

# TENNESSEE STATE UNIVERSITY

## CENTER OF EXCELLENCE IN

# INFORMATION

## SYSTEMS

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**This center of centers includes eight interdisciplinary research areas funded by governmental and private agencies and corporations.**

**by Michael R. Busby**

**L**ocated on the downtown Avon Williams campus of Tennessee State University (TSU), the Center of Excellence (COE) in Information Systems Engineering and Management (ISEM) was established in 1986 as part of the state Centers of Excellence program. From its modest beginnings, the COE has become a center of centers that today has grown to include eight interdisciplinary research areas funded by the National Aeronautics and Space Administration (NASA), National Science Foundation (NSF), U.S. Army, National Institutes of Health (NIH), and other governmental and private agencies and corporations. In fact, since 1995 the center has annually generated more than six times its state funding level. The mission of the center is to expand the research base of the State of Tennessee and to serve its citizens. The goals of the COE are to provide an environment conducive to research for both faculty and students at the university. During the past decade the center has produced more than 500 publications of which more than 400 have appeared in refereed journals and conference proceedings. Presented below are brief descriptions and some notable accomplishments of each of the eight research areas.

### **Astrophysics Research Area**

Center astronomers are developing the capabilities to make a wide variety of astronomical observations with automatic telescopes in order to conduct long-term research projects that would be too difficult or too expensive to accomplish without the benefits of automation. TSU astronomers currently operate seven 10- to 32-inch automatic photoelectric telescopes that make highly precise measurements of stellar brightness changes. Two additional automatic telescopes are under construction: a 24-inch automatic imaging telescope and an 81-inch automatic spectroscopic telescope. All the telescopes are located in the Patagonia Mountains of southern Arizona, where they are maintained for TSU by Fairborn Observatory, a nonprofit scientific research organization. Astronomers in the center use the telescopes to measure brightness changes in sun-like stars, search for planets around other stars, study magnetic activity in cool stars, and measure the fundamental properties of double and multiple stars, among a variety of projects. In November 1999, TSU astronomer Gregory Henry obtained the *first* direct evidence of an extra-solar planet by detecting a planetary transit in the HD 209458 system, confirming the reality of planets outside

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*Above left, Dr. Henry confirmed the reality of planets outside our solar system and provided the first direct measurement of their physical properties.*

*Below left, an 81-inch automatic spectroscopic telescope is under construction.*

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our solar system and providing the *first* direct measurements of their physical properties. This astounding news was heralded around the world.

#### **Control Systems Research Area**

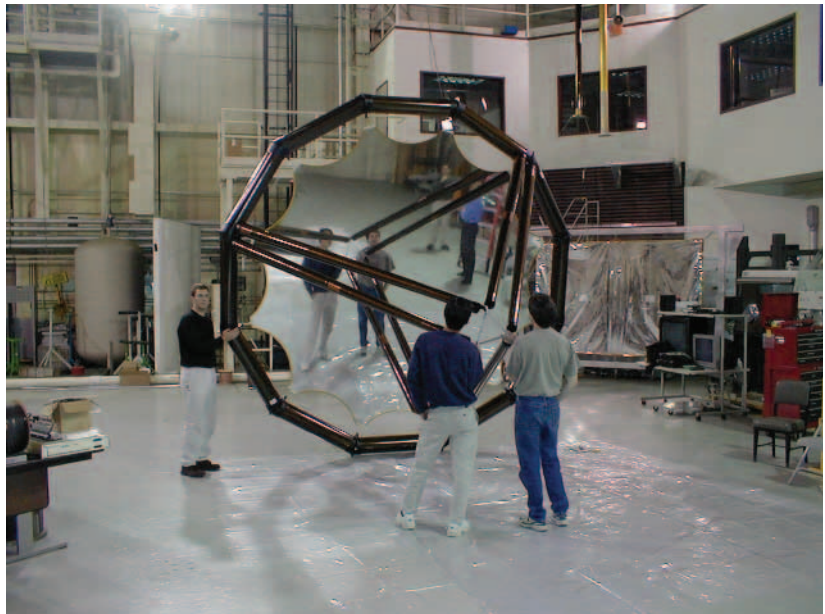
Center researchers are studying fundamental issues of controlling modern systems that are increasingly complex. Current research projects include developing new control design methods to deal with plant and controller sensitivity, robust stability, and robust performance. Areas of research include robust and fixed structure controller design, system identification, and adaptive control using artificial neural networks. Researchers are also contributing to research in robust control and modeling of space structures, satellite control, and the sched-

uling of autonomous telescopes. For example, future spacecraft will most likely be ultra-lightweight and collapsible, ideally inflatable/membrane structures, providing an effective mechanism by which large and ultra-lightweight space structures (ULSS) such as antennas, telescopes, mirrors, shielding, solar arrays, and sails may be deployed. The structural behavior of ULSS becomes highly uncertain and nonlinear, and therefore modeling and robust control issues have prime importance. The center, in conjunction with NASA's Langley Research Center, has developed a control systems laboratory to test and evaluate these structures.

#### **Applied Mathematics Research Area**

The center's applied mathematicians are developing the tools to study the fundamental characteristics of large-scale, complex dynamic systems. Their current research projects include

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*Above right, TSU flexible membrane ultra-lightweight space structures (ULSS) test apparatus.*

*Right, developing the streaming video astronomy courses.*



investigation of dynamic reliability, controllability, estimation, and stability of complex dynamic systems under both structural and environmental randomly varying perturbations. In this context, they are developing (1) stochastic approximation procedures under various modes of convergence, (2) stochastic stability via Lyapunov's techniques and comparison results, and (3) implicit and explicit numerical schemes and algorithms. Their investigation includes real-world problems from multi-species communities, multiple market systems, image processing problems, dynamics of fluids and gas flows, immigration and emigration, and complex environmental systems.

