-technology Police Command and Control system that includes Computer Assisted Dispatch, Mobile Data Terminals, E911, and Automatic Vehicle Location; originated a methodology for evaluating the survivability of communication networks for the Air Force.

The extensive experience in evaluating, developing, and teaching communication systems applies directly to communication and network aspects of IVHS. Any first generation Driver Information System (DIS) will use packet radio transmission concepts, with either area broadcast or roadside transmitter concepts. The experience with specific DIS concepts is valuable in this project; the experience in devising and developing the Detroit Command and Control system provided not only pertinent technical experience, but also the range of political and bureaucratic factors that must be dealt with.

CURRENT PROJECTS

"Methodology for Evaluating the Survivability of Communication Networks," Air Force Rome Air Development, Griffiss AFB, $250,000, from 1986 to 1990.

SELECTED PUBLICATIONS

"Methodology for Network Communication Vulnerability Analysis," 1988 IEEE Military Communications Conference, Oct. 1988.

"A New Post Disaster Mine Communication System," (with E. K. Holland-Moritz and K. Metzger), IEEE Transactions on Industry Applications (ISSN 0093-9994) March/April, Vol. 24, No. 2, 1988.

"A Comprehensive Motorist Communication System," International Conference on Communications" (72-CHO-622-1-COM), Philadelphia, PA., June, 1972.

"Alternatives in Digital Communications," (Invited Paper), IEEE Proceedings, Vol. 61, June 1973.

"Performance Criteria of Spread Spectrum Communications," (with J. L. Daws), IEEE Transactions on Communications, Vol. COM-25, No. 8.

Giorgio Rizzoni

Assistant Research Scientist
Department of Electrical Engineering & Computer Science
College of Engineering, The University of Michigan

Ph.D., University of Michigan, 1986

RESEARCH EXPERIENCE

Giorgio Rizzoni has been Assistant Director of the Vehicular Electronics Laboratory at The University of Michigan since January, 1986.. He also holds an adjunct faculty position with the EECS Department, and has been responsible for undergraduate course development. His most recent research interests are in the area of failure detection and isolation in dynamic systems -especially regarding automotive applications. Dr. Rizzoni has been actively involved in research in the application of signal processing and control theory to vehicle systems since 1982. He has published over fifteen technical papers in the areas of failure diagnosis in passenger and commercial vehicles, and engine modelling and control. He is currently Associate Editor (Vehicular Electronics) of the IEEE Transactions on Vehicular Technology, and has been session chairman and organizer for the two most recent International Symposia on Automotive Technology and Automation. Dr. Rizzoni is a member of Eta Kappa Nu, Tau Beta Pi, the IEEE, and the SAE.

The ability to detect incipiently failures in electronically controlled vehicle subsystems will constitute an important component in assuring the ultimate reliability of an IVHS. The research relevant to the IVHS project in this area includes the design of fault tolerant hardware and software for improved reliability, and the inclusion of diagnosability constraints in the design of IVHS functions. Dr. Rizzoni's research experience encompasses these areas.

CURRENT PROJECTS

"Failure Detection and Isolation," Ford Motor Company, $ 60,000 renewal for 1989.
"A Concept Diagnostic Instrument for Passenger Vehicles," IBM, $ 130,000 (starts Feb.,1989).

SELECTED PUBLICATIONS

"Real Time Detection Filters for Onboard Diagnosis of Engine Failures," (with R. Hampo), SAE International Congress and Exposition, February, 1989.

"Application of Failure Detection Filters to the Diagnosis of Sensor and Actuator Failures in Electronically Controlled Engines," (with P.S. Min), Proceedings of the IEEE Workshop on Automotive Applications of Electronics, Dearborn, MI, October 19, 1988.

"Fault Isolation and Analysis for IC Engine Onboard Diagnostics," (with J. G. Pipe, R. N. Riggins, and M. P. Van Oyen), Proceedings of the IEEE Vehicular Technology Conference, Philadelphia, PA, June 1988.

"A Passenger Vehicle Onboard Computer System for Engine Fault Diagnosis, Performance Measurement and Control," Proceedings of the IEEE Vehicular Technology Conference, pp. 450-457, Tampa, FL, June 1987.

Robert L. Smith

Professor
Department of Industrial & Operations Engineering
College of Engineering
University of Michigan

Ph.D., The University of California, Berkeley, 1971

RESEARCH EXPERIENCE

Research on mathematical models and methods for the efficient operation of man/machine systems, particularly the dynamic aspects of optimal control. Application areas include routing and capacity planning in telecommunication networks, vehicle replacement strategies, and the design and control of automated guided vehicle systems (AGVS). Currently project director on a four year NSF Grant under the Systems Theory and Operations Research Program. Research career started as an NSF Fellow following completion of the Ph.D. degree.

The insights gained from the research above is valuable and in some cases directly transferable to the control of vehicles through driver information. The problem calls upon similar types of modeling skills and analysis methods as applied in telecommunications and manufacturing floor environments.

CURRENT PROJECTS

"Infinite Horizon Optimization," National Science Foundation, $148,000, 1984-89.

"Manufacturing Replacement Economy Studies," General Motors, $150,000, 1986-89.

SELECTED PUBLICATIONS

"Hit and Run Algorithms for the Identification of Nonredundant Constraints," (co-authored), Mathematical Programming 37, 1987, pp. 184-207.

