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CYBERSECURITY Scholarships will open doors for UAH students

UAH Research Magazine //

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Dr. Ray Vaughn

elcome to this edition of FOCUS, UAH's research magazine. It is our intent to use this as a vehicle to focus attention on selected research successes, projects and those engaged in them. We have highly productive, innovative and talented faculty, staff, and students at UAH, which always makes it a pleasure for me to recognize their efforts and achievements. As a Carnegie Foundation Very High Research Activity University - one of only two such universities in the State of Alabama – research is a core value for us, and supporting its growth is a fundamental mission of my office. We take great pride in our support of Redstone Arsenal and NASA's Marshall Space Flight Center and constantly reinforce the historical reasons for that support, beginning with

At UAH, research is a core value

Dr. von Braun's arguments for a "research institute" here in Huntsville.

A feature story in this issue addresses our cybersecurity program. UAH is a National Center of Academic Excellence in Information Assurance Education certified by the National Security Agency and the Department of Homeland Security. Cybersecurity is treated at UAH as a problem area requiring a multidisciplinary approach, and as such, the research in this area engages faculty from our Colleges of Business Administration, Engineering, Liberal Arts, Nursing and Science.

The work we do ranges from traditional computer and network security to human factors to industrial control systems to medical devices and to transportation systems. We offer a Master of Science degree in Cybersecurity with tracks in Business Administration, Computer Engineering or Computer Science. We also provide doctoral studies in this important area, guided by faculty with strong credentials. In 2014, UAH was awarded a highly prestigious National Science Foundation grant to implement a "Cyber Corps" Scholarship for Service Program that allows us to provide full scholarships to students at the undergraduate and

graduate levels to pursue cybersecurity studies in exchange for government service upon graduation.

Also in this issue is a focus on our new Dean of Science, Dr. Sundar Christopher, who has lead UAH to national prominence in the field of Atmospheric Sciences. We are delighted to have such an accomplished individual lead this important college. You will also find an article featuring student success. We hope to continue to publish our student's achievements in every issue of this magazine – they are an amazing and talented resource for UAH and we would like to share some of their many efforts with you.

We are also proud to feature our alumni and their achievements. This issue welcomes Virginia "Ginger" Barnes back home to Alabama in her role as a Boeing vice president and Space Launch System program manager.

Please take a few moments to look through this snapshot of UAH research and contact our office for additional information if needed. My office is always available to provide information on the efforts featured in this magazine or any other research project ongoing at UAH. **Go Chargers!**

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COVER: From left, Dr. Seong-Moo (Sam) Yoo, Dr. Sara Graves and Dr. Jatinder (Jeet) Gupta joined Vice President for Research Dr. Ray Vaughn to bring \$4.2 million in National Science Foundation cybersecurity scholarships to UAH.

The University of Alabama in Huntsville has the largest research expenditures among public universities of its size.



SOURCE: National Science Foundation fiscal year 2012 data

NATIONALLY **5**TH Federally financed Federally financed Department of aeronautical/ Defense R&D business and astronautical management research expenditures engineering research NASA R&D Federally financed Federally financed computer sciences expenditures atmospheric research expenditures sciences research

BOOSINC OPPORTUN

\$4.2 million in cybersecurity scholarships mean students can gain an employment edge

Students will get financial help and an important foot in the door when it comes to employment in cybersecurity positions from a five-year, \$4.2 million National Science Foundation-funded full cybersecurity scholarship program at The University of Alabama in Huntsville (UAH), university officials say.

"This is a highly competitive program with only a few universities nationally that are funded to implement it. It allows us to attract students to UAH for the scholarship and to support those students that are awarded the scholarship," says Dr. Ray Vaughn, UAH vice president for research. "It is prestigious and allows our students to be exposed to other cyber corps scholarship students nationally, as well as to gain valuable on-the-job experience during their internships. The grant provides an opportunity for renewal after five years by submitting another NSF proposal to do so."

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The scholarship is the best opportunity that he knows for a student that wants to enter the field of cybersecurity as a working professional, says Dr. Vaughn.

"It affords the student the opportunity to focus on cybersecurity studies without worrying about financial concerns







More details about Cyber Corps Scholarship for Service Program can be found at www.uah.edu/center-for-information-assurance/cybersecurity-scholarships.

associated with tuition, living expenses or books," he says. "It also gives the recipient the opportunity to immediately move into a cybersecurity position upon graduation and serve the government in an exciting and very important role."

The Scholarship for Service (SFS) program pays for tuition, reimburses health insurance up to a maximum of \$2,000 a year, reimburses books up to \$1,000 a year and pays for professional development travel up to \$3,000 a year. In addition, a stipend is paid each academic year in the amount of \$20,000 for undergraduates, \$25,000 for master's degree students and \$30,000 for doctoral students. Scholarships are awarded for two academic years (four semesters) for undergraduates and master's degree students and for three years (six semesters) for doctoral students. A single student cannot receive more than one SFS scholarship.

