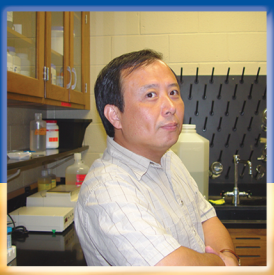
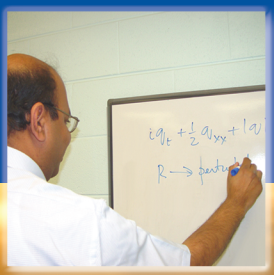
2005 Annual Report

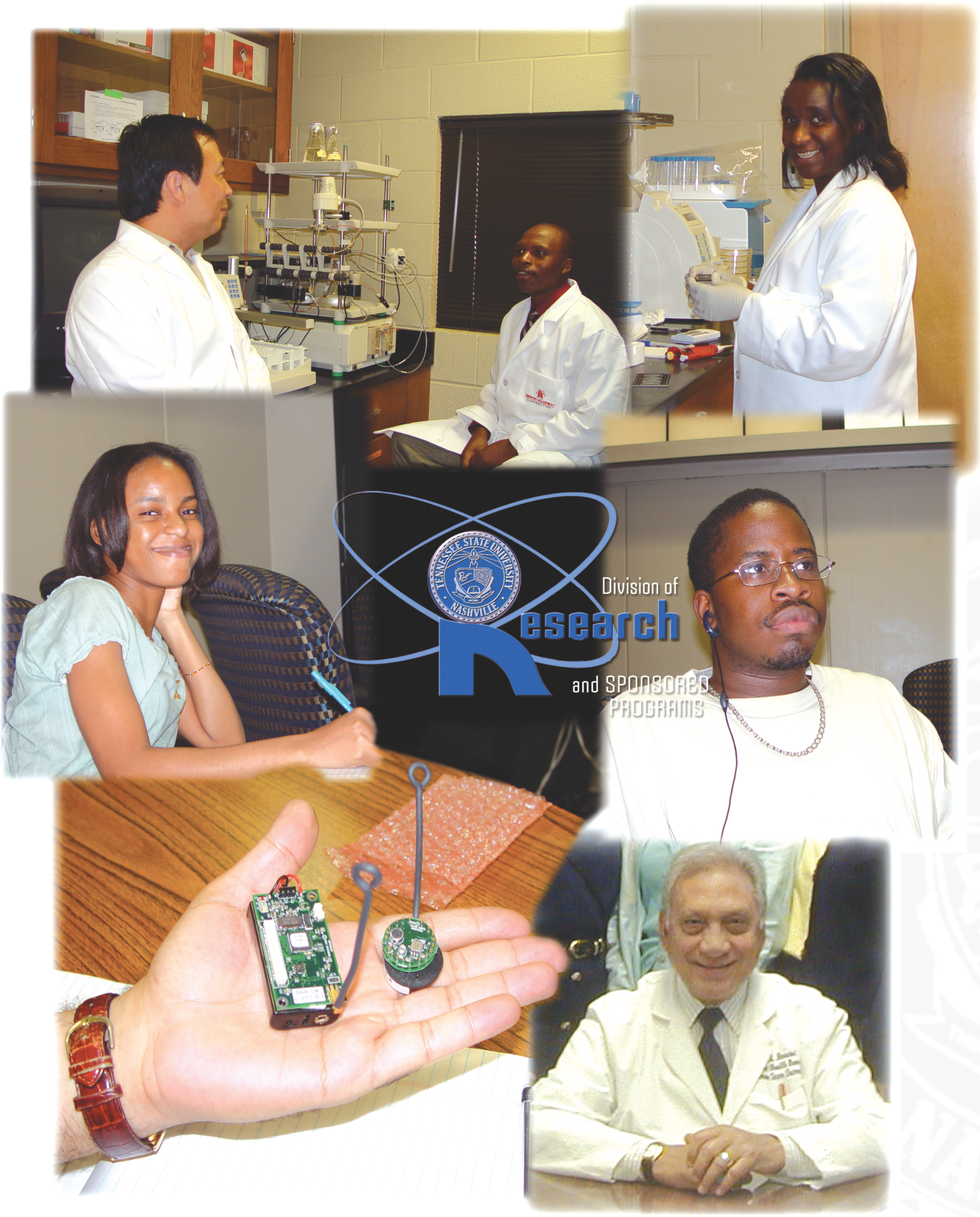





TENNESSEE STATE UNIVERSITY

RESEARCH HORIZONS

Division of Research and SPONSORED PROGRAMS


TENNESSEE STATE UNIVERSITY
NASHVILLE
Division of
Research
and SPONSORED
PROGRAMS

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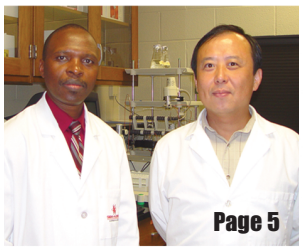
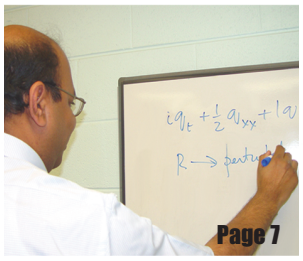










