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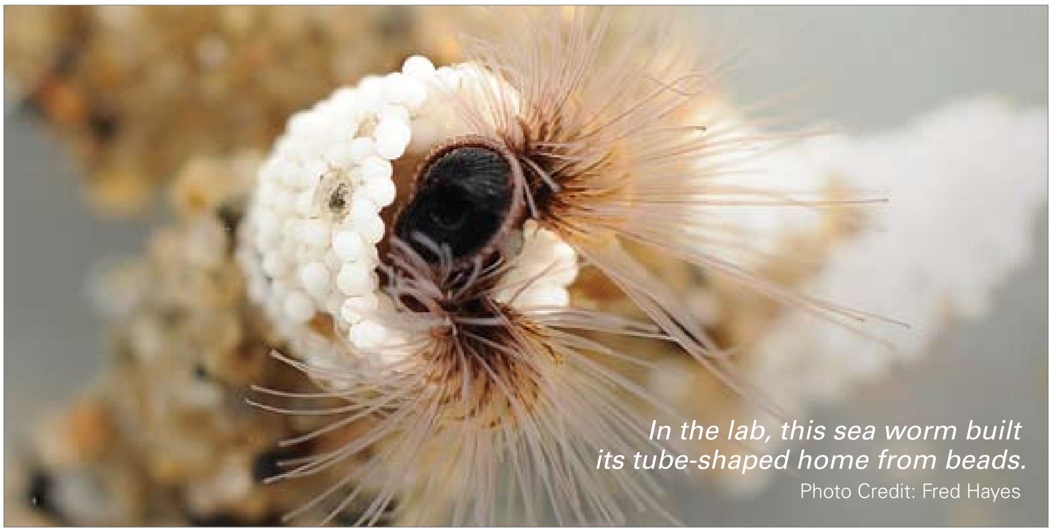
UTAH ENGINEERING

Inside

THE UNIVERSITY OF UTAH

Superglue from the Sea

BY LEE J. SIEGEL



In the lab, this sea worm built its tube-shaped home from beads.
Photo Credit: Fred Hayes

Bioengineers Develop Synthetic Sea Worm Glue for Shattered Bones

Sandcastle worms live in intertidal surf, building sturdy tube-shaped homes from bits of sand, shell and their own natural glue. Bioengineers have made a synthetic version of this seaworthy superglue, and hope it will eventually be used to repair small bone fragments in fractured knees, wrists, elbows, ankles, and also the face and skull.

"You would glue some of the small pieces together," says Russell Stewart, associate professor of bioengineering. The synthetic sandcastle worm glue would not be used for large bone fractures for which rods, pins and screws are now used. "Our goal isn't to rebuild a weight-bearing joint with glue. It is to hold the pieces together in proper alignment until they heal."

In lab tests the synthetic sea-worm glue performed 37 percent as well as commercial superglue. Stewart expects the glue will be tested on humans in five to 10 years.

Bioengineer Patrick Tresco, associate dean for research in the College of Engineering, says, "Most current adhesives do not work when surfaces are wet so they are no good for holding together bone, which is wet and bloody. There is nothing like the synthetic worm glue on the market today."

The synthetic glue also can carry drugs, so it could be used to deliver pain killers, growth factors, antibiotics, anti-inflammatory medicines or even stem cells to sites where bone fragments are glued, "simultaneously fixing the bone and delivering potent drugs or even genes to the spots where they are needed," Stewart says. And where pieces of bone now are cut out due to cancer, the adhesive might be used to attach "tissue scaffolds" that encourage regrowth of the missing bone. >>

>> SUPERGLUE FROM THE SEA

Building a Sandcastle Colony

Stewart conducted the study with Hui Shao, a doctoral student in bioengineering; and Kent Bachus, a research associate professor of orthopedics. The study involved the sandcastle worm, which lives on the California coast. The adult worm is an inch or so long, and an eighth-inch in diameter. But it builds tubes several inches long using sand grains and shell fragments.

Worms build their tube-like shells next to each other, like stacks of pipes, to form a large colony. In the lab, Stewart showed that the worms will use any handy building material, using their natural adhesive to build tubes by gluing together tiny pieces of egg shell, glass beads, red sand, bone, zirconium oxide, and even pieces of a silicon chip.

