Alumni Update Form

We'd like to hear from all of you who called the AE Department home in years past. Share your career news and other news with alumni/alumnae who went to school with you. We're also looking for print or digital pictures. The resolution for electronic pictures must be at least 300 ppi. Mail, fax, or email your news to:

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Name (including maiden name) ____________________ Class year ________

Home address ____________________

Phone (land) ____________________ Phone (cell) ____________________

Email ____________________

Company ____________________ Title ____________________

Company address ____________________

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Company phone ____________________ Company fax ____________________

Other degrees: date, institution, field ____________________

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News:

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Prussing's gift to AE students: 30 years of great teaching

by Susan Mumm, AE Media Specialist

As students presented Prof. John Prussing with his retirement gift—a life-size, cardboard cutout of him dressed in a dark suit (that he said he didn't recognize!)—they joked about how it could be used. They suggested it be positioned at the Department's doorway and, when guests entered, a recording of Prussing's voice be played with the greeting, "Welcome to Aerospace Engineering!"

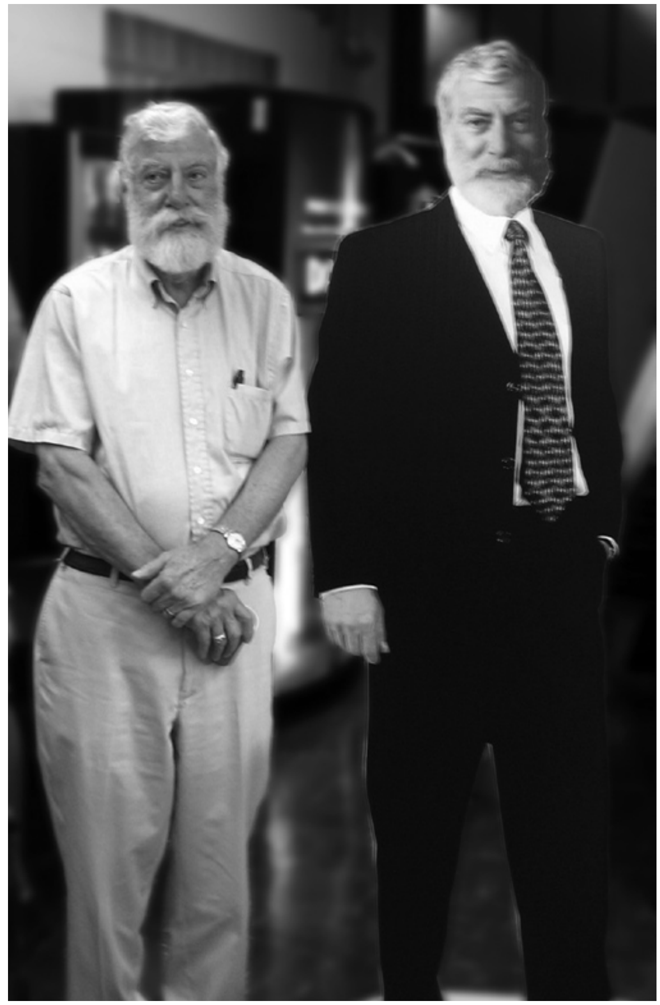
Indeed, as the chief undergraduate advisor for AE students the past 30 years, Prussing's has been the friendly face many students have sought when coming into the Department. Those students have appreciated Prussing's wit and humor as well as his intellect and teaching abilities: 20 times he was named to An Incomplete List of Teachers Ranked as Excellent by Their Students, and this year made the fifth that he was chosen the Department's Teacher of the Year.

In April, the chief advising torch was passed on to the capable hands of AE Prof. Philippe Geubelle. Prussing will continue in the Department part-time, teaching courses such as Orbital Mechanics and Optimal Spacecraft Trajectories, both of which he developed. "The optimal trajectory course was the first of its kind in the U.S.," he said. "I feel like a parent who wants to see it live long and prosper."

