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TRANSPORTATION

As part of the Laboratory's diversification initiative, transportation is one of several areas selected for new business development. At the national level, transportation issues and objectives include improving safety and reducing congestion, developing more effective approaches for managing a deteriorating transportation infrastructure, improving energy efficiency, reducing unwanted environmental impacts, and enhancing our international economic competitiveness. Historically, we have attempted to address these issues by building more airports or paving more miles of highway. Today, however, the direction is to emphasize the application of advanced technologies to solve transportation problems through the use of real-time information systems, adaptive control systems, and automation. This approach draws heavily on the expertise and technologies important to APL.

The addition of a Transportation Thrust Area to the Laboratory's Independent Research and Development (IR&D) Program in 1993 provided a means to encourage staff members to direct their technical skills and creativity toward transportation-related issues. From a business development standpoint, the resulting IR&D projects represented an invaluable means for APL to demonstrate both our commitment to participate in transportation research and development activities and our ability to understand and address problems of interest to potential transportation program sponsors. The Laboratory's IR&D projects to date have resulted in two proposals for funding, five technical papers, and numerous briefings to Department of Transportation representatives.

During the past year, our initial efforts to develop new business in transportation have focused on the Intelligent Vehicle/Highway Systems (IVHS) Program. This program is one of the Department of Transportation's high-priority initiatives, with technical requirements that closely match APL's capabilities and interests. The IVHS Program includes the development of systems to address an identified 27 user services covering private vehicle, public transit, and commercial vehicle operations. System development efforts receiving funding include information systems to provide real-time status information to users and operators; increased use of partial and full automation in traffic control, driving, and vehicle condition monitoring functions; advanced communications systems using wireless and fiber-optic technologies; and advanced management information systems to enhance the efficiency of commercial vehicle operations.

Consistent with the decision to direct initial business development efforts toward the IVHS Program, IR&D projects related to IVHS have been encouraged during the initial years of the thrust area. Staff members' interest in transportation has been strong with an average of over 20 proposals received each year. The proposals and funded projects have addressed a wide variety of problems associated with all modes of transportation, and have been valuable in solidifying a core of staff members with an interest in working on transportation problems. Work conducted under the IR&D's Transportation Thrust Area has been a critical element in the initial success we have achieved in bringing transportation business to APL. The following are brief descriptions of selected projects funded in the Transportation Thrust Area:

Stability and Control of Automatic Highway Systems. Many IVHS concepts utilize automatic longitudinal and lateral control of vehicles. Among the most important assumptions in achieving these objectives are the kinematic performance variables of individual vehicles, such as maximum acceleration, velocity, and braking capabilities. This project addresses the development of vehicle performance estimation and spacing control strategies that maximize vehicle flow while providing safety in the face of vehicle-to-vehicle performance differences. These strategies must provide for platooning (vehicle convoys), merging, and lane changing functions. Another problem addressed in the project is the lateral stability and control of vehicles during lane changes and severe braking conditions.

Detection in Vehicle of Impaired Driving. Alcohol-impaired driving continues to exact a high toll in fatalities, serious injury, and property damage. Currently, no system exists to continuously monitor driving behavior; however, a relatively simple configuration of existing hardware placed in the vehicle would permit real-time data on position and vehicle motion to be collected and evaluated onboard, to determine if the vehicle is being operated safely. The objective of this project is to develop a prototype algorithm that can discriminate between normal and impaired driving by monitoring digitized time series data of vehicle velocities and accelerations. Progress in developing the detection algorithm for such a system could be applied to other areas of federal and commercial research such as drowsy driver detection and warning.

Optimization and Control of Discrete Event Dynamic Systems. Discrete Event Dynamic Systems (DEDS) are systems that change states at discrete, random time instants and evolve in discrete space. Examples of DEDS include bus/subway queuing networks and scheduling operations, communication networks, and manufacturing systems. Controller design and optimization of such systems typically assume that the mathematical model for the system is explicitly known. However, many DEDS are large and complex and the models are unknown. This project focuses on developing optimal adaptive controllers for DEDS where system dynamics

are unknown or intractable. The effort uses an approach similar to the Simultaneous Perturbation Stochastic Approximation (SPSA) method for gradient approximation.

Application of Laser Radar Techniques to the Nondestructive Evaluation of Transportation Structures. Many transportation structures in use today are decades old and require constant assessment of their integrity. Relatively quick and inexpensive approaches to nondestructive testing of structures are needed. The goal is to develop a tool for Nondestructive Evaluation (NDE) that can continually and remotely monitor structures without interruption of their normal use. This project focuses on the development of an NDE system based on laser vibrometry that, ultimately, would use small sensors and perform measurements at significant ranges to the structure under test.

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DENNIS L. KERSHNER received a B.S.E.M. degree from Pennsylvania State University in 1968 and a S.M.C.E. (Transportation Systems) degree from Massachusetts Institute of Technology in 1970. Since joining APL in 1968, Mr. Kershner has worked with the Missile Preliminary Design Group of the Fleet Systems Department, and later with the Transportation Technology and Advanced Systems Groups of the Aeronautics Department. He is a systems analysis specialist in both transportation and advanced weapon systems, and has worked on concept evaluations and performance requirements assessments, scenario generation, and the development of assessment models and simulations. While providing analytical support to the Navy's Summary Warfare Appraisal process, Mr. Kershner was also involved in planning, coordinating, and conducting assessment studies for advanced Navy weapon systems. He has had a leading role in the examination and development of new business opportunities for APL in transportation and is currently the Director of the Transportation Program Development Office.