"Optimal Capacity Expansion Over an Infinite Horizon," (co-authored), Management Science, Vol. 31, No. 12, 1986, pp. 1523-1532

"Turnpike Results for Single Location Capacity Expansion," Management Science, Vol. 25, May 1979.

"Deferral Strategies for a Dynamic Communications Network," Networks, Vol. 9, No. 1, 1979.

Frank P. Stafford

Professor
Department of Economics
College of Literature, Science, & the Arts
University of Michigan

Faculty Associate

Survey Research Center
University of Michigan

Ph.D., Graduate School of Business, University of Chicago, 1968

RESEARCH EXPERIENCE

Published research on household behavior (labor supply, commuting, fertility, skill investment) as well as cost benefit analysis, survey design and econometric analysis, organization of work in firms, and technology based firms.

CURRENT PROJECTS

Quantitative assessment of international comparisons of labor market adjustment to demand and supply shifts with emphasis on those shifts arising from trade and technology. The project has merged time series data on industry output, imports, exports and prices with micro panel data from the Panel Study of Income Dynamics. The research will develop an econometric model of excess supply and excess demand regimes. It is then planned to investigate the influence of these regimes on wages and unemployment. This project is funded, in part, through the U.S. Department of Labor. A second project will extend this effort through a merger of data from the U.S. and West Germany to test whether or not the labor market adjustment process differs across the two countries.

The study of technological changes and innovation in the machine vision industry and the role of job design on coordination of workflows. My current research interests include evaluation of programs in both the public and private sector and competition among firms for critical labor inputs. This project is funded, in part, through the Program in American Institutions at the University of Michigan.

SELECTED PUBLICATIONS

"Automobile Manufacturing in the Great Lakes Region and Japan," Chapter in Fiscal and Economic Structure of Michigan, Harvey E. Brazer, editor, University of Michigan Press, 1981.

"Economic Aspects of Advanced Manufacturing Systems," in Research Program for the Industrial Technology Institute, University of Michigan, 1982.

"The Employment Effects of High Technology: A Case Study of Machine Vision," (with K. Chen), Research Report Series 86-19, May 1986, National Commission for Employment Policy, Washington, D.C.

"Employment and Organizational Aspects of High-Technology: A Case Study of Machine Vision," (with Kan Chen), Human Systems Management, (North-Holland), 1988.

Kent D. Syverud

Assistant Professor
School of Law
University of Michigan

J.D., University of Michigan Law School, Magna Cum Laude, 1981

RESEARCH EXPERIENCE

Kent D. Syverud's present teaching and research interests include Insurance, Settlement, Civil Procedure, and Complex Litigation. Past experience includes being an Associate for Wilmer, Cutler & Pickering, a Law Clerk for the Honorable Sandra Day O'Connor, Supreme Court of the United States, and a Law Clerk for the Honorable Louis F. Oberdorfer, United States District Court for the District of Columbia.

Mr. Syverud's experiences with insurance, litigation and the Supreme Court will be very relevant to our investigation on the legal liability issue of IVHS of the future.

SELECTED PUBLICATIONS

"Contribution and Antitrust Policy," 78 Michigan Law Review 890, 1980.

Book Notice, 78 Michigan Law Review 805, 1980.

A. Galip Ulsoy

Associate Professor
Department of Mechanical Engineering & Applied Mechanics
College of Engineering, The University of Michigan

Ph.D., Mechanical Engineering, University of California at Berkeley, 1979

RESEARCH EXPERIENCE

Galip Ulsoy is interested in the dynamic modeling, analysis, and control of mechanical systems; particularly manufacturing systems. He has received several professional honors and awards including the 1979 Wood Award from the Forest Products Research Society and a Society of Manufacturing Engineers' 1986 Outstanding Young Manufacturing Engineer Award. From 1984-86 he was the Director of the industrially supported Consortium on Diagnostic Sensing and Control for Metal Cutting. He has carried out numerous research projects funded by government and industry, and served as a consultant to industry. Galip Ulsoy was the Project Director for an NSF Grant on "Variable Gain Adaptive Control Systems for Machine Tools" during 1981-1984, and is currently Project Director for an NSF Grant on "Process Modeling for Wear and Breakage Detection in Metal Cutting".

Galip Ulsoy has considerable research experience in the application of model based failure detection and diagnostics to problems of tool wear and breakage in metal cutting. He also has conducted research in advanced control strategies for manufacturing processes, and served as a consultant to the auto industry on problems of vibrations and controls.

CURRENT PROJECTS

"Program in Diagnostic Sensing and Control for Metal Cutting," Industrial Consortium, approximate annual budget of $50,000. (Project Director: S. M. Wu).

"Process Modeling for Wear and Breakage Detection in Metal Cutting," NSF, $193,337 over three years. (Co-Principal Investigator with Yoram Koren, started September 1986).

"Modeling Methodologies for Machining," Ford Motor Company, $150,000 over three years. (Co-Principal Investigator with Jeff Stein, started July 1987).

SELECTED PUBLICATIONS

"An Adaptive Observer for On-Line Tool Wear Estimation in Turning - Part I: Theory, Part II: Results," (with K. Danai), Mechanical Systems and Signal Processing, Vol. 1, No. 2, April 1987, pp. 211-240.

"Sensitivity Reduction by State Derivative Feedback," (with A. Haraldsdottir and P. T. Kabamba), ASME Journal of Dynamic Systems, Measurement, and Control, Vol. 110, No. 1, March 1988, pp. 84-93.