In fact, Prussing was the real pioneer of astronautical education in AE at the University of Illinois at Urbana-Champaign. Having earned his bachelor's, master's and doctorate at Massachusetts Institute of Technology, Prussing came to the Urbana campus in 1969. At that time, the Department had recently changed its name from Aeronautical Engineering to Aeronautical and Astronautical Engineering. None of the faculty was doing astronautics work, and Prussing was hired to introduce it by his teaching and research. Said Prof. Victoria Coverstone, a protégé of Prussing who began her faculty career in AE in 1992, "When AAE 306 (Orbital Mechanics) was introduced, it was one of the very first university courses that combined classical celestial mechanics and engineering applications."

As Prussing was flying to Illinois to begin his career here, Apollo 11 made its legendary first manned moon landing. "The captain came on the intercom and announced 'The Eagle has landed,'" Prussing said. "It seemed to be an omen that I was headed for the right place."

Prussing's work gained notoriety and led to his book *Orbital Mechanics*, co-written with AE Prof. Bruce Conway and published in 1993. This popular book



John Prussing poses with a cardboard cutout of himself, a gift from his students.

since then has been used as a text at the universities of Illinois, Purdue, Michigan, Penn State, Colorado, and Southern Cal, as well as in Canada and Australia, and is in nearly 300 libraries around the world.

Conway said his and Prussing's mutually beneficial working relationship extended in many ways beyond the book. "Of course we collaborated on the textbook," he said, "but we have also collaborated in research (with NASA) and we have had PhD students doing complementary work: One of his students would continue a promising line of research accomplished by one of my students or vice-versa."

Prussing has faith in Coverstone and Conway to continue in his footsteps and teach courses and do research in astrodynamics and spacecraft/satellite trajectories. He feels positive about the future of the Department. "(AE) has hired several excellent new faculty members, which is a sign of good things for the Department," he said.

He also looks hopefully to the United State's continued push for its space programs. "The shuttle program as we have known it is coming to an end, but there will be something else to replace it," Prussing maintains. "For example, if the Chinese or another country starts becoming active in human space exploration, we will be spurred on to do more." Although very expensive, private space exploration and travel will happen, especially if there is a commercial benefit, Prussing predicts. And to those who are skeptical, he recalls another time, back in the early 1960s, when disbelief was widespread. "When (President John F.) Kennedy kicked off the decade leading to the Apollo 11 landing, even aerospace people looked at each other and said, '*WHAT!*'"

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Supersonic business jets, *continued from page 1*

trative Affairs in the College of Engineering at Illinois. "This is the largest industrial research agreement for the Aerospace Engineering Department. While specific details of the agreement are commercially confidential, we have signed a five-year research agreement with funding for the first three years," Bragg said.

AE engineers involved in the research include Bragg, Assistant Prof. Joanna M. Austin, Associate Prof. Gregory Elliott, Associate Prof. Jonathan B. Freund, Prof. Eric Loth, and Department Head J. Craig Dutton, as well as a half-dozen or more graduate students. Bragg said the companies' investment will provide research funding that will support the faculty and students as well as provide for some special facilities to do computational and experimental work.

Illinois researchers will focus on the engine's intake and exhaust systems with a goal of reducing sonic boom and increasing propulsive efficiency. Joined by Loth, Bragg and Elliott will lead research on by-pass air that travels around the outside of the engine core. Loth will lead the inlet research, joined by Bragg, Elliott and Dutton. Austin and Freund will lead research on the acoustics of the exhaust system, joined by Elliott.

"Current Federal Aviation Administration (FAA) regulations prohibit supersonic flight over land, "said Bragg. "One of the prime objectives of this research is to show the FAA and environmentalists that the sound produced by a jet flying at supersonic speeds over land can be reduced to an acceptable level."

Signing an agreement for AE to work with Gulfstream and Rolls Royce Deutschland to develop supersonic business jets are (from left) Craig Dutton, AE Department Head; Preston Henne, representing Gulfstream; Ilesanmi Adesida, College of Engineering Dean; and Mike Bragg, AE Professor and COE Associate Dean.