"I ran this same program at Mississippi State University (MSU) for over 10 years so I'm well versed in its advantages and I know what it takes to be successful," Dr. Vaughn says. "I grew the MSU program into one of the largest in the U.S. and would hope to have the same sort of success here."

Students can get a leg up on cybersecurity hiring through the scholarship as they serve a paid internship during the summer semester in a government cybersecurity related position and fulfill a post-graduation scholarship obligation of one year of government service in a cybersecurity related position for each year of scholarship.

"These students must work for the government – federal, state, local or

tribal – after graduation, so the internship provides them with mentoring and real world experience during their educational experience and offers the government the opportunity to get to know the student prior to making a permanent job offer," Dr. Vaughn says.

Dr. Vaughn is the chief principal investigator for the NSF grant program, along with co-principal investigators Dr. Sara Graves, Computer Science Department professor and director of the UAH Information Technology and Systems Center (ITSC); Dr. Jatinder (Jeet) Gupta, associate dean of the UAH College of Business Administration (CBA); and Dr. Seong-Moo (Sam) Yoo, associate professor in the Electrical and Computer Engineering (ECE) Department.

"I selected a very experienced and mature team of faculty to work with at UAH," Dr. Vaughn says. "They represent three colleges – Science, Business Administration and Engineering. These are the colleges that we will draw students from."

"A number of M.S. and Ph.D. students are conducting research in cybersecurity," Dr. Graves says. "The NSF grant for SFS will help the Computer Science Department attract some of the best students to B.S., M.S. and Ph.D. programs and further enhance the ongoing research activities in the area of cybersecurity."

Dr. Yoo says availability of the scholarships may enhance UAH nationally. "This scholarship is announced nationally, so UAH can recruit scholarship recipients from talented students nationally," he says.

In addition, Dr. Yoo says the scholarships will benefit students in the ECE Department, which offers information assurance

programs, a master of science (MS) degree in cybersecurity with a computer engineering track and a master of science in engineering degree in computer engineering/electrical engineering (CPE/EE) with a concentration in information assurance. In addition, a doctoral student in CPE/EE can select a cyber-security related research subject in his or her doctoral dissertation. Also, the department is planning to offer an undergraduate or graduate certificate in cybersecurity engineering while a student continues to study to obtain his or her BS/ MSE degree in CPE.

"This scholarship program will help the department to recruit new students who have financial difficulty but have strong intentions to study cybersecurity engineering for their careers," Dr. Yoo says. "The scholarship may encourage some existing students to change their future career goals."

UAH's College of Business Administration participates in offering the MS degree in cybersecurity and offers a graduate certificate program in cybersecurity studies and an undergraduate concentration in cybersecurity and information assurance.

"The NSF grant for SFS will help us attract some of the best students, who upon graduation will serve the governmental agencies," says Dr. Gupta. "Cybersecurity is one of the strategic thrusts of UAH. These scholarships and the opportunities created for the students will enhance the university's reputation and will attract more students and more qualified faculty. This will help UAH to serve the community better, as well." Students awarded a

scholarship must be enrolled full-time at UAH, which is a National Center of Academic Excellence in Information Assurance Education, and be U.S. citizens able to obtain a U.S. security clearance. They must meet all requirements for employment in federal service. "These internships often result in the student receiving a security clearance as a necessary part of their employment," Dr. Vaughn says.

Undergraduates must be entering their junior year of studies. A minimum of a 3.0 grade point average (GPA) as an undergraduate and 3.2 GPA as a graduate student are required, and students must be in a bachelor's or graduate degree program in the discipline of Computer Science, Software Engineering, Electrical Engineering, Computer Engineering, Information Systems, or Information Assurance and Security with a focus on cybersecurity.

Participation in a government job fair in early January in Washington, D.C., is required of all students supported by the program.

"We are pleased to offer this program to our UAH students," says Dr. Vaughn. "We believe it will be a valuable source of employees for our Department of Defense, NASA, and government organizations located in this community."

