FOCUS

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THE UNIVERSITY OF
ALABAMA IN HUNTSVILLE

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Dr. Ray Vaughn

Research touches all we do at UAH

Welcome to the inaugural issue of UAH Research Focus magazine.

Research is part of The University of Alabama in Huntsville's legacy and has been a driving force since 1950, coinciding with Dr. von Braun's arrival from Fort Bliss Texas. We were formed as the University of Alabama Huntsville Center and because of the von Braun influence and vision, UAH focused on research, science and engineering. Today, UAH is an autonomous campus of the University of Alabama System and one of the nation's leading research universities. We are listed by the Carnegie Foundation as one of only 73 public universities in the nation with very high research activity. A number of our research programs and academic disciplines are listed by the National Science Foundation as top twenty-five programs (based on research expenditures). In overall Department of Defense research, UAH is 19th among academic institutions. In overall NASA R&D expenditures, UAH ranks 14th in the nation. These rankings reflect our heritage as well as our research focus areas. Other points of pride include a ranking of #5 in Aeronautical/Astronautical Engineering; #19 in Atmospheric Sciences; #14 in Computer Sciences; #16 in Astronomy; and, #13 in Business and Management rankings. For a university our size – this performance is outstanding.

Our research effort is accomplished through focused research centers that engage interdisciplinary faculty and staff as well as through individual efforts by our academic faculty and their graduate students. All are supported by one of the finest administrative teams that I have seen in academia to include our Office of Sponsored Programs, Office of Research Security, Office of Technology and Commercialization, and our newly formed Proposal Development Office. Our UAH research centers are listed at **uah.edu/ovpr/research-organization** and I would invite you to further explore the focus of each. Our work is high quality, leading edge, and very applied.

Our UAH strategic plan includes our desire to be a recognized leader in specific areas of education and research which include Aerospace and Systems Engineering; Biotechnology; Cybersecurity and Big Data; Earth, Atmospheric, and Space Science; and Gaming and Entertainment. I hope as you review the features in this Research Magazine, you will see good examples of how our current work aligns with these objectives. Thank you for taking the time to review this research overview. My office is always available to provide any additional information on the efforts featured in this magazine or any other research project ongoing at UAH. **Go Chargers!!**

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The University of Alabama in Huntsville

IN ALABAMA

1ST

IN ALABAMA in expenditures in the environmental sciences

2ND

IN ALABAMA in federally funded research expenditures

RESEARCH

$421 million
Five-year contract and grant research total

$5 million
Five-year license and royalty total

$97 million
Fiscal 2013 research total

NATIONALLY

- **5TH** Federally financed aeronautical/ astronautical engineering research
- **14TH** Federally financed computer sciences research expenditures
- **19TH** Department of Defense R&D expenditures
- **14TH** NASA R&D expenditures
- **16TH** Federally financed astronomy research expenditures
- **19TH** Federally funded atmospheric sciences research

promoting soldier RESILIENCE

UAH scientists probe possible genetic links to PTSD

It once was called shell shock or battle fatigue. But what if post-traumatic stress disorder (PTSD) is really the result of a hyper-vigilant immune system trying to protect the body from invasion by a traumatic experience in the same way it protects against viral or bacterial invasions? What if that reaction is genetic in origin?

If that's true, say a pair of University of Alabama in Huntsville (UAH) researchers, then looking for a set of biomarkers among the immune system's genes could predict which military personnel are prone to PTSD and who should be more resilient. That knowledge could provide new psychological treatments or protective drugs and help treat a condition affecting an estimated 15 percent of the military, with profound effects on family life, veteran homelessness and suicide.

The Soldier Resiliency Initiative is a Phase I study aimed at answering the genetic questions surrounding PTSD. It's the brainchild of Dr. Joseph Ng, a professor of biology and coordinator of the university's Biotechnology Science and Engineering Graduate Program, and Dr. Eric Seemann, associate professor of psychology.

A Phase 1 study tests the efficacy of the methodology, but even in this early stage, blood samples being DNA sequenced in partnership with Dr. Jian Han at the HudsonAlpha Institute for Biotechnology could give scientists a new glimpse into this life-altering disorder.

Past studies have probed single biological factors for PTSD, such as the rise and fall of the brain chemical serotonin, but armed with the genetic insights made possible by the decoding of the human genome, Dr. Ng and Dr. Seemann are studying a broader range of biomarkers and the effects of epigenetics – the influence of the environment on genetics and behaviors.

"Our knowledge of the human genome has greatly expanded now, and we have noticed through our research that these diagnoses of PTSD have some association

with auto-immune diseases," says Dr. Ng. "We're looking at genes that are associated with a pattern of antibodies that may indicate that you are more susceptible to PTSD. It's the genes that are responsible for immunological response, so do they determine your responses to stressors?"

The researchers think PTSD susceptibility is a profile of factors working together, as discovered in cancer research. The "immune repertoire" – the unique pattern of antibodies that each person has – may be key to how stress resilient they are.

Dr. Seemann says PTSD is hard to correctly identify and is over-diagnosed. Crucial to correct diagnosis is experiencing a Criterion A event – an extreme stressor in close proximity to the threat of death or metaphorical death. Typically, 15-20 percent of soldiers exposed to stress develop PTSD.

The study has about 100 non-active duty veterans as participants. They answer a short questionnaire about their experiences and whether they have been diagnosed with PTSD, blood is drawn, and they talk with a trained counselor about their traumatic experience. Participants are grouped as those diagnosed with PTSD who have trauma or those who have trauma but no diagnosis. A third control group is randomly chosen.

"We had to make the screening process a procedure that is quick and comprehensive," Dr. Seemann says. "We are not diagnosing PTSD, we are determining who has the symptoms."

Blood samples being DNA sequenced at Dr. Han's lab are grouped by the severity of donor-reported trauma. The scientists probe immune system gene profiles, looking for clues to an individual's capacity for PTSD resilience.

"We've worked with a lot of veterans groups here in Huntsville," says Dr. Ng, adding that the study is entirely volunteers, from the participants to those drawing blood and conducting interviews. "Doing this study, I have a whole new respect for the military and for what they go through." Most samples are from inactive Vietnam veterans, but some are from inactive Iraq war veterans.