Rolls-Royce Deutschland supplies engines for aircraft built by Gulfstream, headquartered in Savannah, Georgia. Aerospace Engineering alumnus Preston Henne, BS 69, provided assistance in the companies reaching an agreement with the Department. Henne is Senior Vice President, Programs, Engineering and Test at Gulfstream.

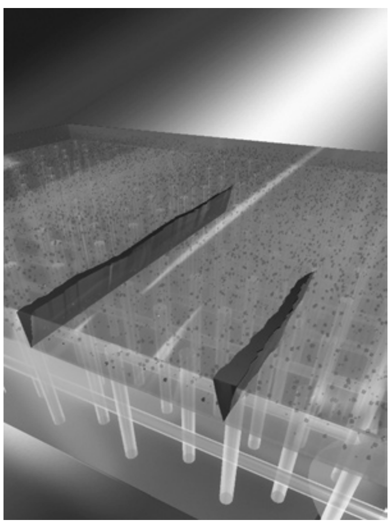
Catalyst-free chemistry makes self-healing materials more practical

by James E. Kloeppel, Physical Sciences Editor for the News Bureau

A new catalyst-free, self-healing material system developed by researchers at the University of Illinois, including AE Professor Scott White, offers a far less expensive and far more practical way to repair composite materials used in structural applications ranging from airplane fuselages to wind-farm propeller blades.

The new self-healing system incorporates chlorobenzene microcapsules, as small as 150 microns in diameter, as an active solvent. The expensive, ruthenium-based Grubbs' catalyst, which was required in the researchers' first approach, is no longer needed.

"By removing the catalyst from our material system, we now have a simpler and more economical alternative for strength recovery after crack damage has occurred," said Jeffrey Moore, the Murchison-Mallory Professor of Chemistry at Illinois. "Self-healing of epoxy materials with encapsulated solvents can prevent further crack propagation, while recovering most of the material's mechanical integrity."

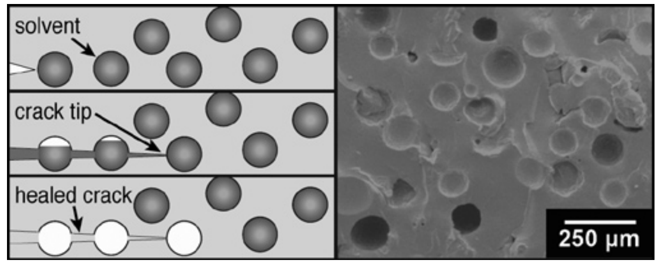


A microvascular sample in which the coating is healed repeatedly by successive infusion of a healing agent (red) supplied by the vascular bed. Image by Janet Sinn-Hanlon, Imaging Technology Group, Beckman Institute.

The new chemistry is described in a paper accepted for publication in Macromolecules, and posted on the journal's Web site.

During normal use, epoxy-based materials experience stresses that can cause cracking, which can lead to mechanical failure. Autonomous self-healing—a process in which the damage itself triggers the repair mechanism—can retain structural integrity and extend the lifetime of the material.

"Although we demonstrated the self-healing concept with a ruthenium-based catalyst, the cost of the catalyst made our original approach too expensive and impractical," said Moore, who also is affiliated with the university's Frederick Seitz Materials Research Laboratory and with the Beckman Institute. "Our new self-healing system is simple, very economical and potentially robust."



On the left side, it describes the system that contains the solvent capsules. Upon crack damage, the solvent is released into the crack plane and heals the crack faces together. On the right is an SEM image of a healed crack surface after the solvent has been released.

In the researchers' original approach, self-healing materials consisted of a microencapsulated healing agent (dicyclopentadiene) and Grubbs' catalyst embedded in an epoxy matrix. When the material cracked, microcapsules would rupture and release the healing agent, which then reacted with the catalyst to repair the damage.

In their new approach, when a crack forms in the epoxy material, microcapsules containing chlorobenzene break. The solvent disperses into the matrix, where it finds pockets of unreacted epoxy monomers. The solvent then carries the latent epoxy monomers into the crack, where polymerization takes place, restoring structural integrity.

In fracture tests, self-healing composites with catalyst-free chemistry recovered as much as 82 percent of their original fracture toughness.