A Synthetic Glue

Sandcastle worm glue contains proteins and dopa, a substance present in glue that mussels use to glom onto rocks and boats. "But we took the compositional characterization a lot further," hypothesized how the worm glue works, and used that to create the synthetic glue, says Stewart.

Stewart used water-soluble polyacrylates, synthetic polymers that are related to commercial superglues, to make the synthetic glue. He hopes to make a better version that has more bonding power, is biocompatible in the human body and biodegradable. "Ultimately, we intend to make it so it is replaced by natural bone over time," Stewart says. "We don't want to have the glue permanently in the fracture."

Lee J. Siegel, *science news specialist, University of Utah Public Relations*

A sandcastle worm colony built with tiny pieces of shell, sand and worms' own natural glue.

Photo Credit: Fred Hayes

OPTIMIZING TECHNOLOGY FOR SUPERCOMPUTERS

Mary Hall, associate professor in the School of Computing, is designing computer program tools for high-end systems and supercomputers. Her project for the U.S. Department of Energy (DOE) uses her skills for developing compiler technology (computer programs that translate source code from one computer language into another computer language) for DOE application programmers to build their own software for faster, better computing.

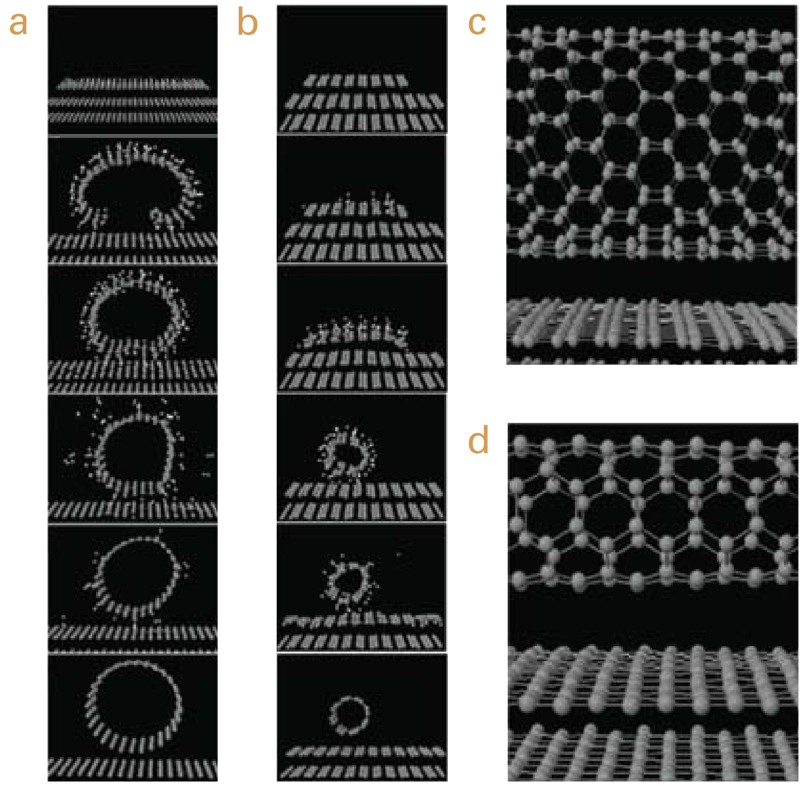
"We work with application scientists to develop software applications with our own eye to the way we view things," says Hall, who joined the U of U last fall from the University of Southern California.

The DOE uses the software tools for projects such as climate modeling or studying nuclear fusion. "The DOE is seeking the best performance for their high-end supercomputers," says Hall. "Because they do large-scale simulations, they are always looking for faster, better, more precise tools."

Hall is also teaching a new class in the School of Computing, called Parallel Programming for GPUs (graphics processing units), that involves training students from across campus to use special-purpose hardware originally designed for graphics and games to solve general-purpose computing problems. The technology for the class was donated by the organization NVIDEA, inventor of the GPU, who recently named the University of Utah as a Compute Unified Device Architechure (CUDA) Center of Excellence.

Nanotechnology

SUPER-SMALL DEVICES FOR ADVANCED MEDICAL APPLICATIONS



This diagram shows molecular dynamics simulations illustrating a new method for synthesizing carbon nanotubes.

Figures a and b show the formation process of two types of carbon nanotubes: zigzag and armchair single-walled respectively.