"Model Reference Adaptive Force Control in Milling," (with L. K. Lauderbaugh), ASME Journal of Engineering for Industry (in press).

Microcomputer Applications in Manufacturing, (with W. R. DeVries), John Wiley and Sons, New York, 1989.

Steven E. Underwood

Assistant Research Scientist
Department of Electrical Engineering and Computer Science
College of Engineering
University of Michigan

Ph.D., Sociotechnological Systems Planning, University of Michigan, 1989

RESEARCH EXPERIENCE

Dr. Underwood has 7 years or research and consulting experience in sociotechnological systems planning. His research has ranged from developing methods for resolving disputes public disputes on technology policy to developing computerized transportation simulations. Dr. Underwood has most recently completed a technology forecast of intelligent vehicle-highway systems (IVHS).

CURRENT PROJECTS

Review of sensors in IVHS.

Implementing integrated traffic simulation of IVHS.

SELECTED PUBLICATIONS

"The future of intelligent vehicle-highway systems: A forecast of markets and sociotechnical determinants," (Report No. IVHS-89-1), Ann Arbor, MI: Program in Intelligent Vehicle-Highway Systems, University of Michigan, 1989.

"Structured participation in technology assessment: The policy exercise," in Simulation gaming: On the improvement of competence in dealing with complexity, uncertainty, and value conflicts, J. Klabbers, et al., Oxford: Pergamon Press, 1989.

Snehamay Khasnabis

Director
Urban Transportation Institute
Wayne State University

Professor
Department of Civil Engineering
Wayne State University

Ph.D., Civil Engineering, N. C. State University, 1973

CURRENT PROJECTS

"Privatization of Transit Services Between Suburban Communities," $85,000, UMTA, U.S. Department of Transportation, 1988-89.

"Investigation of Safety and Structural Implication of Seat Belts on Transit Buses," $40,000, U.S. Department of Transportation, 1989-90, (Co-principal Investigator: Prof. H. Aktan).

"Investigation of Design, Maintenance and Operating Procedures of Wheel Chair Lifts on Transit Buses," $30,000, U.S. Department of Transportation and Michigan Department of Transportation, 1989-90, (Co-principal Investigator: Prof. H. Aktan).

SELECTED PUBLICATIONS

"Bus Garage Planning with Dynamic Vehicle Assignments: A Methodology," (with T. H. Maze), Transportation Research, Pergamon Press, Vol. 19B, No. 1 Feb. 1985, pp. 1-13.

"A Computer Model for Intra-City Transit Route Analysis," (with R. R. Tadi), Proceedings of the International Conference on Roads and Road Transport Problems (ICORT-88), New Delhi, India, Dec. 1988, pp. 571-580.

"Integration of Advanced Technology in Transportation Engineering Curriculum," Proceedings of the ASCE International Conference on Application of Advanced Technologies in Transportation Engineering, San Diego, CA, Feb. 1989, pp. 349-354.

"Analysis of Heavy Truck Accident Data - An Exposure-Based Approach," (with R. Al-Assar), Transportation Engineering Journal of the American Society of Civil Engineers, Vol. 115, No. 3, May 1989, PP. 298-304.

MANAGEMENT AND INDUSTRIAL EXPERIENCE

Consulting for various organizations including, Boston Redevelopment Authority, Michigan Department of Transportation, National Highway Institute, and Southeastern Michigan Transportation Authority.

Member, Transportation Advisory Committee, Southeastern Michigan Council of Governments (SEMCOG), 1982-83 and 1988-89.

HONORS

Certificate of Accomplishment, Institute of Transportation Engineers, for Outstanding Service on Committee 6Y-14, Planning for Bicycle Transportation, 1980.

Fellowship Award, Federal Highway Administration, U.S. Department of Transportation, for developing a University-level graduate course in Highway Safety Analysis, 1984-85.

William C. Taylor

Chairperson & Professor
Department of Civil Engineering
Michigan State University

Adjunct Professor
Urban Affairs Program
Michigan State University

Ph.D., Civil Engineering, Ohio State University, 1967

RECENT PROJECTS

"Detroit-Chicago High Speed Rail Study," (Co-investigators: A. Metcalf and R. Lyles), $298,000, three studies funded by U.S. Department of Transportation, U.S. Federal Railroad Administration, and Michigan Department of Transportation, 1981-83.

"Transportation Safety as a Function of Geometric Design, Operation and Environment," (Co-investigator: T. Maleck), $250,000, Michigan Department of Transportation, 1983-85.

"Evaluation of State Safety Programs," (Co-investigator; R. Lyles), $60,000, Michigan Office of Highway Safety Planning, 1983-84.

SELECTED PUBLICATIONS

"A New Concept of Speed Zoning," Traffic Engineering, September, 1964.

"Speed Zoning, A Theory and Its Proof," Proceedings of the Institute of Traffic Engineering, 1965.

"Sensing and Communication Between Vehicles," National Cooperative Highway Research Program Report 51, National Research Council, 1968, pp. 87-90.

"Progressive Signal Systems in a Network of Arterial Streets," (with T. K. Datta and D. Litvin), Transportation Research Record 597, National Academy of Sciences, 1976.

"Coordination and Integration of Special Transportation Services for the Mobility Handicapped Population," (with F. McKelvey and K. Rajendra), Transportation Research Record 618, National Academy of Sciences, 1977.

MANAGEMENT AND INDUSTRIAL EXPERIENCE

Chairperson, Department of Civil & Environmental Engineering, Michigan State University, 1972-present.