> *"DOING THIS STUDY, I HAVE A WHOLE NEW RESPECT FOR THE MILITARY AND FOR WHAT THEY GO THROUGH."*
>
> *- DR. NG*

A successful Phase I demonstration will advance Dr. Ng and Dr. Seemann to a Dept. of Defense-funded Phase II study with a larger population of 1,000 respondents.

> "As a scientist, when you feel different things or experience different things happening to you, you want to investigate and understand it."
>
> - Dr. Ng

SEMINAL EVENT

The questions that resulted in The Soldier Resiliency Initiative sprang from tragedy. Dr. Ng was at a Feb. 12, 2010, biology faculty meeting in the Shelby Center for Technology when a campus shooting took the lives of three faculty members and injured three others.

"I was in the room during the shooting, and some of us were killed, and some of us were injured, and some of us were unharmed." In the aftermath, Dr. Ng noticed changes in himself and others who had been present. For some, the experience was life altering, while others seemed more able to continue forward from it.

"This interest in PTSD began in that room after the shooting," Dr. Ng says. "As a scientist, when you feel different things or experience different things happening to you, you want to investigate and understand it. I began to wonder, why do some people prove to be resistant to it?"

In 2011, Dr. Ng took his questions to Dr. Seemann, a psychology professor and an Alabama National Guard captain who is a PTSD specialist. "It was like peanut butter and chocolate," Dr. Ng says. "We just clicked. He's coming from a psychological side and I'm coming from a biochemical and genetic side."

OUTCOMES

So what if the study finds an unambiguous set of biomarkers that can predict who is susceptible to PTSD and who is more resilient?

"What do we do with that?" Dr. Ng asks. "Do we use the markers as an indicator before we deploy? And what about the ethical and privacy considerations involved with requiring genetic sampling of all troops?"

"Here on one side we have the excitement of scientific discovery and the huge potential of identifying and treating PTSD, and on the other side of that are these ethical issues," says Dr. Ng. "This is a discussion that society itself has to have when it comes to genetics."

If epigenetic biomarkers are identified, Dr. Seemann says they could be beneficial by being used to screen military personnel properly for PTSD susceptibility, then providing training to those susceptible before deployment. Progress in psychological PTSD treatment could be tracked by measuring resulting epigenetic changes.

"Joe believes you can measure these changes physiologically and I believe you can measure them psychologically," Dr. Seemann says. "You've heard people say after an experience, 'That left a mark on you.' Well, I believe these types of experiences leave a very fundamental epigenetic mark." In their wake, that mark could be healed with psychological therapies.

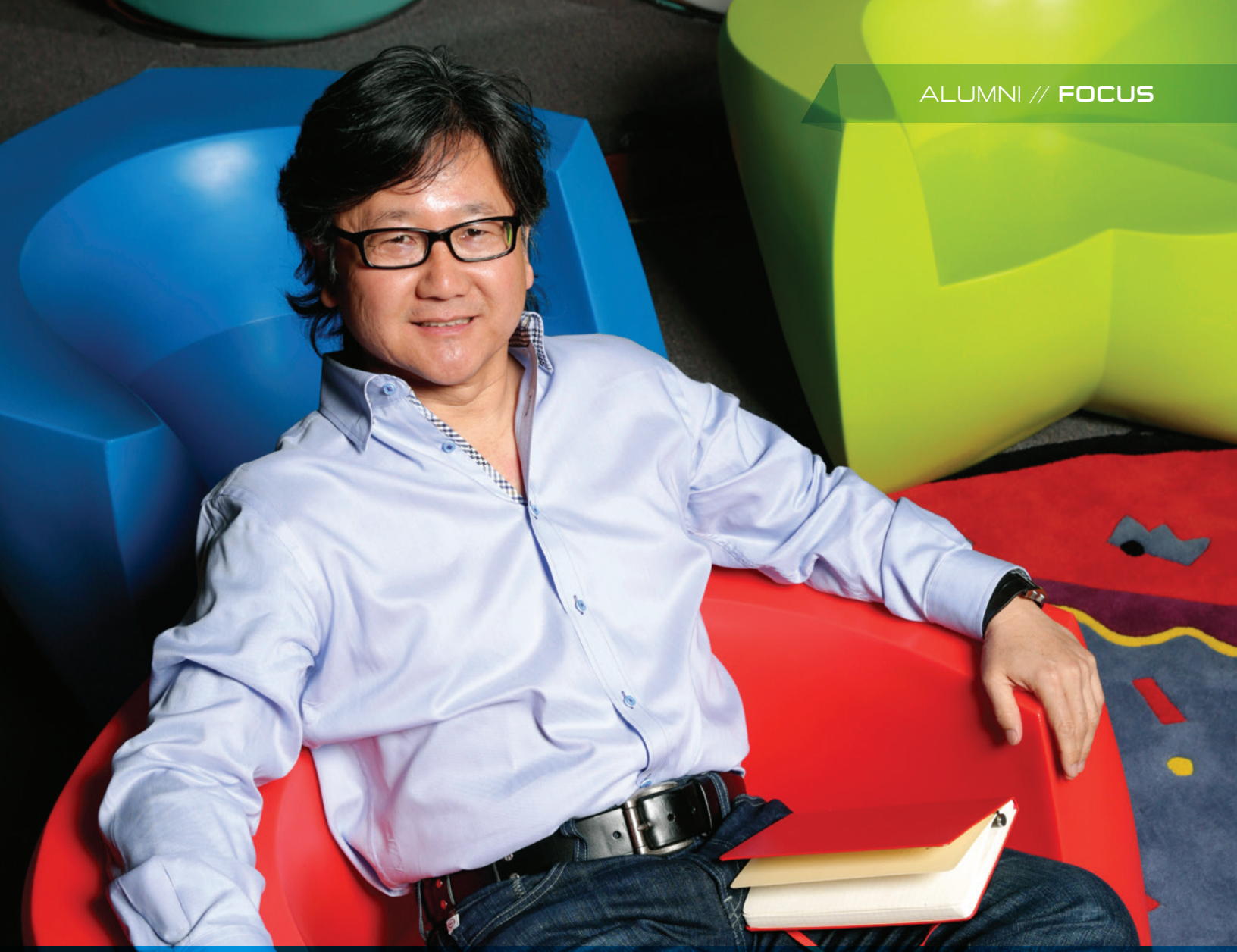
"We can do things behaviorally to change the receptors in the brain," Dr. Seemann says. "We as creatures have a unique way of influencing each other on a very personal level. That is what psychology is all about."