FROM THE VICE PRESIDENT



Tennessee State University (TSU) continues to make vital and significant contributions to the body of knowledge of humankind as evidenced by some of the features in this edition of Research Horizons. On behalf of the Division of Research and Sponsored Programs, I commend the outstanding efforts and contributions of our researchers, faculty, students and staff during the past year. Overall, the research enterprise has experienced significant growth during the past decade. In order to sustain this growth, despite the current economic climate, the University continues to seek and exploit interdisciplinary, collaborative relationships with corporate, academic and government partners in areas that are "mission critical" to those entities. Collaboration is critically important in continuing our success in research areas that represent our strengths as well as developing new research initiatives that will grow the research enterprise at TSU. We continue to focus on and strengthen our research programs in engineering, biomedical sciences, agricultural science, health, education and others to move into high-growth areas such as nanotechnology, biotechnology, learning sciences, and computational science.

Several research initiatives and programs were launched or are underway that are not highlighted in this edition. They include the inauguration of the intramural competition for Faculty Research Awards, collaboration with other minority serving institutions through the Minority Serving Institutions Research Partnership initiative, completion of the RSP Academy to facilitate principal investigator training, continued research on early childhood learning and teacher education, establishment of service learning activities, collaboration with several research-extensive universities on homeland security and nanotechnology research, and stronger relationship with our corporate and government partners – local, state, federal, and Congressional.

We continue to involve our students in research and other scholarly activities so that they might develop the necessary skills and research techniques to make significant contributions in their respective fields. At Tennessee State, we believe research and scholarly activity is essential to excellence in education and enhances the learning experience of our students. The research enterprise at TSU has tremendous potential, and we continue to strive to create an environment that will be conducive to growth and achieve research-extensive classification in the near term!

As always, I remain

Sincerely,

Marcus W. Shute

Marcus W. Shute, P.E., Ph.D.
Vice President, Research and Sponsored Programs
Tennessee State University

"Be the thinker that thinks the thoughts, that creates the things."
African Proverb

"Exploring the question brings more wisdom than having the answer."
A Course in Miracles

"Elimu (education/knowledge) is the key!"
Dr. Marcus W. Shute, P.E.
SEI



FROM THE DIRECTOR

Fiscal Year 2005 was another exciting year for the research enterprise at Tennessee State University (TSU). In fact, we had so many exceptional projects it was difficult to select which ones to feature in this report. Ultimately, we chose seven projects that represent some of the internationally and nationally recognized research conducted at TSU.

In recognition of our land-grant status, we have featured three outstanding agriculture-related research projects. Our agriculture research teams are on the cutting edge of their fields with projects that range from the development of biosensors that detect biological and chemical agents to the establishment of a body of basic research knowledge for meat goats. These projects clearly demonstrate that TSU is a leader in agricultural research.

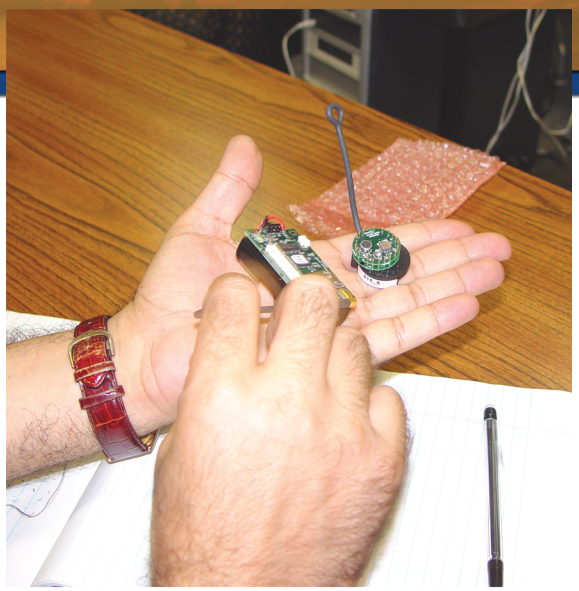
In addition to our agriculture research, we have featured other projects that are just as impressive. Our newly established Center of Excellence for Battlefield Senor Fusion, funded by the Army Research Office, is developing technology that will revolutionize military communications systems. Also, TSU was selected as one of the pilot sites to receive funding from the Central Intelligence Agency (CIA) and other intelligence agencies to establish a Center of Academic Excellence in Intelligence Studies. For the second time in his career, TSU's world-famous astronomer, Greg Henry, has been instrumental in the confirmation of an extra-solar planet.

Our seven featured projects are just a sample of the noteworthy research being conducted at Tennessee State University. After reading our report, I am positive that you will want to know more about our research programs. I invite you to contact us to schedule a tour of our facilities, and meet with our researchers and students. We welcome you as a potential partner in our research enterprise and look forward to establishing a productive relationship with you.