Acting Associate Dean for Research and Graduate Studies, College of Engineering, Michigan State University, 1986-87.

Executive Director, Interagency Transportation Council, State of Michigan, 1969-72.

Member, Steering Committee for Michigan Traffic Accident Records Committee, 1987-90.

HONORS

Member, Tau Beta Pi, Chi-Epsilon and Sigma Xi.
Member, Editorial Board: Journal of Advanced Transportation

Appendix 7: Letters of Commitment

MICHIGAN STATE UNIVERSITY

COLLEGE OF ENGINEERING
DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING
A349 ENGINEERING BUILDING
PHONE (517) 355-5107

EAST LANSING • MICHIGAN • 48824-1226

December 13, 1989

Mr. Robert D. Ervin
University of Michigan
Transportation Research Inst.
University of Michigan
Ann Arbor, Michigan 48109-2150

Dear Bob:

I enjoyed meeting Kan when we had coffee last week. The concept of enriching the Transportation Centers by stressing the education component seems reasonable in light of the recent AASHTO and TRB reports on the impending shortage of Transportation Engineers. I am sure this is what Tom Larson has in mind.

We would very much like to be a part of the program, as I expressed to you last week. In fact, I think our desire would be to become a more integral part of the program than I believe you envisioned. We can clearly provide modules to fit the certificate program, but I think the technology available to transmit courses would allow us to play a more significant role if we can agree on how to define this role.

The attached proposal is based on the preparation of various modules. Each module would include lecture notes, problem sets and typical examination questions. We would also be pleased to participate in the seminar course, as both Tom Maleck and I and several of our students would like to hear the other speakers.

Please let me know if you need any more details for your proposal. We will provide our matching share (up to $50,000) from faculty release time, and waiver of tuition for graduate students.

Very truly yours,

William C. Taylor

William C. Taylor, Ph.D., P.E.
Professor and Chairman

WCT/lm

Attachment

Modules for an IVHS Education Program

I. Car Following Models - this module will cover the models traditionally used to describe car following behavior, illustrating the effect of driver reaction time (T) and system response functions (λ) on lane capacity and safety. Post studies of the automated highway will be discussed.

Time: Two 2 hour sessions

II. Traffic Flow Models - this module will discuss the Q-K-V relationship, illustrating both the theoretical (car following) and emperical (data fitting) derivations. This module will include a discussion of shock waves, capacity and various operating strategies, such as maximizing volumes, maximizing productivity and minimizing acceleration noise.

Time: Two 2 hour sessions

III. Traffic Assignment Models - this module will discuss techniques for assigning traffic to networks with consideration of congestion and capacity restraint.

Time: One 2 hour session

IV. Traffic Control (Urban) - this module will discuss the concept of traffic signal control, from optimization of isolated intersections to control of urban street networks. The module will discuss Webster's delay equations; intersection optimization models (SOAP etc.); linear network optimization concepts and models (MAXBAND etc.); general network models (TRANSYT, SIGOP ect.).

Time: Four 2 hour sessions

V. Traffic Control (Freeway) - this module will discuss concepts of freeway control, including ramp metering strategies and techniques, changeable message signs, incident detection and remediation.

Time: Two 2 hour sessions

VI. Street Network Models - this module will discuss network models for urban street systems. Applications of NETSIM to evaluate geometric changes, traffic control device changes and network changes will be

Time: Three 2 hour sessions

VII. Other modules we can offer, but they may not be directly related to IVHS

a) Planning models (generation)
b) Modal split models
c) Public Transit route assignment models
d) SCANDI case study
e) Effects of age on driver performance
f) Risk Management

Wayne State University
College of Engineering

Department of Civil Engineering
Detroit, Michigan 48202
(313) 577-3789

December 15, 1989

Mr. Robert D. Ervin
University of Michigan
Transportation Research Institute
University of Michigan
Ann Arbor, MI 48109-2150

Dear Mr. Ervin:

Please find enclosed 3 copies of our pre-proposal entitled "Incorporating IVHS Elements Into Transit Related Educational Activities" for possible inclusion into your IVHS Proposal to the U.S. Department of Transportation. Also included in this package is a letter of support from Dr. Mumtaz A. Usmen, Chairman, Department of Civil Engineering, indicating the matching contribution by the Department.

A formal proposal with signatures of appropriate University authorities and a more complete budge will be submitted at a later day. We appreciate your consideration of our proposal and shall be looking forward to working with you on this important project.

Sincerely,

Snehamay Khasnabis, Ph.D., P.E.
Professor, Civil Engineering

SK/amh

Enclosures

cc: Professor Kan Chen
Professor Snehamay Khasnabis

Department of Civil Engineering
Detroit, Michigan 48202
(313) 577-3789

Wayne State University
College of Engineering

December 15, 1989

Mr. Robert D. Ervin
University of Michigan
Transportation Research Institute
University of Michigan
Ann Arbor, MI 48109-2150

Dear Mr. Ervin:

This is to inform you that matching support amounting to about one half of the total project cost, but not to exceed $50,000 per year, will be provided by the Civil Engineering Department, should Dr. Snehamay Khasnabis's proposal entitled "Incorporating IVHS Elements Into Transit Related Educational Activities" be funded by your organization. This support will include funds for faculty (released) time, part of tuition for the graduate assistant, clerical assistance, and the bulk of current expenses such as travel, supplies, printing and reproduction, telephone and postage, computing, etc. Participating of other organizations inside and outside Wayne State University for cost sharing will also be explored when the project budget estimate is finalized. However, it will be the Civil Engineering Department's responsibility to provide the needed matching funds.