Health24 A WINNER!

A prescription drug translation program called Health24 that was devised and developed in two weeks by a University of Alabama in Huntsville (UAH) computer science program-ming team won a regional America's Datafest competition at Auburn and went on to win the Popular Choice Award at the global competition. Advised by assistant computer science professor Dr. Feng (Frank) Zhu, team members Josh Jones, Jarrod Parkes, James Parkes, Mini Zeng, Prabhash Jha and Ha Giang developed the product that include a list of popular medicines sorted by common symptoms, translatable into any language; a searchable database of medicines that lists interactions; and a translation tool that works from photos of medicine instructions.

EXPLORING FUSION ENERGY PROPULSION

Associate professor of mechanical engineering Dr. Jason Cassibry is at the business end of Charger-1, a repurposed nuclear weapons effects simulator at UAH's Aerophysics Research Center on Redstone Arsenal. When it fires up this spring or summer, Charger-1 will do fundamental research on fusion propulsion, which holds promise for human piloted Mars missions. UAH is among a handful of universities doing this research nationally. Charger-1 came from the Defense Threat Reduction Agency, where it was used to test radiation hardened electronics. Now, Dr. Cassibry says it will be used to study how to scale up lithium deuteride fusion reactions in a pulsed Z-pinch so they can be used for propulsion. A Z-pinch is like a lightning bolt of energy in the ultraviolet and x-ray spectrum. In the experiments, large currents will be generated inside the simulator in the area where Dr. Cassibry is shown here, and then be concentrated through a small receptor target, which will vaporize and implode. The experiments, being set up with the help of graduate student and Research Center employee Ross Cortez, involve focusing and smoothing the pulse to optimize and control the fusion energy release for propulsion. Between the basic experimental work and actual spacecraft use is an engineering process of miniaturization in which UAH hopes to play a role. Since a Mars mission is 20-30 years away, he says there's plenty of time to get it done.



GaN's DR. JONN KIM

Dr. Jonn Kim (MS, electrical and computing engineering, 1995) has created a different kind of Huntsville company in Geeks and Nerds (GaN). After earning his doctorate in electrical and computer engineering from Vanderbilt, he started GaN as a high-tech firm focused on enhancing the quality of life through balancing technology and nature. In addition to technological interests, he has initiated urban organic farming, reuse and recycling of trash, and renewable energy research at GaN.

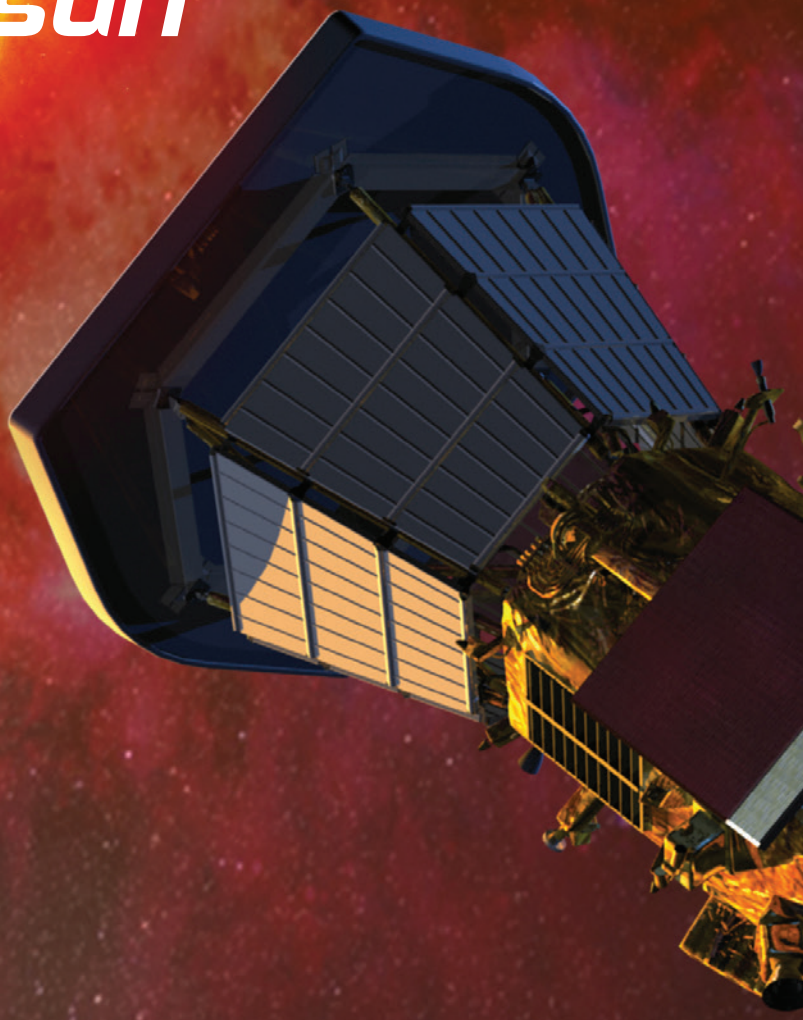
"I don't consider my job as 'work' – it is a vessel for exploring ideas, expanding the horizons and experiencing life," says Dr. Kim. "GaN solves tough technical and organizational problems through innovation. My job as the CEO is establishing the company culture to embrace innovation, encourage collaboration and promote community involvement, thus enhancing overall quality of life for our employees and our community.

"Our Huntsville office is a reflection of the company's open culture and collaborative environment, without boundaries and limitations. Once a historic Huntsville restaurant, we have transformed it to an environment that stimulates new thoughts and encourages collaboration. I am so fortunate to be surrounded by so many smart and dedicated employees."

GaN has been named a Top 100 Best Company in the U.S., the Technology Company of the Year for Huntsville/Madison, received the BBB Ethics Award and has been recognized repeatedly for performance by Inc. 500 and its customers. Dr. Kim's awards include the UAH Alumni Achievement Award, the Huntsville IEEE Professional of the Year and the Huntsville Association of Small Businesses in Advanced Technology Professional of the Year.