Sincerely,

Maria Thompson, Ph.D.
Director, Research and Sponsored Programs
Tennessee State University

CENTER OF EXCELLENCE FOR BATTLEFIELD SENSOR FUSION



The Center of Excellence for Battlefield Sensor Fusion is headed by Dr. Amir Shirkhodaie, Associate Professor of Mechanical Engineering, and his team, Drs. Mohan Malkani, Mohamed Zein-Sabatto, and Wei Chen. This five year Army Research Office project is a joint effort between Tennessee State University (lead) and Pennsylvania State University. The Army's objective in this project is to be able to detect activity on the battlefield and communicate this useful information to officials. This will be accomplished by a large array of small disposable sensors in a battlefield environment. These "friendly landmines" will be the eyes and ears of the military when it is not feasible to deploy soldiers.



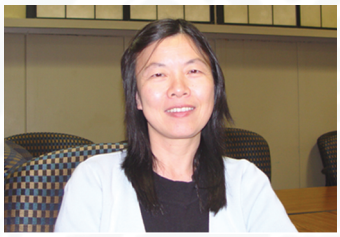
Dr. Amir Shirkhodaie

With the emergence of new micro-scale sensor technology and nanotechnology, it is now possible to deploy large numbers of inexpensive, small-scale, self-organizing, fault-tolerant sensors scattered over a large terrain which then create self-organizing, multi-modal networks. Such sensor networks can significantly improve military battlefield command, control, communications, computing, intelligence, surveillance, reconnaissance, and targeting systems. In rapidly changing battlefields, interoperability of distributed sensory systems is vital to reliable assessment of the correct terrain situation that is critical for strategic decision-making, as well as when counteraction is warranted by the actions of the adversary.



Students Vahid Namvar (L) and Arshad Noor (R)

The Center's vision is to exploit the potential of data fusion techniques for advancement of fundamental understanding of sensor networks scalability, distributed sensing behaviors, fault tolerance schemes, hierarchical communication protocols, sensor network informatics, and power efficient fusion techniques in highly uncertain environments. In particular, the research is focused on sensors with limited functionality in energy, sensing, computation power, and communication.

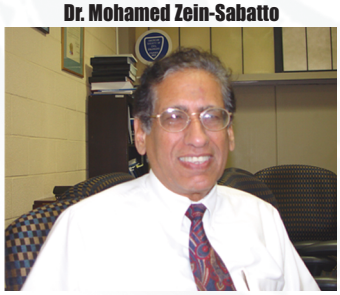


Dr. Wei Chen

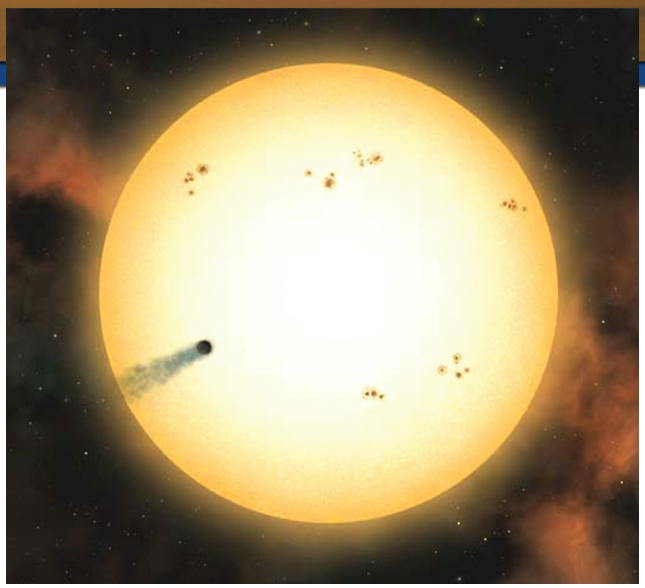
The sensors range in size from a pill to the size of a quarter. They are dropped from the air and scattered onto the battlefield. These self-sustaining micro-sensors will be joined by wireless ad hoc networking systems. The many ad hoc systems will be defusing information gathered and reducing the overhead redundant communication. TSU's challenge will be to develop a suitable algorithm and technology that would help these ad hoc systems work together very effectively and efficiently. It is a technical challenge as well that brings together interdisciplinary sciences: computer science, electrical systems, networking, and statistical probalistic systems. The sensors and ad hoc systems have to be taught to distinguish differences. For example, the sensors have to be able to distinguish between smoke and good smells – they have to be able to tell what is barbecue and not fire.



Dr. Mohamed Zein-Sabatto



Dr. Mohan Malkani



DISCOVERY OF A NEW PLANET

Tennessee State University astronomer Greg Henry is part of an international 21-member research team that discovered a new planet outside of the Earth's solar system in Spring 2005. The new extrasolar planet is the first ever discovered to have a solid core composed of heavy elements. Scientists have not been able to determine the core composition and density in most of the other 150 extrasolar planets found to date.

"This is only the third extrasolar planet for which we can accurately measure its true mass and size and thus learn the density of the planet," Henry said. "The density tells us about composition." Knowing a planet's composition is important for ascertaining how it was formed.

Henry is part of a team of American, Japanese, and Chilean astronomers that first detected the planet's presence with large telescopes in Hawaii. TSU also operates an observatory in the mountains of southern Arizona. The eight robotic telescopes at this observatory have been designed specifically to make precise measurements of a star's brightness.