CanSat team

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Third in the world! That's where two UAH student CanSat teams finished overall among the international competitors at the 2014 International CanSat Competition in Burkett, Texas. But wait! UAH was also the top United States competitor overall, besting 13 other U.S. college and university teams. In team competition, Team Wind Charger was led to third place by Evan Tingley, while Jordan Teats led Team Blackout to seventh. Over 30 international teams competed. UAH's CanSat teams are primarily composed of freshman and sophomore engineering and science students as part of the Space Hardware Club. They faced competition from senior design students at most other colleges and universities entered. The International CanSat Competition is sponsored by the

RECORDER

DO NOT OPEN

American Astronautical Society (AAS), American Institute of Aeronautics and Astronautics (AIAA) and NASA. Competitors conceptualize, design, build, test and fly a small mock satellite. It's an annual student design-build-launch competition for space-related topics, giving students the satisfaction of being involved with the end-to-end life cycle of a complex engineering project. Teams are responsible for funding the construction of their CanSat and all travel and lodging expenses. CanSat at UAH is funded and supported by the Alabama Space Grant Consortium, the College of Engineering, the Student Government Association and the Mechanical and Aerospace Engineering Department, and is advised by Dr. Francis Wessling.

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SPACE HARDWARE CLUP

3rd Place

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STUDENT // FOCL

BUILDING BRIDGES TO INTELLECTUAL DISCOVERY

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Dr. Brian Landrum is an inquisitive guy who won't let his intellectual curiosity be pigeonholed. His growing interest in how aerospace systems can provide solutions to important problems has led the Mechanical and Aerospace Engineering associate professor, whose training lies on the "aero side of MAE," to numerous interdisciplinary interactions across campus. The research from these collaborations raises interesting questions and intriguing possibilities. "I'm interested in technology history and how technology impacts and enables developments in society," he says. Three collaborations are illustrative. Dr. Landrum joins Aerospace Systems Engineering graduate student Tom Percy and Dr. Kathy Hawk of Political Science in a cutting-edge exploration of orbital space debris mitigation that encompasses technology, economics and political policy and has attracted interest from NASA. Next, in a UAH Cross-College Faculty Research (CCFR) funded effort with Dr. Rob Griffin and other researchers in the Earth System Science Center, he's exploring how a hex-rotor unmanned

aerial vehicle - possibly flown to a site by a blimp-like mother craft – can use infrared and multi-wavelength cameras to gather local soil moisture data. This would be compared with wide-scale soil moisture data collected from space by Landsat satellites to calibrate moisture models, which could help boost global agricultural production. Under another CCFR grant, Dr. Landrum joined Dr. Pam O'Neal and Dr. Ellise Adams from Nursing, Dr. Jodi Price from Psychology and Dr. Al Wilhite from Economics to investigate a self-contained rapid prototyping device that may someday 3D print prosthetics for patients in Third World countries by using scans and basic measurements that are input by nurses without the need for special skills. "These are just three current activities that really show the great opportunities available for interacting with other departments," Dr. Landrum says. He's found it broadens his knowledge of UAH research and its possible application. "It makes me keep up to date on what's going on out in the world."

ACULTY // FOCUS

UAH LAUNCHES AN UNEXPECTED LIFE FOR SPACE LEADER

As vice president and program manager for the Boeing Exploration Launch Systems, Virginia "Ginger" Barnes leads the effort to build the core stages and avionics for the Space Launch System, NASA's next generation heavy lift launch vehicle that will take humans into deep space.

NASA

She manages 1,200 people who are designing, developing and building the SLS ahead of schedule. Forging a new way of doing business with suppliers, partners and customers, Barnes has an inclusive philosophy that achieves extraordinary progress on the rocket that may change what we know about the universe.

"The relationships I developed through UAH allowed me to build a great network of friends and colleagues – and those same people helped me to be active right away in the community when I returned to Huntsville to help build this rocket," Barnes says.

Her advice to today's students? "Find your passion and follow it. Take responsibility for your career and then keep learning every day."

The youngest child of six, Barnes was born in Fairfax, S.C., and moved often with her family constructing commercial buildings before settling in Decatur at age 12. As college approached, she knew she would have to make higher education happen for herself with work-study, loans and scholarships.

"I started in pre-med, then changed to a math major, then French and English major, and got married, left school, returned to school, then took a job in my senior year that slowed down graduation but launched my career," says Barnes. She graduated from UAH's accounting program with high honors and earned her master's degree in business from Vanderbilt's Owen Graduate School of Management Executive Program.

"I found a wonderful mentor in Dr. Eugene Bryson, who made all the difference for me. When my first accounting professor called me with a job opening from Boeing, I wasn't sure I should leave school so close to the finish line. But I had Dr. Bryson to advise me. I took the job and I loved it. And Boeing paid for the rest of my tuition!"

On the way to business success, she's also become a commercial pilot, instructor and an FAA-designated examiner for hot-air balloons, all while raising a son.

Barnes began her career in 1981 as a Boeing Huntsville cost analyst, then moved to Houston and St. Louis to accept growing levels of defense and space responsibility. She left Boeing as Vice President, Chief Operating Officer and Deput ty Program Manager, overseeing programmatic and financial aspects of the Army's modernization efforts.