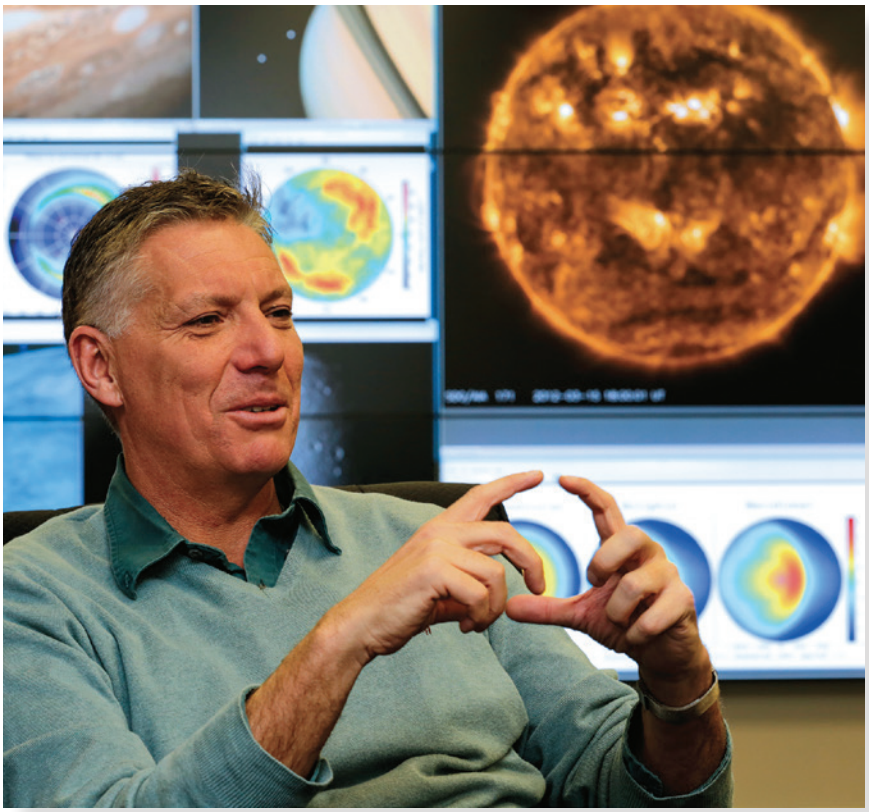
He says UAH provided him a unique opportunity to experience a complete college life of academic, athletic and professional endeavors. "While receiving a great education, the experience of juggling all those tasks taught me lessons on time management, discipline and hard work. I am confident that very few, if any, schools could have provided such a broad exposure during my college days to help me shape the future."

REACHING OUT
to touch the sun



"The desire to create knowledge and share it drives everyone who does science."

- Dr. Zank



CENTER FOR SPACE PLASMA & AERONOMIC RESEARCH PROBES MYSTERIES OF OUR STAR

Scientists at The University of Alabama in Huntsville's Center for Space Plasma & Aeronomic Research (CSPAR) are preparing to touch the Earth's sun so they can study more in-depth how its atmosphere works.

The idea to send a spacecraft into the Earth's sun came up about 40 to 50 years ago.

"It's taken that long to get the right people convinced to do it, and to make sure the technologies are in place to put together such a spacecraft to handle the mission," says Dr. Gary Zank, CSPAR director. "The ideas for the mission have been refined so that scientists know exactly what they want to measure, and the technology has advanced to the point that the right instruments can be placed in the very unforgiving environment that will allow us to understand the science and make sensible measurements."

The billion-dollar NASA spacecraft project called Solar Probe Plus is one of the biggest projects in which CSPAR is involved.

Dr. Zank says CSPAR and Marshall Space Flight Center are part of a consortium with Harvard Smithsonian Astrophysical Observatory, NASA Goddard Space Flight Center, Los Alamos National Lab, University of California-Berkeley Space Sciences Laboratory, University of New Hampshire and the Massachusetts Institute of Technology to build the Solar Wind Electrons Alphas and Protons (SWEAP) instruments that will be used during the Solar Probe Plus mission.

"The spacecraft will have essentially a big heat shield, allowing it to plunge deep into the atmosphere towards the photosphere, or surface of the sun," Dr. Zank says. The SWEAP investigation is the set of instruments on the spacecraft that will directly measure the properties of the plasma in the solar atmosphere during these encounters.

A special component of SWEAP is an instrument called a Faraday Cup that will be positioned outside the protective heat shield of the spacecraft to make direct measurements of the solar atmospheric plasma. This will allow SWEAP to sweep up a sample of the atmosphere and touch the sun for the first time.

"So far we're going on schedule and on budget and it looks like it's going to work and hopefully launch in 2018," Dr. Zank says.

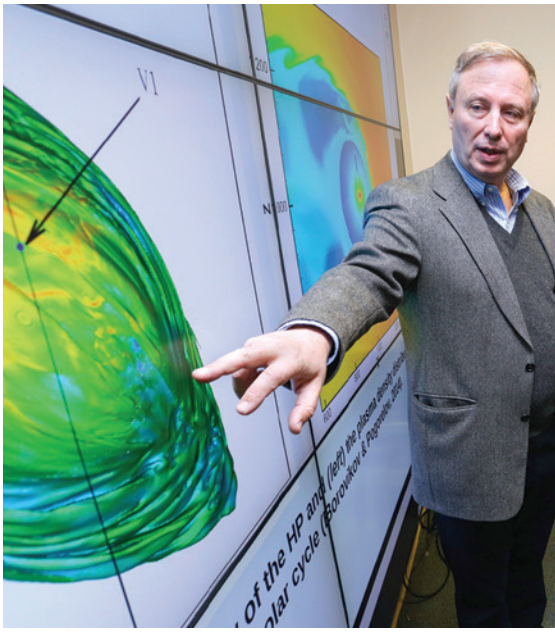
"The sun is enormous and its internal heating is from atomic fusion," he says. "The nuclear processes take place deep in the interior of the sun and the sun cools the further you get from the center until the temperature is a relatively benign 6,000 degrees Kelvin. Then, quite contrary to common sense, the solar atmosphere above the photosphere begins to heat up again, becoming as much as or more than 1 million degrees Kelvin.