Henry's contribution was to discover that the planet's orbit was tilted at the right angle to allow the planet to move across the face of its host star as seen from Earth. He used the TSU robotic telescopes to measure the amount of dimming of the star's light during these transits (eclipses), which provides a direct measure of the size of the planet. The slight amount of dimming allowed Henry to deduce that the planet is much smaller and denser than expected.

The new planet is very close to its star, so it is much too hot to support life. "Given the new planet's large, heavy core," said Henry, "it is likely that it formed in a manner similar to the Earth and the other rocky planets in our inner solar system. This is tremendously exciting because it is another step towards determining whether or not other Earth-like planets might exist in the universe."



Dr. Michael Busby (l.) and Greg Henry (r).

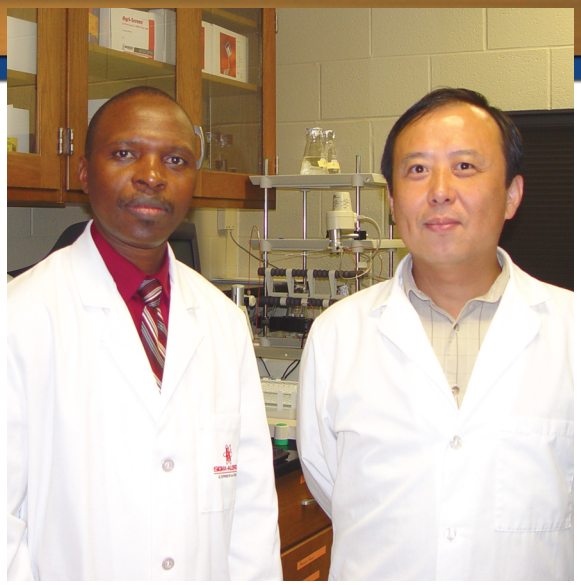


Greg Henry



TSU Telescope in Arizona

DEVELOPMENT OF A BIOSENSOR FOR RAPID DETECTION OF BIOLOGICAL AND CHEMICAL AGENTS



The traditional methods of detecting different biological agents – in historical labs complete with Petri dishes and test tubes — took several days or longer to grow the cultures needed for the work. As technology progressed more rapid methods such as DNA and protein analyses were developed that took about a day. Since the advent of bioterrorism, information about contaminants and pathogens has to be identified immediately. It is the goal of TSU researchers to detect biological and chemical agents in a few hours, ultimately working down to real time.

Drs. Fur-Chi Chen and Samuel Nahashon are currently engaged in research activities that relate to the development of rapid detection methods for biological and chemical agents in food, soil and water supply. The specific activities include the following: (1) construction of cDNA antibody libraries, followed by production of recombinant antibodies to emerging pathogens (*Salmonella* and *Campylobacter*), and (2) development of multi-channel biosensors for rapid identification of contaminants in food, soil and water.



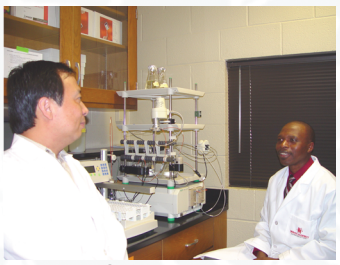
Dr. Samuel Nahashon

Recombinant antibodies are bio-engineered. The use of recombinant antibodies offers several improvements that are considered difficult or impossible with the conventional polyclonal antibodies. Recombinant antibodies can be generated against an innumerable quantity of known antigens including those considered to be toxic to animals. Moreover, affinity maturation (increasing the affinity and specificity) of recombinant antibodies is relatively simple and fast. Large numbers of different antibodies against a specific antigen can be generated in one selection procedure. These bio-engineered recombinant molecules provide solutions to improve and potentially replace the conventional antibodies.



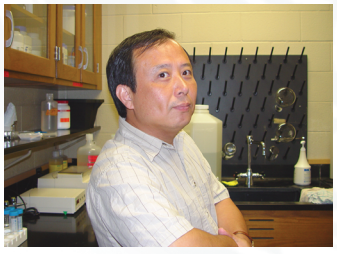
Dr. Agnes Kilonzo-Nthenge

The novel recombinant antibodies developed will serve as the essential part of several advanced technologies, such as biosensors and microarray chips which will have the recombinant molecules imbedded. These techniques have the potential to revolutionize current detection methods by providing high throughput and real-time detections. The successful completion of this USDA funded project will result in the first rapid detection method to use the phage, a virus that is parasitic in bacteria, displayed recombinant antibodies.



Drs. Chen and Nahashon

Chen's and Nahashon's goal is to develop a sensor platform that incorporates a commercially available integrated miniature SPR (Surface Plasmon Resonance) liquid sensor for rapid detection of *Salmonella* and *Campylobacter SSP* in foods. The sensing system will be fabricated using phage displayed recombinant antibodies developed in our laboratories. The sensor will provide a smaller, inexpensive, and portable format for applications in non-laboratory settings.