As president and chief executive officer of United Space Alliance LLC (USA) from April 2010 to May 2013, Barnes was responsible for U.S. strategic direction and operations through the last five flights of the Space Shuttle, retiring that program as NASA began its deep space exploration vision. She then returned to Boeing to lead the SLS program.

Her ties to UAH remain strong, she says. "And Dr. Bryson is still mentoring me!"

RESEARCH // FOCUS



GATHERERS MAKE IT ALLURING TO GIVE AWAY OUR INFORMATION ONLINE. HOW CAN WE BE EFFECTIVELY WARNED NOT TO? n ground-breaking research, two University of Alabama in Huntsville (UAH) professors are figuring out the most effective ways we're influenced to give away personal information online and what warnings would be most effective to get us to stop being so generous with people who profit from our information or use it in other ways that are bad for us.

Dr. Sandra Carpenter, professor of psychology, and Dr. Feng (Frank) Zhu, assistant professor of computer science, are currently working under a \$464,000 National Science Foundation (NSF) grant, and as far as the NSF can tell, the UAH professors are among the first asking these types of questions.

"We're trying to have people be more careful with the personal information they divulge online," says Dr. Carpenter. "The problem is what is it you can say to them that will be an effective warning?"

The scientists routinely call such inquiries "attacks," because while they seem friendly and innocuous on our screen – and are designed to appear so – we don't really know who is collecting the information

"We grouped what elements people think are important and what are not important," says Dr. Zhu.

or for what it is intended. Gatherers often use one or more social influencing strategies that originate in marketing or cultural contexts, like providing us a reward, to increase their success rates.

It would be nice if something could effectively clue us in to all this by getting our attention before our fingers go tappity-tap. Warning apps or plug-ins are possible outcomes of the research, but they'll only work if they use effective methods that grab our attention.

Dr. Zhu and Dr. Carpenter are using eye trackers to detect where a user's eyes are on a screen and how long they stay at any point, and they have looked at the research on which warnings work in industry for toxic chemicals and other dangers. They are probing with the Communication Human Information Processing (CHIP) model to discover which authoritative warning sources are more credible with users.

"CHIP indicates the stream of processes a person goes through in order to accept a warning," Dr. Carpenter says. They include assessing the strength of the authority issuing it, comprehending it, remembering it, changing attitudes because of it and being motivated to modify behavior.

"We're looking at all those different stages and the effectiveness of warnings," Dr. Carpenter says.

The scientists have performed experiments with disclosure behaviors when test subjects are not under attack, when they are under attack, and when they are under attack but have been effectively warned.

"When they are under attack with an effective warning, we find that people disclose at about the rate of those not being attacked," says Dr. Carpenter. "We are currently trying to see which warning words work best and we are testing now to see which source is more credible and effective for the warning."

PEOPLE TARGET

They've been asking these kinds of questions awhile, determining the scope and parameters of disclosure since 2008. That research identified the types of information people are more cautious about divulging and what private information inquiry techniques are most effective.

Dr. Carpenter recalls the day psychology met computer science and the seed for collaboration was planted.

"What's that quote? Amateurs attack software: professionals attack people?" Dr. Carpenter says. "Well, Frank came into my office one day and said that quote to me, and then he said, 'So I have to know about psychology.'"

Dr. Zhu digs a book from his office shelf to provide the exact quote from computer privacy and security expert Bruce Schneier: "Only amateurs attack machines; professionals target people."

At first, the researchers experimented to find out how concerned we are about the whole privacy issue and then organized a chart of relative concerns.

"We grouped what elements people think are important and what are not important," says Dr. Zhu. "What privacy concerns do you have and what safety measures have you taken? We had to design an experimental environment that would reflect their true attitudes."

"We asked people questions like how important to them it is to keep a hobby private, and how important it is to keep your Social Security number private," Dr. Carpenter says.

And they found out very early in the research just how amazingly open people are online. "One of the biggest problems is that, even when people know we are trying to collect this information on them, they are willing to give it out freely," Dr. Carpenter says.

Initially, "we didn't think any kind of a warning that we were collecting the information was necessary," Dr. Carpenter says. Right away, they discovered in experiments that just about everybody tested was willing to share all under any conditions if simply asked.

"We looked to see under reciprocity conditions what information people would give us and we found out that even in the control group, they gave us all the information requested," says Dr. Carpenter.

So next, they informed test subjects that what they supplied was being collected for use, even though during the experiments none of the data provided by subjects left the laboratory or was permanently collected.

"We told them we were collecting it for a third party," Dr. Carpenter says.

Within that framework, they began to explore the success rate of attacks launched by asking for information without using social influences (reciprocity) to attacks made using social influences.

"Using a social influencer with a third-party scenario, we found that people are three to five times more likely to disclose their private information," says Dr. Carpenter.