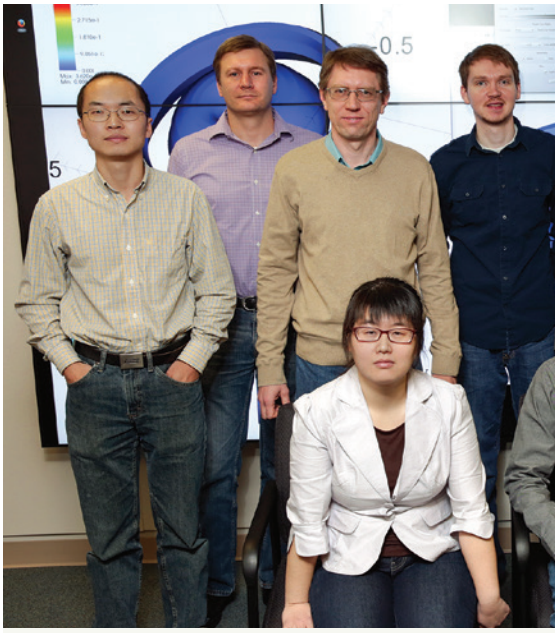
"This is quite different than the Earth's atmosphere, for example, which cools the further you get from the Earth's surface," he says. "Why the sun's atmosphere should get hotter the further out you go is one of the enduring mysteries of the sun. You would expect the atmosphere's temperature to decrease the further away you get from the sun's surface, but in the solar atmosphere it increases, and no one understands why."

Out of many theories, Dr. Zank helped develop one of the two theories believed to explain the curious heating of the sun's atmosphere or solar corona, but the Solar Probe Plus will help answer the questions with data from measurements of plasmas, magnetic fields and very energetic particles.

Dr. S. T. Wu founded CSPAR in 1986 and served as its director until he retired in 2005. Dr. Zank was named director in 2008. Within a year, he brought his entire research team of 21 scientists to UAH from the University of California-Riverside. The history of physics research at UAH and the school's relationships with NASA were factors in Dr. Zank relocating his team to Alabama.

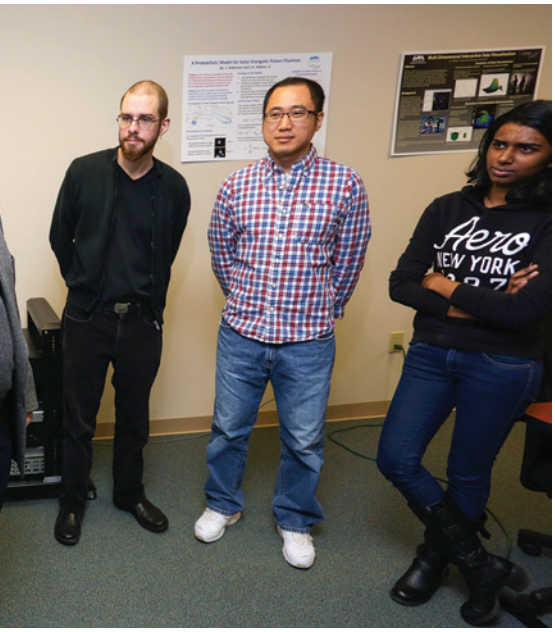
"The idea was to integrate CSPAR and Marshall Space Flight Center scientists so there would be greater opportunity

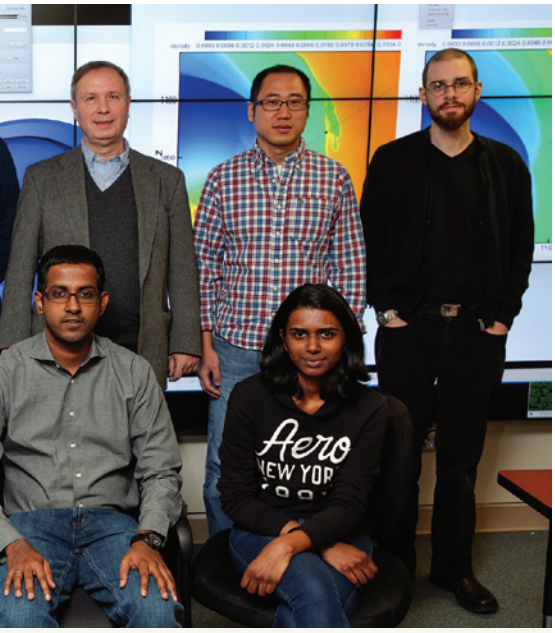




Above:

Dr. Nikolai Pogorelov with, from left, Matthew Bedford, Tae Kim and Parisa Mostafavi.





Below:

UAH CSPAR scientists and students, from left: Top row: Xiaocheng Guo, Dr. Jacob Heerikhuisen, Dr. Vladimir Florinski, Eric Zirnstein, Dr. Nikolai Pogorelov, Tae Kim, Matthew Bedford. Bottom Row: Yihong Wu, Udara Seneyake, Parisa Mostafavi.

"The sun is enormous and its internal heating is from atomic fusion," says Dr. Zank.

to interact on common projects and write proposals and work on ideas together," Dr. Zank says.

Spacecraft exploration is key to CSPAR's research.

There's the IBEX mission, of which Dr. Zank is a co-investigator. The mission is to gather neutral particles coming in all directions toward earth from the edge of our solar system so we can learn about the processes occurring there.

The Voyager Interstellar Mission (VIM) has been ongoing for 36 years and is crucial to exploring the boundaries of the heliosphere, Dr. Zank says.

"Now it's crossed over into the interstellar medium and is wandering the galaxy," he says.

Dr. Zank also mentioned the Rosetta spacecraft. It was launched several years ago but is expected to rendezvous with a comet at some point during this year. Dr. Zank says Rosetta will actually land on the comet and take measurements to help scientists better understand their composition and activity.

On the UAH campus, CSPAR researchers collaborate closely with academic departments, especially the newly formed Department of Space Science, in supporting graduate and undergraduate student research activities. CSPAR provides opportunities for students to investigate the physics of plasmas found in natural environments throughout the universe.

"We have critical mass of research scientists allowing us to make a large impact in our research areas," Dr. Zank says. Space and solar physics observations, theory and modeling, and astrophysics observations – especially in the area of gamma ray astrophysics – represent the major strengths of the CSPAR. We are among the best in the world in those areas."

A major part of what goes on at CSPAR involves high-end, high performance computing, Dr. Zank says.