Please call me or write to me if further clarification and details are needed on this matter.

Sincerely,

Mumtaz A. Usmen, Ph.D., P.E.
Professor and Chairman

MAU/amh

cc: Professor Kan Chen
University of Michigan

Dr. Donald Silversmith
Executive Associate Dean

Dr. Snehamay Khasnabis
Professor of Civil Engineering

INCORPORATING IVHS ELEMENTS INTO TRANSIT RELATED EDUCATIONAL ACTIVITIES

A Pre-Proposal Submitted By

Snehamay Khasnabis
Professor of Civil Engineering and
Director, Urban Transportation Institute
Wayne State University
2168 Engineering Building
Detroit, MI 48202
(313)577-3915

December 15, 1989

To

The University of Michigan
Intelligent Vehicle Highway
System (IVHS) Program

Attn:

Professor Kan Chen
Electrical Engineering &
Computer Science Department
University of Michigan
Ann Arbor, MI 48109-2150

Mr. Robert D. Ervin
University of Michigan
Transportation Research
Institute
Ann Arbor, MI 48109-2150

INCORPORATING IVHS ELEMENTS INTO TRANSIT RELATED EDUCATIONAL ACTIVITIES

A. INTRODUCTION

The College of Engineering (COE), Wayne State University (WSU) has, over the last few years, established a strong graduate program in Transportation through its Department of Civil Engineering (CE), emphasizing both education and research aspects. The COE offers programs leading to the B.S., M.S. and Ph.D. degrees in Civil Engineering, with four speciality areas in the graduate program, Transportation being one of them. An interdisciplinary approach to Transportation is encouraged by the Department requiring students to enroll in courses offered by other departments, including Urban Planning,Industrial Engineering and Operations Research, Economics, Marketing, Business and Mathematics. The Transportation program has received research funding from agencies such as the USDOT, the Michigan DOT, the Michigan State Police, the GLCTTR, the Motor Vehicles Manufacturers Association of the U.S., Inc. and others.

Within the transportation program, areas of speciality include highways and traffic engineering; transportation planning and design; and transit. Since the focus of this proposal is on transit, the following specific information on research and educational activities pertaining to transit is provided.

A1. Transit Research

During the last twelve-year period, WSU has received UMTA Research and Training funds (section 11 monies) on four occasions on transit related activities as follows:

1. "The Feasibility of Joint Development in Selected Transit Station Locations in the Detroit Metropolitan Area," (1977-78) (MI-11-0003).

2. "A Methodology for Locating and Sizing Transit Fixed Facilities," (1980-81) (MI-11-0004)

3. "An Analysis of Total System Costs Related to Bus Garage and Network Configuration," (1981-82) (MI-II-0005).

4. "Privatization of Transit Services Between Suburban Communities in the Detroit Metropolitan Area: A Marketing Approach." (1988-1989 (MI-11-0010).

The first three of the above have been successfully completed and the fourth one is nearing completion. Additionally, WSU is also currently involved in transit related research under the University Transportation Center program in Region V, through the GLCTTR at UMTRI. The two projects funded jointly by the GLCTTR and the Michigan DOT are as follows:

5. "Investigation of Safety and Structural Implication of Seat Belts on Transit Buses," 1989-90.

6. "Investigation of Design, Maintenance and Operating Procedures of Wheel Chair Lifts on Transit Buses," 1989-90.

A2. Transportation Education

Transportation is a major element of the engineering education program at Wayne State University. The undergraduate curriculum includes two required courses comprising 8 credits out of a total of 137. A brief description of these courses as they appear in the University catalog is as follows:

*CE 460. Transportation Engineering. Cr. 4. Transportation functions; transportation systems including highways, railways and airways. Techniques of transportation systems analysis including optimization, network flows and queueing theory.

CE 464. Transportation Design. Cr. 4. A description of design elements of various system components of transportation; including the driver, vehicle and roadway. Traffic flow design elements including volume density and speed; interaction design elements including delay, capacity and accident countermeasures.

At the Master's level, a total of six out of the following eight courses (18 credits) are generally taken by all students specializing in the transportation area. The following course descriptions are taken from the University catalog.

*CE 701. Civil Engineering Decision Process. Cr. 3 Application of probability, statistics and decision process to civil engineering problems.

CE 760. Highway Safety Analysis. Cr. 3. Safety aspects of highways; emphasis on design, implementation and evaluation of highway safety measures.

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*Note: Courses thus marked are targeted for upgrading through incorporation of IVHS materials

CE 762. Traffic Engineering Control and Operation. Cr. 3. Traffic control theory and application. Traffic regulation rationales, laws and ordinances; speed control, intersection control, flow control, parking control.

*CE 763. Urban Transportation Planning. Cr. 3 Analysis of urban transportation characteristics and studies. System demand and origin-destination study techniques, land use, parking, demand projects. System capabilities; use studies; transit surveys, transit systems terminals, economics.

CE 764. Economic Analysis in Transportation Systems Planning. (IE 764). Cr. 3. Application of engineering economy and price theory in optimization of transportation system designs, functioning primarily in an urban environment; analysis of congestion costs, externalities, primary and secondary costs and benefits.