Dr. Fur Chi Chen



Dean William Lawson

CENTER FOR ACADEMIC EXCELLENCE IN INTELLIGENCE STUDIES

September 11, 2001, changed the way we viewed the world. It taught us about the necessity of some critical skills that go beyond what we traditionally teach our students. A significant component of the 21st century workforce will need a knowledge of research, multiple languages, political structures and a real understanding of the rest of the world.

In response to this, fifteen different intelligence agencies in the United States have formed an Intelligence Community under the leadership of the Central Intelligence Agency (CIA). This combined Intelligence Community has a need for greater diversity in both racial/ethnic composition and perspective.

The Intelligence Community diversity campaign is beginning with the first four pilot centers:

- Trinity University, Washington, D.C.
- Tennessee State University, Nashville, Tennessee.
- Florida International University, Miami, Florida.
- Clark Atlanta University and Georgia Institute of Technology, a joint center in Atlanta.

Each pilot center will have its own focus.

TSU's center, led by Dr. William Lawson, Dean, Arts and Sciences, and Dr. Soumen N. Ghosh, Director, Office of Business & Economic Research, will pursue activities designed to improve the curriculum used to prepare students for professional roles in the Intelligence Community. Several courses in the College of Arts and Sciences and the College of Business will be modified to include Intelligence Community knowledge and skills. Special topic courses will also be developed based upon Intelligence Community competencies.

The project will also consist of professional development activities. Professional development will include seminars on intelligence matters such as forensic accounting and money laundering. Two-way exchanges with the Intelligence Community will consist of workshops on our campus and at Intelligence Community agencies. Additionally, study abroad programs with an intelligence focus are planned.

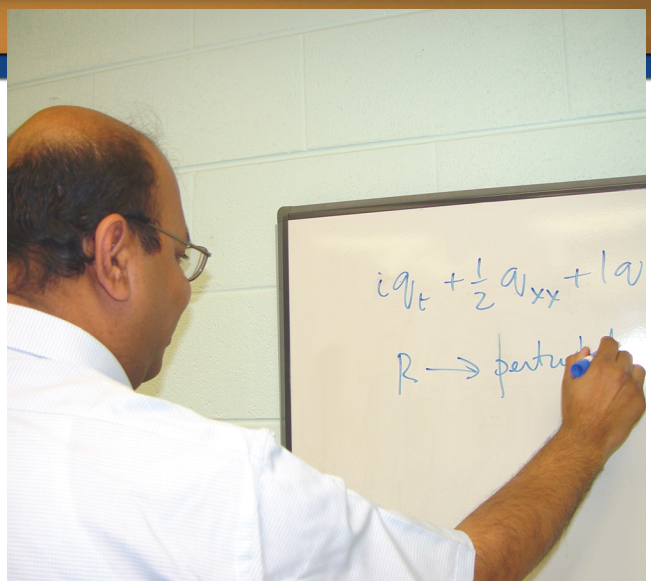
Research and outreach components are significant parts of the project. Research mini-grants will be available to those who develop proposals to do research germane to intelligence. Summer outreach activities for high school teachers and students will expose them to the nature of intelligence work. Strategic partnerships will be developed with other intelligence agencies and universities that will include faculty exchanges and technical support to strengthen existing partnerships

For TSU, this Center will be initiated with an 18 month endeavor. The objective is to strengthen our curriculum in order to better prepare our students with the necessary skills and knowledge needed to better serve our Intelligence Community. TSU will offer a minor and certification program in intelligence studies. Faculty and student development will be in the areas of history, political science, sociology, criminal justice economics, finance, accounting, information systems, computer science, information technology, and international business.



Dr. Soumen Ghosh

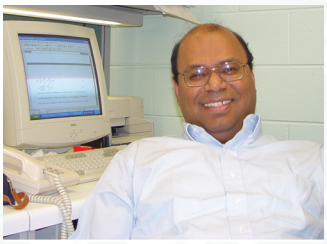
RESEARCH IN APPLIED MATHEMATICS

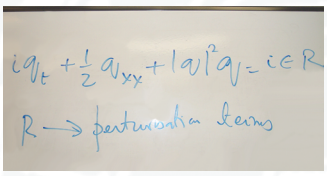


Dr. Anjan Biswas

Dr. Anjan Biswas, Professor of Mathematics, has had a very busy summer. He has presented papers of his research in Sozopol, Bulgaria, Kiev, Ukraine, and St. Petersburg, Russia, as well as presenting here in the United States. His research specialty is applied mathematics, which he describes as the "application of mathematics to various real world problems. Examples include the world of fluid dynamics, biological phenomenon, fiber optics and the physics of plasmas. This is in contrast to pure mathematics, or abstract analysis as it is also called, which is all theoretical.







Dr. Biswas, one of Tennessee State University's most published faculty, publishes ten to twelve articles each year in peer-reviewed journals. If he publishes fewer than ten articles, he considers himself a failure. He has published approximately 60 papers in refereed national and international journals during his seven plus years of research. Biswas' funding comes from the National Science Foundation through TSU's Center of Excellence, Information Systems and Engineering Management. This funding began in 2002 and will run through the summer of 2007. Dr. Biswas is extremely thankful for the constant support and encouragement provided to him by Dr. Michael Busby, the director of the Center of Excellence in Information Systems and Engineering Management.