"The models we develop are among the most sophisticated in the world. In order to run our models and solve the underlying equations requires that we use the most sophisticated, best and fastest computers in the world so we try to obtain and use as much supercomputer time as we can get," he says.

"In a sense we are improving knowledge and enriching our culture. The pursuit of trying to understand nature and the universe around us creates knowledge, which allows us to contribute to society, understand our place in the world, and allows us to share this newly created knowledge with our students and colleagues," Dr. Zank says. "The desire to create knowledge and share it drives everyone who does science."

Stormy Weather

EARTH SYSTEM SCIENCE CENTER PROBES HOW THE ATMOSPHERE WORKS

Dr. John Christy

Dr. John Christy peered intently and carefully at the yellowing document, with its printed grid filled with hand-written data.

Co-creator of the world's first satellite-based system for keeping track of Earth's climate, Dr. Christy is using antique paper records to solve a tiny climate mystery: Did the nighttime temperature in a small town in central Alabama actually drop into the 30s one midsummer night more than 75 years ago?

"Here it is," he says, pointing. "The low temperature that night was 57, not 37. The five isn't clear, so whoever transcribed it into the database just missed that." Alabama's state climatologist, as well as director of the Earth System Science Center (ESSC) at The University of Alabama in Huntsville (UAH), Dr. Christy has used a range of records, including official Weather Office forms as well as records from agricultural stations and railroads, to build climate datasets for Alabama, California and, recently, Uganda. This data gives scientists new tools for tracking the climate and its changes.

"That's sort of what we do here, is to look at things from several perspectives," Dr. Christy says. "From soup to nuts, we have the curious people on staff who ask important scientific questions, but we also have the skills and the resources to answer those questions."

Harking to its origins in the Johnson Environmental Science Lab in the 1980s, ESSC has grown through the years to become one of UAH's largest research centers, with about $10 million in funded research each year.

ESSC scientists look at everything related to the atmosphere, "all the way down to the chemical reactions of pollution," Dr. Christy says. "From the tiniest particle in the atmosphere to the global average temperature, we look at the many pieces of the whole picture because each can have an effect on everything from tornadoes to lightning to climate change. It's all interconnected."

A large majority of research projects at the ESSC involve the use of remote sensing systems, including instruments carried aboard satellites, ground-based Doppler radar, pollution-monitoring laser systems and instrumented aircraft.

In addition to tracking global climate change, ESSC scientists use these instruments to study pollution and the intricacies of how it changes through time. They

> "THERE'S AN OLD SAYING IN ALABAMA THAT WE'RE NEVER MORE THAN A WEEK FROM A DROUGHT."

use satellites to study forest fires around the world to better understand both land use changes and the effects of the pollution. They use atmospheric modeling and chemical monitoring to study air pollution in places like Houston, Birmingham and Nashville. Recently, they have begun using remote sensing on tiny remotely-controlled helicopters to find subtle changes in vegetation that might signal footprints of undiscovered archaeological sites, such as Maya ruins in central America.

Two labs recently established in the ESSC give focus to some of the center's major research programs.

The Severe Weather Institute – Radar & Lightning Laboratories (SWIRLL), led by acronym wizard Dr. Kevin Knupp, provides a base for the center's emphasis in severe weather research, ranging from the behavior of land-falling hurricanes to better understanding the factors that cause thunderstorms to make hail, dangerous lightning, powerful straight-line winds and tornadoes. Dr. Hugh Christian's lightning team is wrapping up the design and testing of their third and fourth instruments that will soon fly in space.

A major research and education facility for SWIRLL is under construction.

The Human Dimensions, Discovery and Decision Making (HD3) lab gives students — especially undergraduate students — opportunities to get involved in important research projects in topics ranging from emergency planning to monitoring pollution and habitat loss.

In addition to these projects, about 12 years ago Dr. Christy and Dr. Richard McNider — ESSC's founding director — began to look into why Alabama's row crop farming had lost 90 percent of its production since the 1950s.

"The state had gone from 12 million acres of active farmland to a little less than two million acres at the time," Dr. Christy says. "It came down to the inability of the state's farmers to cope with drought, coupled with the state's poor water-holding soils."

On average, the state gets enough rain for agriculture about two years out of three, he says. But even in years when there is enough rain, it might not fall at the right times. And with the state's sandy and clay soils, the ground can dry after only a few days without rain.

"There's an old saying in Alabama that we're never more than a week from a drought," Dr. Christy says. Despite that, Alabama ranks near the bottom among the states for the acres of irrigated farmland.

Because Alabama usually gets plenty of rain in the winter and spring, the strategy developed at UAH is to increase pond storage so water captured during the wet season can be pumped out in the summer, when it's needed.

Dr. Christy and his team played a major role in getting farm bills passed to provide matching money and tax credits for farmers interested in building irrigation systems so they won't be at the mercy of Alabama's fickle weather.

UAH GETS NSF GRANT TO PLAN INDUSTRIAL RESEARCH CENTER

Stronger research ties between The University of Alabama in Huntsville (UAH) and local industry partners will result if an effort to establish an Industry & University Cooperative Research Center (I/UCRC) site at UAH succeeds.