#### **Astrobiology Research Area**

This research area is housed in the Institute for Understanding Biological Systems. The institute focuses on emerging areas in life sci-

ence that include astrobiology, bioinformatics, proteomics, biotechnology, nanotechnology, and science education (including a summer program for high school teachers). Located in the Department of Biological Sciences and jointly funded and sponsored by the COE, the mission of this institute is "to conduct and encourage collaborative research and assist in the public understanding of biological systems at the cellular, organismal, and environmental levels for the benefit of the citizens of Tennessee and the Nation." The sequencing of human and other genomes is a result of an interdisciplinary approach to studying science. This approach has resulted in technological and conceptual advances in biology that have led to a major paradigm shift in biological science. The "post-genomic" scientific era will require educating life science students in an interdisciplinary manner.

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**Exploring Minds is a scientific/literacy interdisciplinary project designed to stimulate an interest in earth/space science in middle, secondary, and postsecondary students.**

*Above left, TSU summer students participating in Exploring Minds.*



*Left, Professor Myles and students checking samples in the astrobiology lab.*

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### **Computational Fluid Dynamics (CFD) Research Area**

The research in CFD centers around development of modeling techniques applied to the investigation of various fluid systems and associated physical phenomena. For example, the current research work in flow through a phase-change packed bed enables one to numerically simulate a three-dimensional melting packed bed and a two-dimensional evaporating thin liquid film on a curved surface. This fundamental

research provides both macroscopic and microscopic modeling techniques for typical fluid flow-solid interaction encountered in energy storage and heat transfer enhancement engineering applications.

Another current application of CFD techniques relates to the Giant Segmented Mirror Telescope (GSMT) project. The stability and accurate operation and control of an automated telescope system, in this case the GSMT, are affected by wind speed and pressure at the telescope site. Accurate prediction of wind velocity and pressure fields around the telescope system can assist in developing an operational or phenomenological model to provide important

input to the dynamic control model of the automated telescope. CFD modeling techniques are being used at TSU to determine detailed velocity and pressure fields under a specified operating field condition.

### Network Resources and Training Site

Network Resources and Training Site, a NASA-funded project, was established in 1995 as a five-year program to bring high-speed connectivity to the Internet for the historically black colleges and universities in Mississippi, Alabama, Kentucky, and Tennessee and to bring connections to local elementary and secondary schools. The goals of this five-year endeavor were achieved in three years, and training and additional services were added to the program. TSU was awarded a follow-up grant, and our current effort is the development of content for the Internet, specifically two online streaming video undergraduate astronomy courses. These courses heavily integrate discussions with some 50 practicing astronomers from all parts of the globe.

### Education and Critical Thinking

*Exploring Minds* is a scientific/literacy interdisciplinary project designed to stimulate an interest in earth/space science in middle, secondary, and postsecondary students. The aim of *Exploring Minds* is to engage students in learner-centered, self-directed, case-based instruction by incorporating other subject areas using an emerging curriculum. Students actively participate and learn science in a collaborative format with their teachers, university educators, community resources, and practicing scientists. The classroom teacher is the catalyst in this endeavor, facilitating the instruction and learning process.

The focus of this project is on ways that teachers and students become a “community of thinkers.” The classroom is a place where ideas are shared through interactive learning environments in an atmosphere of coming to know through understanding and discussion—a learning environment in which teachers think about their subject in ways that promote and invite students to participate by offering lessons and assignments that require critical thinking (about ways to bring about change in one’s experience) and imaginative thinking (exploring future possibilities with existing ideas) rather than emphasizing rote memorization of facts.

### Project DIANE

Project DIANE (Diversified Information and Assistance Network) uses digital public networks and interactive video/multimedia computer technologies to support cooperative electronic alliances in education, community service, healthcare, and economic development. Since 1992, Project DIANE has recruited and trained teachers, scientists, artists, librarians, community workers, business counselors, medical professionals, and others in the use of emerging information technologies. The network of more than 200 participating videoconference locations and organizations has helped to electronically connect schoolchildren, college students, families, handicapped individuals, senior citizens, small businesses, and others to a variety of beneficial online learning resources, information, and professional expertise. Project DIANE’s current online membership consists of a diverse group of universities, schools, museums, libraries, zoological parks, neighborhood community centers, healthcare groups, government agencies, and business assistance organizations.

The Project DIANE Consortium is first and foremost a “people net,” one in which individuals work together in support of cooperative programs and activities for the betterment of schools, local economies, and the community in general. Examples of DIANE-based programs and applications include distance learning and tutoring, K-12 interactive remote field trips, distance mentoring, leadership development, children’s story hours, puppet shows, arts and humanities outreach, small business counseling and training, science and nature lectures, library reference and research services, expert faculty consultations, workshops and seminars, technology training, support for the deaf and hard of hearing, health counseling, senior citizen assistance, family services, and other community-oriented applications. In addition to regularly scheduled activities and by-request services, DIANE organizations also hold various special events on the network, ranging from business workshops to community forums. Overcoming traditional time, distance, and language barriers to learning and community service, Project DIANE users telecollaborate with each other in real-time digital mode via full-screen, two-way video teleconferences coupled with simultaneous high-fidelity voice conversation, interactive “data sharing,” remote operated learning and developmental software, and other types of electronic multimedia interactions. ■

*Michael R. Busby is director of the Center of Excellence in Information Systems Engineering and Management.*

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