Figures c and d show the sideview of these nanotubes, resulting from the formation process.

Feng Liu, professor of materials science and engineering, is designing structures and devices so tiny that they could be measured in terms of merely a few atoms. One nanometer is equal to one billionth of a meter. "To give you some perspective on nanotechnology, ten atoms laid out side by side would be equal to one nanometer," says Liu.

These so-called nanostructures and nanodevices are potentially very important to many industries. In high-tech electronics, for example, silicon nanoelectronic devices could hold far more information than can current microelectronic technologies.

"The advantage of creating electronics on a nanoscale level is that not only would they be smaller than current technology, but the density would be greater, and therefore, the nanodevices would be much faster for information processing," says Liu. Nanoelectronics could be used in computers for storing vast amounts of data.

Liu is specifically interested in designing and creating nanotubes, round or coiled structures that resemble tiny tubes, which have many potential applications. One promising method for making nanostructures is by utilizing the scientific principle of self-assembly or self-organization. For example, the planets in the solar system self-assemble through gravitational forces, and similarly, tiny atoms arrange or order themselves through chemical bonding.

Liu is collaborating with medical researchers at the U to create implantable nanotube- and microtube-based organ pressure monitors that continuously measure the pressure inside a human organ. Current methods of measuring pressure use bulky devices that are not suitable for implantation in the human body, and are not accurate or sensitive enough. "Several diseases, such as glaucoma, are either related to or caused by pressure inside an organ," Liu says. "It would be beneficial to have a way to very precisely measure organ pressure continuously from inside."

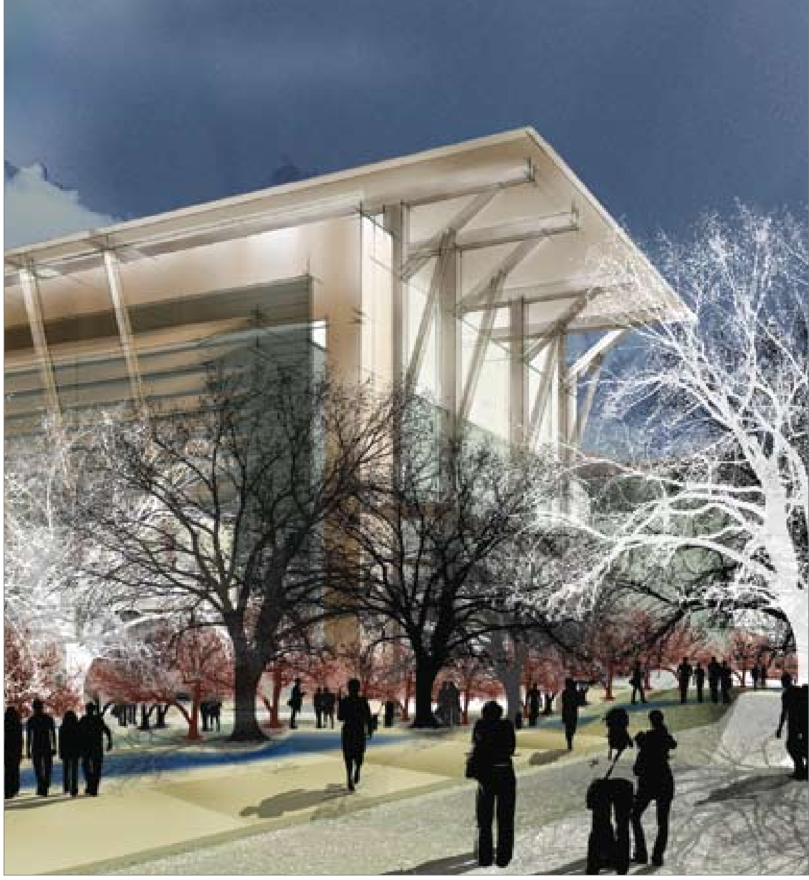
In the case of glaucoma, the highly sensitive and minimally invasive microtube would be implanted inside the eye, where it would convert intraocular pressure inside the eye to electrical signals and then to a recording chip. In a normal eye, the tube would maintain its shape. However, in an eye with elevated pressure, the high pressure would squeeze the tube into an elliptical shape, and then, into a peanut shape. Once collapsed, the tube would become very soft and highly responsive to pressure change, providing a sensitive way to measure pressure.