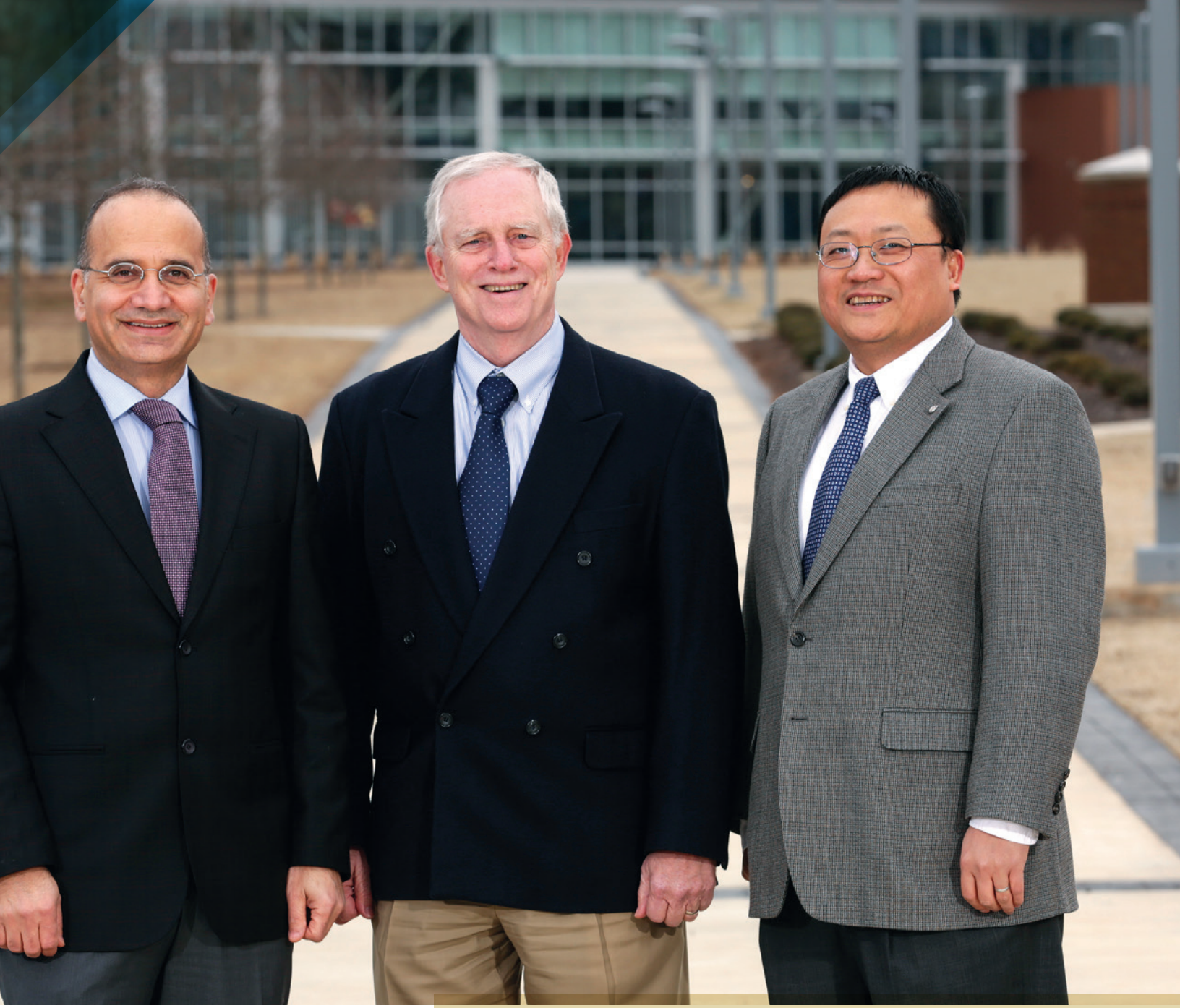
The National Science Foundation (NSF) has funded a UAH planning proposal for the project. In collaboration with lead organization Mississippi State University (MSU), the planned UAH research center would focus on advanced composites in transportation vehicles. Each I/UCRC requires membership of multiple universities and multiple industry partners. In addition to being a research site, UAH would act as a co-equal partner with MSU to perform the related research.

"The ultimate goal that our team is focusing on now is successfully gaining the NSF approval for an I/UCRC," says Dr. Gang Wang, an assistant professor of mechanical and aerospace engineering who is a principal investigator in the effort along with Chris Sautter, associate director for reliability at the UAH Research Institute, and Dr. Houssam Toutanji, professor and chair of civil and environmental engineering. The planning proposal funds will support UAH's center planning workshop in summer 2014, Dr. Wang says.

"We plan to bring all our industry and university partners together to solidify the center concept and proposed projects," says Sautter. "At this meeting we will vet the research topics selected by the industrial partners and provide the schedule for completing the full proposal, which will be due at NSF by Sept. 27."A final decision on the proposed center is expected in the first quarter 2015. The research performed under the center's auspices would be selected and directed by its Industrial Advisory Board (IAB), which is made up of the center's industrial partners. Proposed research areas are composite materials and structures, materials (sustainable, extreme environments, out-of-autoclave), manufacturing (process simulation, automation), multi-scale modeling (atomic to macro scale), reliability and failure, damage tolerance and fracture, design optimization, damage diagnostics and prognostics, and nano-enhanced multifunctional composites.

"The I/UCRC is a proven model for successful industry-university cooperation," says Sautter. "Through the IAB, our researchers select and provide proposals on the topic areas that our industrial partners deem significant. This process ensures that the UAH researchers, faculty and their students will be focused on issues that impact our members. The result of this cooperative effort is a significant benefit to our local workforce. They will have the opportunity to hire UAH graduates that possess first-hand experience and knowledge in the

Left to right:
Dr. Houssam Toutanji
Chris Sautter
Dr. Gang Wang



"The I/UCRC is a proven model for successful industry-university cooperation," says Sautter.

cutting edge of the field of composites."

To date UAH and MSU have garnered support from over 20 potential industry partners. "As we put together the proposal, we will be contacting each of our potential members to advise them of our schedule and the recommended research topics," Dr. Toutanji says. "We will be asking them to refine the topics and provide any assistance to the final proposal. In addition, we will work closely with our faculty members at UAH to put together research teams addressing different research topics within the theme of the center."

Locating an NSF I/UCRC at UAH would be a significant milestone for the university. Currently there are 61 centers in the U.S. There are no composite centers located in Alabama, Mississippi, Louisiana, Arkansas or Tennessee.

"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," says Dr. Wang. "We believe that creating this center in Alabama and Mississippi will have long term positive effects on our local economy and our university."

Complexity Engine

NEW SEARCH ENGINE MATCHES CONTENT TO STUDENT READING ABILITY

An Internet search engine developed specifically for schools by two University of Alabama in Huntsville professors is being tested as a way to increase reading abilities in challenged students and help motivate intellectual development in gifted students, while saving schools money on textbooks.

Complexity Engine has been awarded a $10,000 development grant from the UAH Charger Innovation Fund and a $35,000 award from Alabama Launchpad. Launchpad is a program of the Economic Development Partnership of Alabama to promote, reward and increase the pipeline of high-growth, innovative ventures that have the potential to grow and thrive in the state.

"We just have a host of features we want to roll out with Complexity Engine," says developer Dr. Philip Kovacs, an associate professor of education who conceived the system and is collaborating with Dr. Ryan Weber, an assistant professor of English, to develop it.