*CE 765. Mass Transportation Systems. Cr. 3. Design and operation of alternate systems of mass transportation. Rail rapid transit, bus systems, other systems; service capabilities, operating characteristics, public demand, advantages and disadvantages, economics, system coordination.

*CE 790. Directed Study. Cr.1-4 (Max. 6). Independent investigation by a student on a special problem.

*CE 795. Special Topics in Civil Engineering. Cr. 1-4 A consideration of special subject matter in civil engineering. Topics to be announced in Schedule of Classes.

The remaining 14 credits for the MS program are selected by the student in consultation with his/her advisor, from other areas, both within and outside civil engineering. Student pursuing Ph.D. degrees are required to complete a minimum of another 28 credits of coursework.

B. (IVHS) PROGRAM - TRANSIT ELEMENT

WSU is desirous of continuing its consortium activities with the UMTRI and GLCTTR in their efforts to develop an education program in IVHS, focusing primarily upon the transit area. The specific objectives of WSU's project are:

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*Note: Course thus marked are targeted for upgrading through incorporation of IVHS materials

(1) To complement UMTRI's effort in IVHS educational program, with a specific focus on transit related activities.

(2) To conduct a detailed review of transit related IVHS research and development activities in the US, Japan, and Europe.

(3) To identify specific IVHS transit elements for incorporation into academic programs.

4) To identify specific courses offered by the College of Engineering and other departments for possible incorporation of IVHS materials.

(5) To explore the feasibility of introducing new courses in the IVHS area.

(6) To initiate the courses on a trial basis with appropriate mechanisms for student feedback.

(7) To implement the targeted courses as a part of undergraduate and graduate curriculum.

The courses marked * in the preceding section are targeted initially for two reasons. First, these course, in their current form, include transit elements in varying degrees. Secondly, there are opportunities of incorporating transit elements of IVHS in these courses within their overall scope as described earlier. The proposed program is to be realized in three phases over a three year period according to the Pre-plan developed by UMTRI.

1990 - 91 - Planning and Development
1991 - 92 - Formal Initiation
1992 - 93 - Full-Blown Implementation

Thus, the first phase of the project will entail a detailed review of the Transit IVHS literature, and developing a comprehensive information file on IVHS technology either for incorporation into the existing courses for developing new courses. The IVHS area can be divided into the following broad categories:

- Advanced Traffic Management System (ATMS)
- Advanced Driver Information System (ADIS)
- Freight and Fleet Control (FFC)
- Automated Vehicle Control System (AVCS)

The UM IVHS program will focus on ADIS and FFC, although it will give adequate coverage to various aspects of ATMS and AVIS that are synergistic with ADIS and FFC. In accordance with UM's approach, WSU's educational development programs will cover the following:

- Engineering and Non Engineering Transit Aspects
- Modular Technologies and System Integration
- Freeways, arterials and rural roads

B1. Initial Target Courses for the IVHS Program

As mentioned earlier, a number of existing course has been targeted for the IVHS program based upon their content, scope and coverage. The following course-specific details are provided.

CE 460. Transportation Engineering

This is a required undergraduate course, with 25% of the course content devoted to design. The purpose of this course is to provide a broad overview of the various engineering and numerical principles that are used in the analysis and design of multi-modal transportation problems. Besides providing a broad overview of transit related IVHS technical developments, the course may include design projects requiring application of some of these emerging technologies. Examples include: evaluation of alternate strategies for field testing of new navigation and communication devices; design and evaluation of alternate route guidance programs; techniques to determine reliability of transit services, etc.

CE 701 - Civil Engineering Decision Process

This course is designed to teach the graduate student the application of mathematical tools in solving civil engineering problems. Emerging developments in the application of expert systems, artificial intelligence and inductive learning can be incorporated in this course.

CE 763 - Urban Transportation Planning

This is a required graduate course and is designed to cover elements of socio-economic, land use and demand aspects of multimodal transportation. Possible IVHS elements for this course are: User acceptance and liability, System integration, Real-time information to the motorists for route switching, Autonomous vehicle and navigation techniques for HOV lanes and Automated route design.

CE 765 Mass Transportation System

This is a required graduate course and covers the technological aspects of alternate forms of public transportation, including urban rail, buses, para transit and automated guideway transit. This course may be the most ideal vehicle for disseminating the new research findings on IVHS. Topical areas include: Automated buses on urban freeways, Bus pre-emption strategies and instrumented vehicles, Expert systems in signal pre-emption devices, Real-time control for improving transit level of service, Machine-vision to monitor vehicle performance, Expert systems to select transit routes, Telecommunication for vehicle monitoring for demand responsive system.

CE 790 Directed Study

This course is designed to provide students with the opportunity to conduct an independent investigation of a specific topic, including literature search, software development, application of new techniques, etc. No formal class meetings are scheduled; the course requires a one-to-one interaction between the student and instructor in the pursuit of a mutually agreed upon topic. Thus the course can be used as a vehicle for student research focussing on specific areas of IVHS technology.

CE 795 - Special Topics

This course may be used to familiarize graduate students with ongoing IVHS research efforts, to develop a forum for exchanging ideas between students, faculty and outside experts and to select graduate students for appointments as GRA's (Graduate Research Assistant) for the IVHS program.

B2. Other Educational Activities

Besides upgrading the above courses, the WSU team will also be exploring the development and implementation of new courses. Further, WSU will also like to exchange ideas with the UMTRI team members whenever possible. This might include the WSU team members participating in the special topics course offered by the UM, and encouraging WSU's graduate students to participate in the UM's IVHS educational program offered either under the certificate program (CIVHS) as well as the Continuing Engineering Education and the Michigan Engineering Television Network (METN).