"We're doing this research to try to figure out how we can best reduce that disclosure behavior."

STUDENT ENGAGEMENT, RESEARCH DEDICATION HALLMARKS OF UAH'S NEW DEAN OF SCIENCE

As the new Dean of the College of Science at The University of Alabama in Huntsville (UAH), Dr. Sundar Christopher brings an active research and academic portfolio with him along with 17 years of experience in the university's nationally recognized, top-tier Atmospheric Science Department and a desire to remain directly connected with research, students and faculty.

"I am a research-active dean, engaged in discipline-specific and interdisciplinary research projects," Dr. Christopher says. "Bringing leading-edge research into the classroom for the College of Science students is important."

At the same time, Dr. Christopher understands that broadening the university's research portfolio and engaging industry partners in the region and beyond will provide opportunities for UAH's students, faculty and staff.

"These are relationships I will foster," he says, "so that our students gain experience working alongside industry professionals."

Dr. Christopher has received more than \$10 million in research funding through grants and contracts and has earned a NASA New Investigator award and also a 2006 UAH Foundation Research and Creative Achievement award. He holds advanced degrees both in the liberal arts (Master of Arts, psychology, with industrial/organizational specialization) and in science (Ph.D. in atmospheric science), a balanced academic background he says provides him with a well-rounded approach. "Students and faculty are mindful of how

their interests and experience can be applied to solve interdisciplinary problems that cut across departments and colleges," says Dr. Christopher, who has written more than 100 peer-reviewed research papers. "My goal is to continue to encourage faculty to bring their leading-edge research to the classroom."

Dr. Christopher joined the UAH faculty as an assistant professor 17 years ago and rose through the ranks.

He has taught, encouraged and mentored more than 20 graduate students through their master's or doctoral degree programs, including four NASA Earth and Space Science Fellowship recipients and Dr. Jianglong Zhang, who received both a 2010 Presidential Early Career Award for Scientists and Engineers and the 2011 NOAA David Johnson Award.

"Our students are truly ambassadors for our programs," says Dr. Christopher. "Their success reflects the hard work of the faculty at UAH."

In May 2010, Dr. Christopher was named chairman of UAH's Atmospheric Science Department, which has been ranked as one of the top 10 programs in the nation since 2007 by The Chronicle of Higher Education.

While he was chair, the department added a master's degree program in Earth system science and expanded its student recruiting activities. He served the university's research enterprises as both the associate director of the Earth System Science Center (ESSC) and director of the Institute of Remote Sensing Applications within the ESSC, developing research and academic initiatives to foster partnerships with National Oceanic and Atmospheric Administration (NOAA) cooperative institutes, NASA and other organizations.

"UAH is truly a unique place where



Dr. Sundar Christopher is a research-active dean who plans to remain directly connected with research, students and faculty.

SUNDAR CHRISTOPHER

"I AM A RESEARCH-ACTIVE DEAN, ENGAGED IN DISCIPLINE-SPECIFIC AND INTERDISCIPLINARY RESEARCH PROJECTS."

research centers and academic departments work together to advance research and train the next generation of scientists," he says. "It has been a privilege to serve these organizations in a leadership role."

Throughout his tenure as department chair, Dr. Christopher has continued to teach courses related to Satellite Remote Sensing and to lead a team of research scientists and students.

"Mentoring students is an important part of my life at UAH," he says. "Empowering students to reach their potential and then seeing them succeed at the highest levels inspires me to remain student-centered."

Expanding his role as a student mentor, he wrote "Navigating Graduate School and Beyond," published by the American Geophysical Union. In it, Dr. Christopher outlines the steps and skills needed to succeed in graduate school and in a research or academic career.

"This book provides practical advice on how to navigate graduate school and beyond," he says, "and provides important tools such as proposal writing and time management."

Before coming to UAH, Dr. Christopher held positions at the South Dakota School of Mines and Technology, where he earned a Master of Science in meteorology. He earned his doctorate in atmospheric science at Colorado State University, his Master of Arts in industrial organizational psychology at UAH, and a bachelor's degree in engineering from the P.S.G. College of Technology. RESEARCH CENTER // **FOCUS**



ROTORCRAFT CENTER HARNESSING UAH'S CAPABILITIES

David Arterburn is a retired U.S. Army aviator who flew Black Hawk helicopters and spent his last seven years of active duty as an experimental test pilot. He has also been the chief engineer for two major helicopter development programs, UH-60M Upgrade and OH-58F, and the chief of the Technical Management Division for the Armed Scout Helicopter Project Office.

Now he's devoted to advancing technology for the future.