Dr. Biswas' favorite study is the dynamics of pulses that propagate through fiber optics. He studies mathematically the measurements of distortion and impurities of plasmas when pulses spread through plasmas. When two or more pulses travel through the same fiber, they tend to interact and will hamper the information we receive. Biswas and associates are developing a mathematical model that will suppress this interaction and keep the pulses separated so that what comes out of the fiber is basically what went into it. Biswas and associates are developing and studying very short, nanosecond pulses.

Biswas' other research includes the use of multiple-scale perturbation analysis to study perturbed optical solitons, a comparative study of the advantages and the disadvantages of two approaches used for studying the classical optical solitons along with its perturbations. Other research involves the evolution of quasi-linear pulses in optical fibers, with strong dispersion management, is studied analytically. He views his work as a collaborative effort among physics, real world engineering (those who actually design optical fiber systems), and applied mathematical technology.

In addition to research and publishing, Dr. Biswas is an editorial board member of the Journal of Electromagnetic Waves and Applications which keeps him very busy. He reviews papers from all over the world. He also mentors students, assisting them in their research and helping them publish their work.

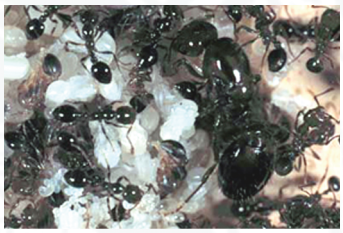


BIODEFENSE AGAINST THE RED IMPORTED FIRE ANT

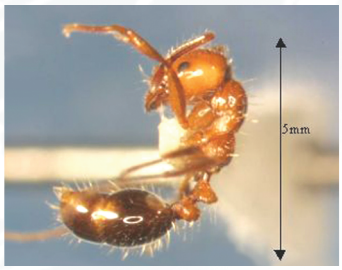
Biological research continues to open new doors to combat natural or intentional disasters. Often, the most specific and effective strategies against an unwanted circumstance include mimicking the detection and countermeasures that nature already uses. This philosophy holds promise in defense against a variety of challenges from human diseases to garden pests. One of the many areas of biodefense expertise at Tennessee State University is in entomology. Dr. Jason Oliver has developed a number of visual and chemical traps for a variety of insects from his studies of their natural preferences. Dr. Samuel Ochieng has studied the discriminating sensors of insect antennae and the possibility of exploiting their ability to detect as well as quantify the presence of specific chemicals. Currently, Drs. Oliver and Ochieng are studying natural methods to manage the invasion of red imported fire ants at TSU's Otis L. Floyd Nursery Research Center in McMinnville, TN.











The red imported fire ant was introduced into the United States from South America at the port of Mobile, Alabama, in the early 1900s. It is a serious pest of agricultural, wildlife and urban areas. The ant dramatically reduces populations of native ants, other insects, and ground-nesting wildlife in infested areas. Fire ants often become the dominant ant species due to their high reproductive capacity, aggressive foraging behavior, and lack of effective natural enemies. In the US, stings from fire ants inflict intense pain to millions of Americans each year with thousands requiring medical treatment. A small number of people develop a life-threatening allergic reaction, and there have been confirmed deaths due to imported fire ants in several southern states. Imported fire ants also attack and occasionally kill domestic animals and wildlife as well as destroy seedling corn, soybeans, and other crops. Fire ant mounds can damage farm equipment and lawn mowers. Since fire ants are attracted to electrical equipment and chew on insulation, short circuits and interference with switching mechanisms may result. Fire ants can also shut down air conditioners, traffic signal boxes, and even airport runway lights leading to damage and control costs estimated to be more than $6.5 billion a year.

Jason Oliver and Samuel Ochieng are investigating alternative ways of controlling the imported fire ants using safer and more environmentally friendly methods. One solution they are investigating is to increase the utilization of biopesticides in nursery production. The EPA defines biopesticides as pesticides derived from natural materials such as plants, bacteria, and certain minerals. Biopesticides have a number of advantages over conventional pesticides, including: 1) inherently less toxic to humans, 2) generally affect only the target pest, 3) often effective in small quantities, 4) decompose quickly, and 5) can reduce reliance on conventional insecticides. Unlike chemical pesticides, natural enemies can be utilized in any habitat where fire ants occur. Natural enemies approved for use in the US affect only fire ants and may improve and extend the effectiveness of insecticide treatments. Drs. Ochieng and Oliver tell us that everyone benefits from the biological control of the imported fire ants: agricultural and livestock producers, schools, businesses, military, and, especially, the natural environment.

GOATS: AN ALTERNATIVE FOR TENNESSEE FARMERS

More than 200 goats and kids roam the fields of the farm on Tennessee State University's main campus. These animals are part of research projects on meat goats led by Dr. Richard Browning, Associate Professor, Institute of Agricultural and Environmental Research (IAgER). The purpose of this research is to develop and introduce a competitive goat production system for small farmers in Tennessee as an alternative to beef cattle production, tobacco farming, and other farming activities for which they are losing markets, or are likely to lose market share. The educational program investigates breeding evaluation, or which goat breed hybrids work the best for the small farmer. The research for this is based on work done at the farm at TSU.