C. PARTICIPANTS

The project will be directed by Dr. Snehamay Khasnabis, Professor of Civil Engineering and Director, Urban Transportation Institute. As the principal investigator of the project, Dr. Khasnabis will have the responsibility of the project management and technical aspect. Professor Khasnabis has an established track record of participating in transit-related activities. He was the principal investigator of all the four completed UMTA projects and currently serves as the Co-PI of the two projects being conducted under the GLCTTR program. Many of his publication deal directly with transit operation, design and planning. He is also the regular instructor of the courses targeted for the IVHS program. Professor Khasnabis was also the co-PI of an educational development project funded jointly by the NSF and IBM Corporation in 1983 entitled "A Computer laboratory For Freshman and Sophomore Level Civil Engineering Education - An Equipment Grant" (1983-86)". Lastly, he is the co-author of a paper entitled "Integration of Advanced Technology in Transportation Engineering Curriculum", presented at an ASCE Speciality Conference, held in San Diego in February, 1989 (copy enclosed).

Professor Khasnabis will be assisted in his effort by Professor Tomasz Arciszewski of the Civil Engineering Department. Professor Arciszewski's formal background is not in the traditional transportation area. However, his expertise in the areas of design methodology, expert systems, knowledge engineering and inductive learning will have direct application in the course development effort. Professor Arciszewski's research on design methodology has been supported by the NSF and he has widely published his work on the application of expert systems and artificial intelligence techniques in solving engineering problems. He is also the editor of the monograph "Knowledge Acquisition is Civil Engineering", to be published by ASCE.

D. BUDGET

An annual budget of $50,000 is being requested from the GLCTTR for this project. A contribution of an equal amount is expected to be provided by the Department of Civil Engineering, WSU through faculty released time, staff support, etc. (See attached letter from the Chairman of Civil Engineering Department). The budget includes partial salary support for Professor Khasnabis and Arciszewski, plus stipend for a Graduate Research Assistant. Other items included in the budget are fringe benefits and University overhead. A detailed budget with appropriate signature of University authorities will be submitted later.

Appendix 8: "Thrusts of the Michigan Program in IVHS"

Thrusts of the Michigan Program in Intelligent Vehicle-Highway Systems

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Abstract

After a one-year research planning study, the Intelligent Vehicle-Highway Systems (IVHS) Program at Michigan is now in its second year of operation. The Michigan program has been characterized by an incremental approach to IVHS technology deployment, an extrapolation from the interests and capabilities of the automotive industry, and complementarity to other university programs in North America. Consequently its research thrusts are in the areas of advanced driver information systems and freight & fleet control. Its proximity to Canada has also resulted in Canadian sponsorship and potential IVHS demonstrations involving the two North American countries.

Introduction

In May of 1988, the University of Michigan began a study for planning a program of research and development in Intelligent Vehicle-Highway Systems (IVHS) and for promoting a national initiative in this area. The IVHS concept pertains to the use of information technology, including advanced computer, communications, sensors, and associated electronics systems for integrating vehicles and highways into a total system for communication and control. The purpose of such integration is to enhance traffic flow, operational safety, and the overall efficiency of highway transportation. During the planning study, a score of governmental and industrial organizations in North America joined with the University of Michigan to explore the IVHS matter on technical, institutional, and strategic grounds. These organizations co-sponsored the study as they shared the common perception of three converging forces -- the stress of increased traffic on urban road systems, a pervasive technology push which matches up well with the technical needs of IVHS, and international competition -- which push for an accelerated development in IVHS in North America [1].

Defining Characteristics of the Michigan Program

The defining characteristics of the Michigan program were developed early in the formative stage through a series of discussions with the Michigan Department of Transportation and the Big Three automobile companies. These discussions led to the following guiding principles.

First, we take the perspective that development of an IVHS capacity in North America should follow an *incremental* path. That is, we envision that IVHS will be implemented in stages, with new technologies and products gradually replacing older ones as technical advances and infrastructure development permits. The incremental approach will depend upon reflective learning throughout the research and implementation process and will provide short and medium-run incentives while in pursuit of inherently long-run objectives.

As a second defining characteristic, the Michigan program will extrapolate from the technical interests and capabilities of the *automotive manufacturing industry*. Thus, our research initiatives are expected to emphasize developments in the vehicle-side technologies as they relate to IVHS capabilities.

Furthermore, recognizing the enormous tasks involved in bringing about IVHS to North America, we have made an early commitment to cooperation with other universities and institutions to work together in the development of a national or continental IVHS program.

First-year Activities

Three of the distinctive tasks which have been conducted in the Michigan IVHS planning study are (1) a technology demonstration event, (2) a Delphi survey of future IVHS scenarios, and (3) a future research plan. The technology demonstration was shown to about 100 invited guests, who are opinion and decision makers that could influence the future of IVHS in North America. It satisfied the need of these guests for some first-hand exposure to real hardware to begin to visualize what IVHS is all about. The technologies were demonstrated mainly by our sponsors and included technologies which contribute toward "smart cars" as well as "smart highways". Many of the technologies were relevant to IVHS in modular forms but, of course, had not been integrated in the sense of vehicle-highway systems. Thus the demonstration conveyed the message that these technologies, without a national collaborative effort, do not solve the problem; but they do illustrate

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that there is a great deal of domestic capabilities upon which to build.