Arterburn took over as director of UAH's Rotorcraft Systems Engineering and Simulation Center (RSESC) in late 2013. RSESC was established in 2003 as an initiative between the Program Executive Office – Aviation (PEO-AVN), Aviation and Missile Research and Development and Engineering Center (AMRDEC) and UAH. Since its inception it has grown to 17 fulltime employees, 12 on-call researchers, and 34 student employees – six on staff.

His new mission is to guide the RSESC back to its roots to advance engineering for rotorcraft and have an impact on the future of Army aviation through interaction with the faculty and students at UAH.

"We want to harness the power of the university to support vertical lift," Arterburn says. "I'm excited about moving it forward and about the university getting more involved in unmanned systems."

To do that, Arterburn is focusing on developing stronger partnerships with vertical lift research centers of excellence at Pennsylvania State University, the University of Maryland and Georgia Institute of Technology to broaden research opportunities.

"We have been working hard on research problems that are of interest in the rotorcraft community," Arterburn says. "We have 28 students working at the Boeing Huntsville Design Center. They get to work in an engineering environment, mentored by folks in the rotorcraft center. We select, hire, and manage those positions here and it's a model of how the industry works with the university to tap talent early." He says the students work part-time, year around, not just two months in the summer.

"It's a very interesting opportunity for them to learn about the work culture and the tools they use and then it provides Boeing a tremendous asset to use when the students graduate and they hire them."

Clay Colley, a principal investigator who oversees the Boeing students, says the program allows students to earn real work experience doing relevant work in the aerospace field.

"They get to learn aspects of engineering that you don't learn in a book or in the classroom," Colley says. The six students on the RSESC staff are aligned to specific projects involving design, engineering and fabrication of payloads.

"We have computer science majors who write the software, design engineers who design and build it, and then systems engineers who work on the systems," Arterburn says. The center features an electrical, mechanical design and manufacturing lab with a machine shop, a prototype lab, a system engineering lab, and a materials and non-destructive experimentation lab. Two labs are currently undergoing renovation, Arterburn says, including a complex system engineering lab and a flight simulation and human factors lab.

Arterburn says the objective for RSESC is to be a recognized scholastic center of rotorcraft engineering and provide a vehicle for aviation-related economic growth and technology development in Alabama. "We want to develop an immersive simulation environment for the iterative design and evaluation as well as an educational opportunity that supports that vision."

From defining requirements to handover of prototypes, RSESC smoothly integrates mechanical, electrical and software systems, ensuring that no other system is adversely affected. RSESC management works closely with the funding agency's technical point of contact to ensure that all aspects of the design have been addressed and expectations are met.

Right now, the center is developing ways to use unmanned systems to solve everyday problems. For example, they're working with GEO Huntsville and local municipalities to find ways for unmanned systems to aid public safety agencies. They're also looking for ways to support area utility companies to better manage and maintain their transmission lines.

"We have been building NASA and NOAA payloads for unmanned systems because we have a strong expertise there, but we definitely want to harness the power of the university's capabilities to also build payloads and mission equipment tools and payloads in the area of rotorcraft," Arterburn says. "Everybody has to work together, from information science to applied optics to modeling and simulation. We have all of those centers and it is my intention to tap into all of them centered on vertical lift and unmanned system development."

RSESC is applying for a Certification of Authorization from the Federal Aviation Administration to fly unmanned systems for the university in support of the SMAP center. "This initial certificate of authorization will be the first of many that will be needed to support researchers across the university collecting valuable data for the FAA and other agencies," Arterburn says. His plans include flying everything from small unmanned aerial systems such as the 2.5-pound Phantom 2 to a ScanEagle – a small, low-cost, long-endurance unmanned aerial vehicle. The center is a member of the ASSURE coalition of 14 universities competing for the FAA UAS Center of Excellence.

"Unmanned systems can be used to solve a variety of problems," Arterburn says. "We need to have the right sensors with the right platform and an understanding of the operations someone is trying to put together to be truly effective as a research organization and support our customers effectively. Municipalities need affordable solutions that are capable of being safely operated without burdensome training."

The center is also a collaborator with the Systems Engineering and Research Center (SERC) managed by the Stevens Institute of Technology for the Department of Defense. "The complexity of manned and unmanned platforms will require new tools for systems engineering as well as an educational system that can support the integration of those tools." The center is working with multiple academic departments, engineers, Redstone Arsenal, and industry to look at the next generation of model based tools. "We want to be part of a long-term revolution in systems engineering required to create affordable and reliable manned and unmanned platforms for the future," says Arterburn.



OTHER PROJECTS INCLUDE:

- NASA Hurricane Imaging Radiometer (HIRAD) field support;
- NASA Advanced Microwave Precipitation Radiometer (AMPR) field support;
- Laser Interferometer Space Antenna (LIS) Payload International Space Station;
- Aviation Ground Power Unit (AGPU) Trade Study and Redesign;
- Graphical Editor Development for Architecture Analysis and Design Language (AADL);
- Development of a Strategic Planning and S&T Portfolio Management Course;
- Boeing Huntsville Design Center (HDC) Product Development Team (PDT) Support;
- URII Whale Biomimicry use for Noise Reduction in Rotating Blades;
- Remote sensing of stress-strain for the UH-60 with TRI-Austin.