Dr. Philip Kovacs, left, and Dr. Ryan Weber are the UAH developers of Complexity Engine.

Complexity Engine uses a sophisticated algorithm to search websites for content and delivers free, customized and age-appropriate reading materials to a user's computer. It promises to give teachers, parents and students an efficient, affordable way to promote reading. Teachers and administrators can set parameters for the search results, and the reading experience can be either student self-directed or guided by the teacher.

"What we're developing is a way to get through the nonsense and junk online and get to the learning material," says Dr. Kovacs. Complexity Engine is currently in testing with 500 gifted fifth and sixth grade students at a mid-sized regional school system.

"The reason the school system wanted to use it is because they have a hard time finding challenging material for their gifted students," Dr. Kovacs says. "The second issue with this group of students is that if you go and search the web for 'submarine,' you will get thousands of results that are all over the place compared to what you want to find. With our search engine, you will get around 150 results that are more closely about what you were searching for."

Teachers and administrators get feedback from the program about a student's reading material. The reading comprehension level of each file retrieved is scored. "That score is composed using a variety of reliable measures of reading score," Dr. Weber says. Over time, the teacher can assess a student's reading progress from that information.

The idea for Complexity Engine arose four years ago, when Dr. Kovacs was studying ninth-grade at-risk students who were reading at a second through sixth grade level. Rather than conventional schooling, students in the study picked their own topics of interest and researched them on the web. They made class presentations on those topics during the year.

The study found that in a control group of students reading comprehension increased 11 percent, but in the experimental group, it zoomed 59 percent.

"We know that reading is fundamental to the educational development of students because lots of studies have shown that to be true," says Dr. Kovacs. "So then you ask, how do you make the Internet so that teachers can provide the right level of materials for a student's reading level for free?"

Its developers see Complexity Engine as a replacement for textbooks that offers a less regimented, more varied and interest-driven educational model to students.

"The information a student gets is no longer generic, like it is from a textbook," says Dr. Weber. "The individual students can search for reading material that matches their interests, so they can be more self-motivated readers."

Motivation is a major reason students drop out of high school, Dr. Kovacs says. "Many students who leave school don't do it because they can't do the work. They do it because they are not challenged by it and they are not motivated to learn. They get bored."

During the earlier study, researchers found that behavioral problems dropped and parents who had never attended parent-teacher conferences began attending to compliment the teachers.

"We are creating the circumstances for motivation to appear," says Dr. Kovacs, citing autonomy, a sense of purpose and a sense of mastery as essential to creating conditions for motivation to manifest. "A lot of kids who are really smart learn to hate school. How can we as teachers show them how to learn a thousand times better?"

The pair found plenty of help on campus for their project, says Dr. Weber, who lauds the roles of Director Kannan Grant and Research Program Coordinator Becky England of the Office of Technology Commercialization (OTC), as well as Dr. John Whitman, visiting assistant professor of management at the UAH College of Business Administration.

"We could not have done this without all the intellectual support and the resources that are available to us on the campus," says Dr. Kovacs. "Alabama Launchpad has also been a tremendous resource in helping us to refine our idea and concept."

Sweet Success

DEVICE AIMS TO LOWER COSTS OF CELL PRINTING

A UAH sophomore and his collaborator have developed an extruder that could lower the costs of 3-D printing cellular structures for drug testing.

The Carbohydrate Anhydrous Rapid Manufacturing Aluminum extruder, or CarmAl extruder, its software and the manufacturing processes being developed by second-year biological sciences student Tanner Carden and collaborator Devon Bane produce a sugar grid that mimics blood vessels.

Normally a UAH mechanical and aerospace engineering undergraduate, Bane is taking the semester off to catch up with numerous inventions and commercial projects.

The CarmAl extruder's name is also a play on words. The technology's inspiration came from 3-D printers that make specialty candies.

"We're using the sugar molecules in a form of reverse 3-D printing," says Carden. "In this process, we first make the structures we want and then we embed them into a cellular matrix." After cells are grown around the vascular structure, the sugar is washed away, leaving a cell mass with vessels like a human organ.

For drug tests, the structure more accurately represents living tissue and more test cells can be kept alive by vessel-supplied nutrients. "It helps to prevent necrosis in your sample," says Carden.

Awarded $9,948 in Charger Innovation Fund support for further development and advised by Biology Department Chair Dr. Debra Moriarity, the device's creators aim to lower production costs of testing cultures to allow drugs to be screened faster.

"This specific technology is only about two years old," Carden says. It originated from work by the University of Pennsylvania. When he and Bane became interested, Carden was awarded a UAH Research and Creative Experiences for Undergraduates Program (RCEU) grant to work with Dr. Moriarity. "Our whole goal was to keep it cheap and keep it simple."

One day while pondering how to design the extruder, Bane had an inspiration.

"He thought it up on the spot and he freehanded a drawing of it," says Carden. "Then he brought me this complex technical drawing that my dad understood, and the next day my dad handed me this extruder. It's very simple and designed much like a syringe."

After charging his son $12 for the aluminum used, Rodney Carden machined the extruder at General Dynamics Global Imaging Technologies in Cullman, Ala.

Software controls a solenoid valve that regulates the timing of nitrogen pushing on a sugar solution in the CarmAl extruder. It uses a modular tip and a heated process at temperatures higher than other extruders to better control the viscosity of the sugar solution for more accurate vascular structures.

The next step is growing cells around the structures, and Carden plans to learn more at Wake Forest University's Institute for Regenerative Medicine, a program already using cells for 3-D printing of biological structures.

"What we're looking to do with this new funding is to increase the proprietary features our process has," Carden says. The pair is especially keen to develop unified proprietary software. "I think that's going to allow us a lot more flexibility in the future because having to make all these open source software programs talk to each other has been the biggest pain."

UAH's Severe Weather Institute – Radar & Lightning Laboratories (SWIRLL) takes form near Robert "Bud" Cramer Research Hall. The state-of-the-art facility will feature a visible spiral staircase that mimics a tornado and a five-foot diameter globe showing real-time weather patterns.

Inset: The Weather Channel's Jim Gagne, Mike Bettes and Christina Glowacki interview Dr. Kevin Knupp on tornadoes and severe weather recently for a segment airing on the cable network.

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