The new catalyst-free chemistry has taken down the barriers to cost and level of difficulty, Moore said. "From an economics and simplicity standpoint, self-healing materials could become part of everyday life."

With Moore, co-authors of the paper are graduate student and lead author Mary Caruso, former post-doctoral research associate David Delafuente (now a chemistry and physics professor at Augusta State University), visiting University of Texas at Austin undergraduate student Victor Ho, materials science and engineering professor Nancy Sottos, and aerospace engineering professor Scott White.

The work was funded by the Air Force Office of Scientific Research and the National Science Foundation.

Now, self-healing materials can mimic human skin, healing again and again

by James E. Kloeppel, Physical Sciences Editor for the News Bureau

The next generation of self-healing materials, invented by researchers at the University of Illinois, including aerospace engineering Prof. Scott White, mimics human skin by healing itself time after time. The new materials rely upon embedded, three-dimensional microvascular networks that emulate biological circulatory systems.

In the same manner that a cut in the skin triggers blood flow to promote healing, a crack in these new materials will trigger the flow of healing agent to repair the damage," said Nancy Sottos, a Willett Professor of materials science and engineering, and the corresponding author of a paper accepted for publication in the journal Nature Materials, and posted on its Web site.

The vascular nature of this new supply system means minor damage to the same location can be healed repeatedly," said Sottos, who also is a researcher at the university's Beckman Institute.

The next generation of self-healing materials, invented by researchers at the University of Illinois, mimics human skin by healing itself time after time. The researchers, clockwise from front, graduate student Katie Toohey; Nancy Sottos and Jennifer Lewis, both professors of materials science and engineering; Scott White, professor of aerospace engineering; and Jeffrey Moore, professor of chemistry, pose in the robocaster lab. Photo by L. Brian Stauffer

In the researchers' original approach, self-healing materials consisted of a microencapsulated healing agent and a catalyst distributed throughout a composite matrix. When the material cracked, microcapsules would rupture and release healing agent. The healing agent then reacted with the embedded catalyst to repair the damage.

With repeated damage in the same location, however, the supply of healing agent would become exhausted," said White, a Willett Professor in AE and also a researcher at the Beckman Institute. "In our new circulation-based approach, there is a continuous supply of healing agent, so the material could heal itself indefinitely."

To create their self-healing materials, the researchers begin by building a scaffold using a robotic deposition process called direct-write assembly. The process employs a concentrated polymeric ink, dispensed as a continuous filament, to fabricate a three-dimensional structure, layer by layer.

Once the scaffold has been produced, it is surrounded with an epoxy resin. After curing, the resin is heated and the ink—which liquefies—is extracted, leaving behind a substrate with a network of interlocking microchannels.

In the final steps, the researchers deposit a brittle epoxy coating on top of the substrate, and fill the network with a liquid healing agent.

In the researchers' tests, the coating and substrate are bent until a crack forms in the coating. The crack propagates through the coating until it encounters one of the fluid-filled "capillaries" at the interface of the coating and substrate. Healing agent moves from the capillary into the crack, where it interacts with catalyst particles. If the crack reopens under additional stress, the healing cycle is repeated.

"Ultimately, the ability to achieve further healing events is controlled by the availability of active catalyst," said Kathleen S. Toohey, a U. of I. graduate student and lead author of the paper. "While we can pump more healing agent into the network, 'scar tissue' builds up in the coating and prevents the healing agent from reaching the catalyst."

In the current system, the healing process stops after seven healing cycles. This limitation might be overcome by implementing a new microvascular design based on dual networks, the researchers suggest. The improved design would allow new healing chemistries—such as two-part epoxies—to be exploited, which could ultimately lead to unlimited healing capability.

"Currently, the material can heal cracks in the epoxy coating—analogous to small cuts in skin," Sottos said. "The next step is to extend the design to where the network can heal 'lacerations' that extend into the material's substrate."

For years, research in White's labs has been directed toward the creation of new materials systems that exhibit autonomy—the ability to achieve adaptation and response in an independent and automatic

continued on page 26