AEROPHYSICS RESEARCH CENTER PROVIDES HIGH-ENERGY EXPERIMENTS here are plenty of things Mark Zwiener can't share about the work that happens at the UAH Aerophysics Research Center (ARC), which operates a hypervelocity interior ballistics free-flight research test range on Redstone Arsenal with three twostage light gas gun systems that provide a variety of capabilities to investigate the interactions of a high speed vehicle and its environment.

"There's always a new twist or challenge to solve," Zwiener says. He started in 1995 as a student employee, transitioned to full time, worked his way up and today is the manager of range operations at ARC, which is part of UAH's Research Institute.

The facility provides training and research opportunities for academic staff and undergraduate and graduate students. Zwiener and a staff of seven at the ARC carry out applied research and engineering programs, principally to meet the needs of Department of Defense customers, but with significant related work for NASA and private industry.

The two major areas of application for ARC are in phenomenology related to hypervelocity impact and hypervelocity flight in the Earth's atmosphere. The applications in hypervelocity impact include the development and evaluation of the performance of kinetic energy weapons for strategic and tactical systems and damage assessment.

Zwiener says the hypervelocity impact tests involve single or multiple fragments, single or multiple rods and various configurations of representative flight vehicles.

He says the range has demonstrated capabilities to vary and evaluate projectile parameters, which include mass, materials, geometry, velocity, impact location and active attitude control of projectile pitch/yaw. The facility has also demonstrated the capability to evaluate various target configurations and materials, which can vary in size from a few to several thousand pounds.

The hypersonic flight phenomenology tests can be used for studies of signature and hypersonic flow related to medium and high altitude flight environments, including effects on sensors, weather encounter and propulsion-related topic areas. In addition, Zwiener says the range has proven its value in developing the understanding of the physical basis for coherent radar signatures scattered from the body and wakes of re-entry vehicles.

The ballistics range has also demonstrated its capability to determine the effects of boundary layer plasma on the bore-sight error of millimeter wave sensors on-board interceptors. For aerooptics and aero-thermal effects studies, it is possible to perform experiments in which one-quarter to one half-scale fore-body models of the interceptor configuration are launched at full-scale flight velocities.

High-speed flow and combustion can be investigated by launching scaled models under free-flight conditions through various simulated altitudes from ground level to about 65 km.

They work for several months on some projects to create projectiles and set up an experiment for testing. "I've made a lot of things over the years and they tore them all up," says Tony Doll, chief machinist. "The only thing to show for it is a lot of data."

Zwiener says the time between when the fire button is pushed and the dust settles from a test is milliseconds.

"It's stressful because there are so many variables and only a few opportunities to do it right," Zwiener says. "It takes a good team working together to get everything settled and we have that here. You have to think of every possible issue and try to address it beforehand."

Among the variables:

• Is the projectile going to survive the launch?

• Are the shot conditions correct to meet flight requirements?

• Have you set up the experiment to get the trigger mechanism or detection system to record the data? There has to be something in place to tell you when to take the pictures, x-rays or recordings from sensors.

"You only have a limited memory and time frame and if the trigger is off just a little it's a big deal because all of that effort, the days, weeks and months leading up to that test, are lost. Redundant systems are nice, but there are situations with single-point failure possibilities," he says. "And if it fails, you may not have the resources to start over. You only get one shot at a destructive test. Can't reboot and try again."

The process begins with a customer discussing needs with the ARC staff. Then the ARC works to come up with a design based on the customer's information.

"Sometimes they come in with a fullscale concept and need to evaluate it under a certain environment," Zwiener says. "We work with them to develop the experimental method to create as close to a representative, full-scale environment as possible."

Sometimes, he says, it's a very close representation of environment. Other times it's a smaller-scaled approximation. On occasion, the ARC develops custom launcher techniques to meet customer requirements. No two projects are ever the same, Zwiener says.

DIVERSIFICATION

The two major areas of application for this facility are in phenomenology related to hypervelocity impact at speeds at or greater than 2,500 meters/sec or 8,200 feet/sec, and hypersonic flight at speeds at or greater than Mach 5, in variable atmospheres.

The gun systems utilize a fully enclosed flight range and are operated in a large high bay, which provides for an all weather test capability.

Experiments performed in a ballistic range are low cost relative to full-scale flight tests, often costing thousands rather than millions of dollars. The testing can also be done within weeks rather than months to years for full-scale testing.