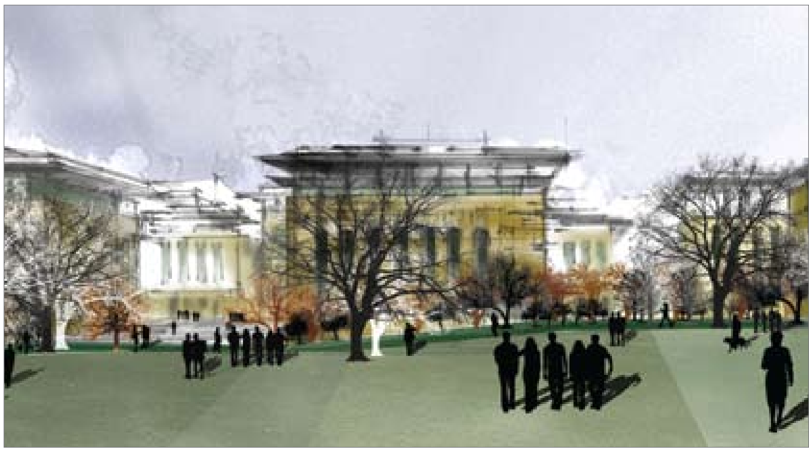
The nanotube-based pressure sensors will also be applicable for measuring pressure and detecting disease in other organs and tissues, such as in the brain and the stomach.

New Building

Groundbreaking is set for April 22, 2009 on a sophisticated 200,000-sq. ft. biomedical and neurosciences building designed to help develop the next wave of health sciences technology. Named the James L. Sorenson Molecular Biotechnology Building, a USTAR Innovation Center, in honor of Utah's world-renowned medical device inventor and entrepreneur, the facility will become the heart of the state's USTAR (Utah Science Technology and Research) Initiative and will anchor the university's new "Interdisciplinary Quadrangle" on 11 acres bridging upper and lower campus.

As a hub for USTAR's research and development, the building will be home to advanced imaging and nanotechnology laboratories, including a 20,000-square-foot nanofabrication area designed to create and develop new bioengineered materials and devices, as well as MEMS, circuits, memory and sensors, among others. The facility will support internationally recognized senior faculty researchers and their staff. Funds for the building came from a $100 million commitment from the state, a $15 million cornerstone gift from the Sorenson Legacy Foundation, and $15 million in university and other private funds, including $1.25 million from the Micron Technology Foundation.





NEW FACULTY HIRES

Jake Abbott
Mechanical Engineering

Research interests: Wireless magnetic control of microrobots, medical robotics, telemanipulation of novel systems, and haptics

Adam Bargteil
School of Computing

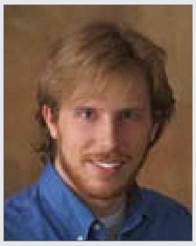
Research interests: Computer graphics and animation, scientific computing, numerical methods, computational physics, and computational geometry

Alan Dorval
Bioengineering

Research interests: Neuropathophysioloy, translational neuroscience, neuromodulation, and neuronal semiotics

Mary Hall
School of Computing

Research interests: Automatic performance tuning, model-guided empirical optimization, interprocedural analysis and optimization, and parallelizing compilers



Matthew Might
School of Computing

Research interests: Static analysis of software systems, static analysis by abstract interpretation, security, parallelism, verification, and optimization

TIKALSKY ELECTED TO CZECH NATIONAL ACADEMY

Paul Tikalsky, chair and professor of civil and environmental engineering, has been elected a Fellow (foreign) of the National Academy of Engineering of the Czech Republic (EACR), a member organization of the International Council of Academies of the Engineering and Technological Sciences. The announcement was made at the annual meeting of the EACR in Prague and recognizes the contributions Tikalsky has made in advancing simulation-based reliability assessment techniques for long-life structures in the European Union and the Czech Republic.

GRAINGER ELECTED TO THE AMERICAN ACADEMY OF SCIENCES

David Grainger, professor of bioengineering and chair of pharmaceutics and pharmaceutical chemistry, was elected as a 2008 fellow of the American Academy of Sciences for distinguished efforts combining diverse aspects of chemistry, materials, and biomedical science to creative research, education, and new biomedical technology. He also presented the 15th Annual Fritz Straumann lecture at the AO Foundation Orthopedic Courses in Switzerland last December.