The purpose of the Delphi survey among some 30 experts in our sponsoring organizations was to provide a common base for collective research planning involving UM staff and UM sponsors from the various sectors. It is distinguished from previous surveys (e.g., see [2]) in that we have taken an optimistic outlook, have emphasized an incremental approach, and have included experts from both American industry and government in the panel. The preliminary results of our study are portrayed in Figure 1. The vertical axis represents successive stages of market penetration of the various types of IVHS, and the horizontal axis is time from the present (P) to the year 2080 and beyond (L = later than 2080 and N = never). Four IVHS types are shown: advisory 1 (local information systems) includes motorist information systems, automatic tolls and road pricing, and collision warning; advisory 2 (geographic systems) includes vehicle location and identification, autonomous vehicle navigation, and cooperative route guidance; backup control systems include speed and headway keeping and collision avoidance; and continuous control systems include automated highway chauffering and automated guideway systems. An interesting result of our forecast reveals that the vast majority of IVHS (specifically those of the Advisory and Backup types) will be introduced within the next ten years, making the field attractive to the private sector. The survey also identified and prioritized specific technical and institutional barriers, necessary government policy changes, driving forces for technology adoption, and social impacts of each IVHS technology. These detailed results have helped us develop specific research plans.

Through extensive interactions, both internally with an interdisciplinary group of UM faculty and staff and externally with our sponsors and other experts in the field, we have developed a future research plan. We have determined that not only applied research but fundamental research is also needed insofar as a number of basic issues need to be resolved. For example, it is unclear how the intelligence should be distributed between the vehicle and the highway, and how centralized or decentralized the communication systems should be to collect, process and disseminate information. What is clear is that, since the driver will remain in control in most of the IVHS functions, human factors and user behavior need to be much better understood for the design of IVHS systems. In addition, there are socioeconomic aspects for research, including user acceptance and legal liability. Given the strengths of many modular technologies already in existence, the critical challenges lie in system integration although some components such as sensors are also badly needed.

Second-year Activities

The second year of the Michigan-based program will include the initiation of research in the form of selected projects, likely to be small in scope, which begin to define the opportunities and challenges for IVHS implementation. Candidate projects include (1) systems aspects of the urban parking problem, (2) traffic flow analysis as a precursor to automated incident management on a central urban corridor, (3) an assessment of existing technologies for fleet location, navigation, and dispatch, (4) evaluation of in-vehicle requirements for computational and fault-tolerant functions, (5) the profile of driver decisionmaking by which existing travel information and human judgements determine route selection, and (6) categorization and evaluation of both proximity and wide-area sensors for IVHS.

The selection, timing, and scheduling of one or more of these projects will depend on the preferences of our Industial Advisory Board, the level of support and cooperation we receive from other organizations, and the possibilities of additional project-specific funding. However, some of the activities which have been planned or have already taken place for the second year include the Traverse City Demonstration which has been held at the Grand Traverse Resort on June 3, 1989, a special-topic course on IVHS to be offered at the University of Michigan in the fall, continued interactions with proponents of the American program in IVHS, and exchange of information with researchers and interested parties in various domestic and international workshops and conferences. Because of its geographical proximity to Canada, the Michigan-based IVHS Program has received Canadian sponsorship and has been considering potential IVHS demonstrations involving the two North American countries

In sum, the development of IVHS in North America is entering into a very dynamic stage. We at Michigan expect to continue our contributions to this development both technically and institutionally.

References

R.D. Ervin and K. Chen, "Toward motoring smart," Issues in Science and Technology, 5(2), pp. 92-97, 1989.

O. Sviden, "Future information systems for road transport: A Delphi panel-derived scenario," Technological Forecasting and Social Change, 33, pp. 159-178, 1988.

Delphi Projections of IVHS

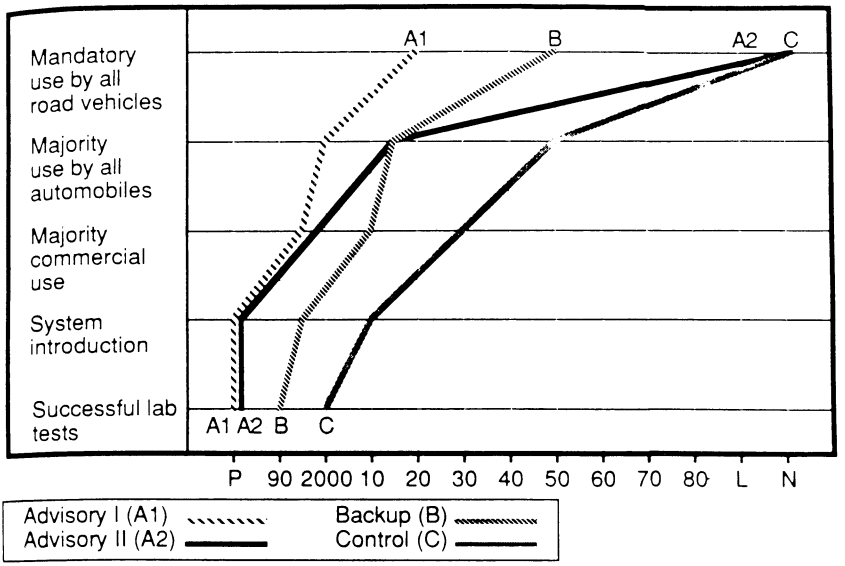

Figure 1

[redacted]