Zwiener says the ARC is also expanding its capabilities with other donated equipment. ARC acquired a smaller light gas

gun from Marshall Space Flight Center that it will be implementing for small particle type testing. A plasma drag gun is also being installed that will accelerate a shotgun blast of glass powder micro-meteoroids at 5 to 15 km per second. The ARC facility is also home to the Propulsion Research Center's repurposed nuclear weapons effects simulator called Charger-1, which will be used for fundamental research on fusion propulsion and holds promise for human-piloted Mars missions.

"We're trying to get them all operational and implemented," Zwiener says. "It's all part of the experimental capabilities that are being made available by the university, to range from high kinetic energy and hypersonic flight testing in a laboratory environment to an evolving test capability in high electrical pulse power."

RESEARCH // FOCUS

WITH INDUSTRY TO ESTABLISH TWO RESEARCH CENTERS

esponsiveness and collaboration with business are among the fundamental founding principles of The University of Alabama in Huntsville (UAH) and were key elements of space pioneer Dr. Wernher von Braun's formative vision for UAH.

"It's the university climate that brings the business. Let's be honest with ourselves," Dr. von Braun said then. "It's not water, or real estate, or labor or cheap taxes that brings industry to a state or city. It's brainpower."

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Today, UAH is a world-class research institution ranked fifth in the nation in federally financed aeronautical and astronautical engineering research by the National Science Foundation (NSF). The university has partnered with aerospace firms including The Boeing Co., Dynetics, General Dynamics, Lockheed Martin, Raytheon and Northrop Grumman to collaborate on efforts to establish two new Industry/University Cooperative Research Centers on campus, both of which could have broad positive future impacts for area manufacturers.

"The faculty and staff working to establish this center are trying to help manufacturers in Alabama and the Southeast region, which ultimately helps all of us," says Dr. Farrington.

> UAH and its aerospace partners are planning for the Southern Alliance for Advanced Manufacturing (SAAV) Center, in conjunction with Auburn and Tennessee Technological universities. UAH's effort is led by principal investigator Dr. Phillip Farrington, professor of Industrial and Systems Engineering and Engineering Management.

> Concurrently, the Center on Advanced Composites in Transportation Vehicles (ACTV) is being led at UAH by principal investigator Dr. Gang Wang, assistant professor of Mechanical and Aerospace Engineering, and is a partnership with Mississippi State University. Now in the planning stages, officials anticipate the center will be established in spring 2015.

SAAV MANUFACTURING CENTER

Core thrust areas for the SAAV Manufacturing Center will include manufacturing systems design; technologies and processes for mass customization, including using lightweight-high strength materials or additive manufacturing; Lean manufacturing and management; data driven approaches for advanced quality control; and occupational safety and ergonomics.

"A vehicle is anything that transports people or products from one location to another," says Dr. Farrington, the SAAV Center principal investigator. "That would include automobiles, planes, trains, ships, submarines, spacecraft, missiles, unmanned aerial systems and helicopters."

Regional automotive manufacturing growth is one of the factors driving the need for the SAAV Manufacturing Center. Alabama ranks fourth in the U.S. for automotive exports, with \$5.4 billion in exports and auto plants owned by Mercedes-Benz, Honda, Hyundai, Toyota Motor Manufacturing Alabama and Navistar International. Regionally, they are joined by Volkswagen, Nissan and General Motors plants in Tennessee; Nissan in Mississippi; a Kia plant located in Georgia just across the border from Auburn; and BMW in South Carolina. But the same manufacturing information and techniques is of interest across a wider spectrum of manufacturers.

"The automotive and aerospace industries share common challenges related to manufacturing processes," says UAH SAAV Center co-investigator Dr. Farbod Fahimi, assistant professor of Mechanical & Aerospace Engineering. "By investing in the new center, they gain access to teams of experts that find solutions to the common challenges, while only paying a portion of the cost of high-caliber research and expertise."

UAH is ultimately interested in trying to improve the conditions for manufacturers across the state, Dr. Farrington says. "In my view, our economic future – in the state, in the region and in the country – is based on our ability to manufacture products. The faculty and staff working to establish this center are trying to help manufacturers in Alabama and the Southeast region, which ultimately helps all of us."

ACV CENTER

The new ACTV center will put UAH at the heart of many manufacturing sectors, says Dr. Wang. "The fact that we are focused on composites in transportation places UAH in the favorable position of being able to support our local aerospace sector while also reaching out to the automotive sector in the Southeast, which is adding composite materials to vehicles for weight reduction and the resultant fuel economy."



BOEING MANAGERS TOUR CAMPUS

Fourteen national Boeing Company research and technology managers took a full-day tour of the research facilities at The University of Alabama in Huntsville (UAH) on June 24 to look at the university's capabilities.







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