NEW BRAIN INSTITUTE DIRECTOR

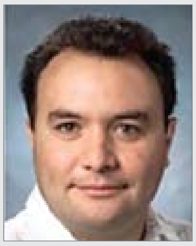
John A. White, USTAR professor of bioengineering, has been selected as the new executive director of the University of Utah Brain Institute. White joined the U in 2007 as part of the Utah Science, Technology and Research Economic Development Initiative, which encourages researchers to commercialize technology to create companies and jobs for economic development in Utah. White, who is also a Brain Institute investigator, uses an engineering approach to research how the brain processes information.

Kenneth Monson
Mechanical Engineering

Research interests: Traumatic brain injury, blast injury, cerebral vessel mechanics and mechanotransduction, solid mechanics, and dynamics

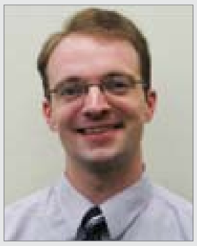
Erin Parker
School of Computing

Research interests: Programming languages, and computer memory systems and performance



Valerio Pascucci
School of Computing and SCI Institute

Research interests: Data analysis, topological methods for image segmentation, progressive and multiresolution techniques for scientific visualization, and computer graphics



Leonard Pease
Chemical Engineering

Research interests: Structure of soft complex nanomaterials, biomanufacturing, reactions of macromolecular proteins related to disease, particle sizing, and vaccines and genetherapy vectors

Michael Scarpulla
Electrical & Computer Engineering and Materials Science & Engineering

Research interests: Compound semiconductors, dilute semiconductor alloys, transparent conductors, and novel materials for thin film photovoltaics

Massood Tabib-Azar
Electrical & Computer Engineering

Research interests: Nanodevices and molecular electronics, metrology tools, microwave-AFM for bio-nano-info, and novel fabrication technologies

AIChE CENTENNIAL MEETING

The AIChE (American Institute of Chemical Engineers) held its annual meeting and Centennial Celebration last November, in Philadelphia, PA. During the celebration chemical engineering professors, alumni and students were honored. Professor Edward Trujillo received the Outstanding Student Chapter Advisor Award. Professor J.D. Seader was recognized as one of the 30 Best Authors for his groundbreaking chemical engineering books. And Alumnus Marvin Johnson and the late Chemical Engineering Professor Donald Dahlstrom were chosen as two of 100 eminent chemical engineers of the modern era.

ULTRASOUND FOR BREAST CANCER

Robert Roemer, professor of mechanical engineering, is developing ultrasound technology as an alternative to breast cancer surgery. Roemer and his collaborators received a grant of $1.6 million from the National Institutes of Health to develop the technology. Ultrasound beams would pass through tissue in the body and focus on the tumor with temperatures high enough to destroy it. With high-intensity ultrasound, breast cancer patients may be able to forgo intensive surgery. In its preliminary stages now, the research is a collaborative effort between Roemer and Radiology Professor Dennis Parker, as well as researchers around campus and Siemens Medical Solutions. Eventually the technology could be used to treat other types of cancer.

Technology Commercialization at the U

DEVICE AIMS TO STOP TEEN CELL PHONE USE WHILE DRIVING

Xuesong Zhou, assistant professor of civil and environmental engineering, has invented a wireless car key device to stop teenage motorists from talking on cell phones and sending text messages while driving. When the key is extended from the device, it sends a signal, putting the phone in "driving mode" so it cannot be used to talk or send texts. Parents can control the system from a computer, which collects safety scores on cell phone use and on driving speed and traffic violations tracked by Global Positioning System satellites.

For adult drivers, the system prevents texting and allows calls only on hands-free cell phones. Zhou says the goal for adults is to improve safety by encouraging them to reduce the time they spend talking while driving. The encouragement could come in the form of insurance discounts by insurers, who would receive monthly scores showing how well an adult driver avoided talking while driving. The University has licensed the technology—Key2SafeDriving—to a private company, which hopes to have the device on the market within in the next several months. Zhou invented the device with University of Utah Alumnus Wally Curry.

Between 2006 and 2008, the U of U College of Engineering has launched 25 new startup companies based on its research.