In the meat goat business, this research is building fundamental information as there is no basic research on goats for this purpose. More cattle research is done in laboratories because the basic, fundamental knowledge has already been established. Therefore, these researchers, including student researchers, are in the field, learning to recognize recurring diseases, observing maternal and kid performance, and doing everything it takes to keep the goats and kids healthy.

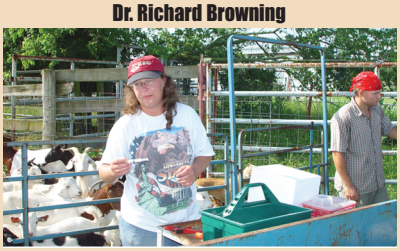
TSU became involved with meat goats in 2001, starting with a small herd for investigating the possibility of converting the research focus from cattle to goats. In April 2002, TSU introduced the first breeding goats, the Boer breed of goats from South Africa, 14 of which were does (female goats). In Spring 2005, 162 does bred. In the next cycle, 200 does are expected to breed.

Meat goats are growing in popularity in the state and country. Approximately ten years ago, Tennessee began experiencing an increase in ethnic diversity. Many of the recent immigrants have had goat as part of their daily diet. This led to the importation of Boer (South African) and Kiko (New Zealand) goats. The Spanish herds have been in this country since the Spanish Exploration days. Tennessee is the second largest goat producer in the nation, behind Texas. There are more than 100,000 meat goats in Tennessee, while there are over 1,000,000 head of cattle in the state. Today, Tennessee State University has the only research herd of Kiko goats in the nation.





Dr. Richard Browning











Far right photo from left to right: Prashant Pandya, Animal Science senior and August 2005 graduate, Bridget Donnelly, Research assistant, 1994 TSU graduate, William Hendrixson, Animal Science graduating senior and Mozell Byars, Research assistant and TSU graduate.











SUBMISSIONS
BY CENTER/COLLEGE/SCHOOL

Academic Affairs	$ 457,860
Agriculture and Consumer Sciences	1,126,243
Arts and Sciences	15,025,304
Business	1,106,226
Cooperative Extension Program	5,116,024
Center for Health Research	3,560,263
Center for Excellence - ISEM	4,123,150
Center for Excellence - RPC	7,358,531
Education	2,598,751
Engineering, Technology, & Computer Science	14,892,979
Health Sciences	2,388,423
Institute of Agricultural & Environmental Research	8,833,890
Massie Chair of Excellence in Environmental Engineering	2,197,691
Nursing	399,095
RIMI Center for Neuroscience	3,431,498
Student Affairs	1,450,333
Institute of Government	150,000
Research and Sponsored Programs	16,989,695
Total	**$ 91,205,956**

AWARDS
BY CENTER/COLLEGE/SCHOOL

Academic Affairs	$ 2,500
Agriculture and Consumer Sciences	156,642
Arts and Sciences	1,158,082
Business	590,508
Center of Excellence – ISEM	2,640,730
Center of Excellence – RPC	4,715,250
Center for Health Research	1,164,933
Cooperative Extension Program	2,410,694
Education	1,072,323
Engineering, Technology, & Computer Science	3,693,648
Finance and Accounting	24,576
Health Sciences	1,489,456
Institute of Agricultural & Environmental Research	4,178,134
Massie Center of Excellence in Environmental Engineering	410,000
Nursing	27,998
RIMI Center for Neuroscience	795,854
Student Affairs	605,808
Research & Sponsored Programs	1,977,150
Title III	6,403,680
Total	**$ 33,517,966**

SUBMISSIONS
BY AGENCY/CORPORATIONS/FOUNDATIONS

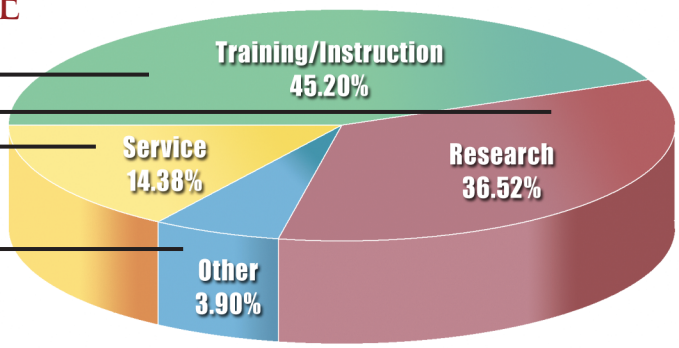
Corporations	$ 178,500
Foundations	2,372,186
Environmental Protection Agency	554,565
Institute of Museum and Library Services	994,100
National Aeronautics and Space Administration	5,771,972
National Science Foundation	17,401,910
Tennessee State Agencies	2,152,668
U.S. Air Force Research Lab	214,577
U.S. Army	891,242
U.S. Department of Agriculture	13,675,449
U.S. Department of Defense	3,878,673
U.S. Department of Education	7,621,388
U.S. Department of Energy	8,644,777
U.S. Department of Health and Human Services/NIH	18,690,347
U.S. Department of Homeland Security	1,516,442
U.S. Department of Housing and Urban Development	4,375,060
U.S. Department of State	750,656
U.S. Missile Defense Agency	627,004
Other	894,440
Total	**$ 91,205,956**