Ed Catmull
SPEAKS AT COMPUTING LECTURE

Edwin E. Catmull discussed the lessons he has learned as president of Walt Disney and Pixar Animation Studios, during the School of Computing's 2008 Organick Memorial Lecture. Catmull, who chairs the College of Engineering National Advisory Council, is an alumnus of the U of U where he earned B.S. degrees in computer science and physics and a Ph.D. in computer science.

"A lot of what I learned about a creative environment started at the University of Utah," said Catmull, referring to the setting that fostered exchanges of ideas between faculty and students. A member of the Academy of Motion Picture Arts and Sciences and the National Academy of Engineering, Catmull co-founded Pixar Animation Studios.

Catmull told two packed auditoriums in the Warnock Engineering Building about lessons he learned while making such animated films as "Toy Story" and "Finding Nemo." He discovered that animation teams had to be empowered and feel safe telling studio heads what they thought without compromising the creative process.

"It was important to let the people actually doing the work figure out [solutions]," he said. The key to success is getting "the right people and the right processes."

Referring to the ten animated films Pixar has made so far, he said that although each had difficult problems at times – even some "meltdowns" – the key to making the films work was to set an initial course direction while being willing to course-correct. "Then we end up with something we're proud of," he said. "Ideas are very complex. People like to think of them as singular, but hundreds of thousands of decisions [go into making] these movies."

The Organick Lecture Series honors the late Professor Elliott I. Organick, pioneering computer science faculty at the University of Utah, who helped shape the department's academic and research programs in computer science.

NEW **EAA** PRESIDENT

Jonathan Richards is the new president of the Engineering Alumni Association at the College of Engineering. Richards will serve as president for two years. An electrical engineering graduate of the University of Utah in 1981, Richards went on to earn a J.D. in Texas at Southern Methodist University School of Law. Richards is a senior member of Workman Nydegger, a Salt Lake law firm specializing in intellectual property, in the patent prosecution group. He has extensive experience in patent, trademark, and copyright matters. For information about joining the Engineering Alumni Association, visit *www.eaa.utah.edu.*

Study Abroad

Last spring, Phillip Badger, a senior in materials science & engineering, spent a memorable five months studying at Tsinghua University in Beijing, China. "This was a very rare opportunity," says Badger. "Tsinghua is a top university in China. It is known as the MIT of China."

Badger went abroad as part of the Engineering International Exchange Program at the University of Utah College of Engineering. The College has partnered with top engineering schools in China, India, Korea and Germany to offer students an opportunity to study engineering in a foreign country while remaining on schedule to graduate from their home institution. The program allows students to expand their foreign language technical vocabulary, prepare to work in the global engineering community, and understand engineering from an international perspective.

Studying in China allowed Badger—who had learned Mandarin while serving a two-year LDS mission to Taiwan—to increase his ability to speak, read and write Chinese. "I was really overwhelmed at first," says Badger. "But after spending hours a day with my dictionaries to understand engineering concepts in Chinese, I ended up with A's and B's."

Badger is the first student to take advantage of the international exchange program at Tsinghua University. He even ran a half-marathon that included the Great Wall. "I would have missed the opportunity to go to Tsinghua if I weren't at the U because few schools have that kind of arrangement, says Badger. "The U offers a lot of great opportunities for students."

Photo Credit: Scott G. Winterton, Deseret News

SWEET SUCCESS: Mechanical Engineering Student Plays Key Role in Sugar Bowl Victory

Is the undefeated Utah football team the best in the country? According to Ute players, including mechanical engineering student Zane Beadles, the answer is arguably yes. The Utes had no problem moving the ball against Alabama in the first quarter of the Sugar Bowl and shut down Alabama's highly respected running game. But even though they dominated Alabama with a 31-17 thumping, they settled for the number two spot in the nation in the AP Top 25 poll.

Zane, a junior from Sandy, Utah, is a starting offensive lineman. In addition to being named to the all-MWC first team, Zane is excelling in his mechanical engineering studies. Congratulations to Zane and his teammates for a perfect year.

THE UNIVERSITY OF UTAH
COLLEGE OF ENGINEERING
OFFICE OF THE DEAN
72 S. Central Campus Drive
Salt Lake City, UT 84112-9200
www.coe.utah.edu