AWARDS
BY AGENCY/CORPORATIONS/FOUNDATIONS

Corporations and Foundations	$ 360,999
Institute of Museum and Library Services	994,100
National Aeronautics and Space Administration	4,204,759
National Science Foundation	1,300,994
Tennessee State Agencies	112,742
U.S. Department of Agriculture	6,548,912
U.S. Department of Defense	665,073
U.S. Department of Education	9,298,826
U.S. Department of Energy	793,000
U.S. Department of Health and Human Services/NIH	8,162,103
U.S. Department of Housing and Development	585,050
U.S. State Department	194,167
U.S. Small Business Administration	166,341
U.S. Department of Interior	65,000
U.S. Department of Transportation	40,900
U.S. Department of Labor	25,000
Total	**$ 33,517,966**

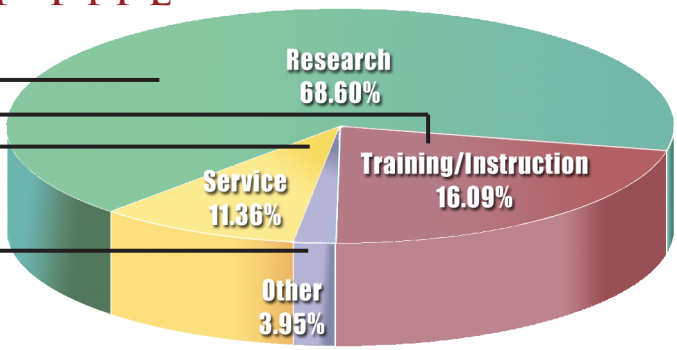
AWARDS BY PROJECT TYPE

Training/ Instruction $15,147,531 (76)
Research $12,239,095 (42)
Service $4,820,790 (24)
Other $1,310,550 (12)
TOTAL $33,517,966 (154)



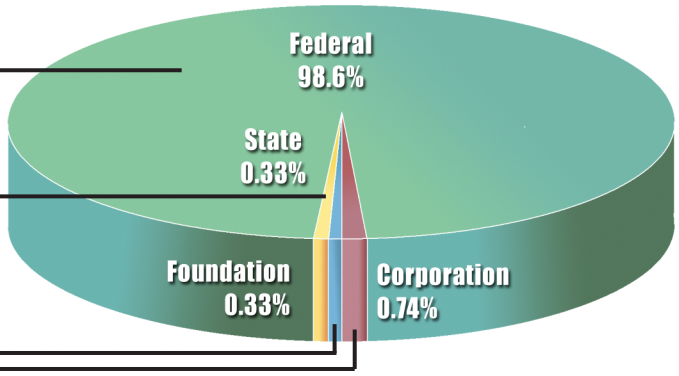
SUBMISSIONS BY PROJECT TYPE

Research $62,562,948 (113)
Training/Instruction $14,677,044 (36)
Service $10,364,140 (17)
Other $3,601,825 (12)
TOTAL $91,205,956 (178)



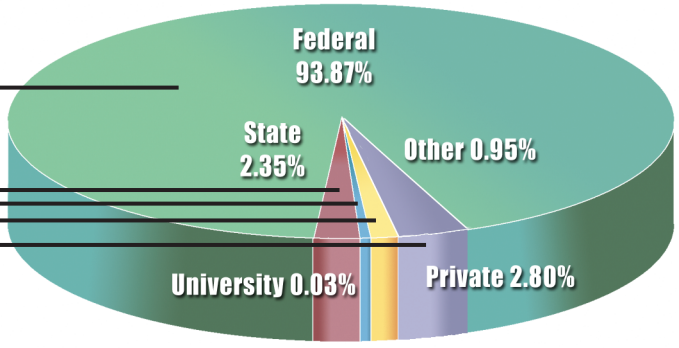
AWARDS BY SOURCE

Federal $33,044,225 (134)
State $112,742 (7)
Foundation $114,576 (2)
Corporation $246,423 (11)
TOTAL $33,517,966 (154)



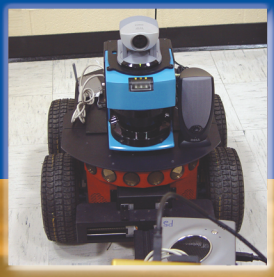
SUBMISSIONS BY SOURCE

Federal $85,619,327 (143)
State $2,141,503 (12)
University (Other) $24,000 (1)
Other $870,440 (2)
Private (Foundation) $2,372,186 (11)
Private (Corporation) $178,500 (9)
TOTAL $91,205,956 (178)



Division of Research and SPONSORED PROGRAMS






Research at Tennessee State University utilizes the diverse skills and expertise of our researchers, faculty, staff, and students to make significant and sustained contributions to the knowledge of humankind through new discoveries that have positive impact on our community, our nation, and the world in which we live. At Tennessee State, we believe research is essential to excellence in education and enhances the educational experience of our students.

Marcus W. Shute, P.E, Ph.D.
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