



Hillman came to the University of Delaware to work on his idea for a composite beam, which carries fully loaded freight trains at high speeds and can last for up to an entire century



Top Story

CCM Collaborator Awarded Engineering News-Record Award of Excellence

In April, Civil Engineer John Hillman accepted the Engineering News-Record Award of Excellence in Manhattan for his innovative design and use of construction materials in a Hybrid Composite Beam for bridge applications. He naturally had a slew of mentors, co-workers, colleagues and friends to thank for helping make his dream come to fruition after the 14-year journey from concept to realization of commercial success.

One major player in bringing his vision of composite beams to reality was the University of Delaware, through its Center for Composite Materials and Department of Civil and Environmental Engineering. Hillman came to work on his idea for a composite beam, which carries fully loaded freight trains at high speeds and lasts a century, after his technology earned its first TRB-IDEA (Transportation Research Board - Ideas Deserving Exploratory Analysis) Grant in 1999.

At that time, Hillman's employer, the Chicago-based engineering firm of Teng & Associates, had retained the services of CCM and Civil Engineering to help with the development of the project, as no one was quite sure how to build a composite member of the size and complexity, as well as provide a facility to test the completed beam, according to Hillman.

TOP STORY (Continued)

“While working on a previous composite bridge project in the late 1990s, I met (Civil Engineering) Professor Dennis R. Mertz, who eventually encouraged me to submit for the TRB-IDEA grant and (CCM Director) Dr. Jack Gillespie,” Hillman said. “So I was familiar with their work at UD in the areas of bridge specifications and composite research, and I also knew that UD had an interesting relationship between the Civil Engineering Department and the Center for Composite Materials.”

In November of 2000, Hillman received a U.S. patent for his creation, a structural beam consisting of a corrosion-resistant fiberglass box containing self-consolidating concrete, steel strands, foam and a pink, inflatable plastic bag. The team then went to work load testing the first beam, which Hillman admits was “not a very pretty beam,” nor was it a scalable manufacturing process, but nevertheless, worked.



Jack Gillespie
CCM Director
Professor, Materials
Science & Engineering
Donald C. Phillips
Professor of
Civil & Environmental
Engineering



Dr. Nicholas Shevchenko
CCM Associate Scientist

In 2003, the team submitted a proposal for a Type 2 HSR-IDEA (High Speed Rail) Grant and set about to develop a cost-effective manufacturing process as well as fabricate and construct the world's first composite railroad bridge, according to Hillman. “We started small, with 8-foot-long beams, until we had a process that seemed to work. We then scaled up to a 30-foot mold to build beams we knew would fit in the railroad test facility in Pueblo, Colo.”

It was during this Type 2 Grant that CCM Associate Scientist Nicholas Shevchenko was brought in to help with the high-speed rail project. At the time, Hillman's group knew they wanted to proceed with a closed mold scenario, keeping the lid on the beam closed during infusion while vacuum would be used to draw the resin into the fabric perform.

“The issue was that the part we were making (the beam) had an internal cavity (the arch). During the processing the arch needed to be kept empty,” Shevchenko said. “Later after the processing, the arch-shaped cavity would be filled with concrete, thereby making a concrete arch.”

Shevchenko's idea, though simple and straightforward, was to install a bladder or tubular bag into the arch section during the part layout. When vacuum was later drawn on the mold, the bag would expand and maintain the hollow arch.

“Conventional thinking causes people to imagine things shrinking as the air is vacuumed out,” Shevchenko said. “So, from the perspective of the part, it is compacted and the internal volume is reduced. But if you turn that situation inside out, the vacuum effectively causes the arch shaped space outside the vacuum bag to expand. That is how we maintained the arch shaped cavity within the beam.”



Dennis R. Mertz
Professor,
Civil & Environmental
Engineering

"The unique combination of resources at UD-CCM were essential to be able to address all the facets of developing a large scale composite beam for infrastructure applications," Hillman said.

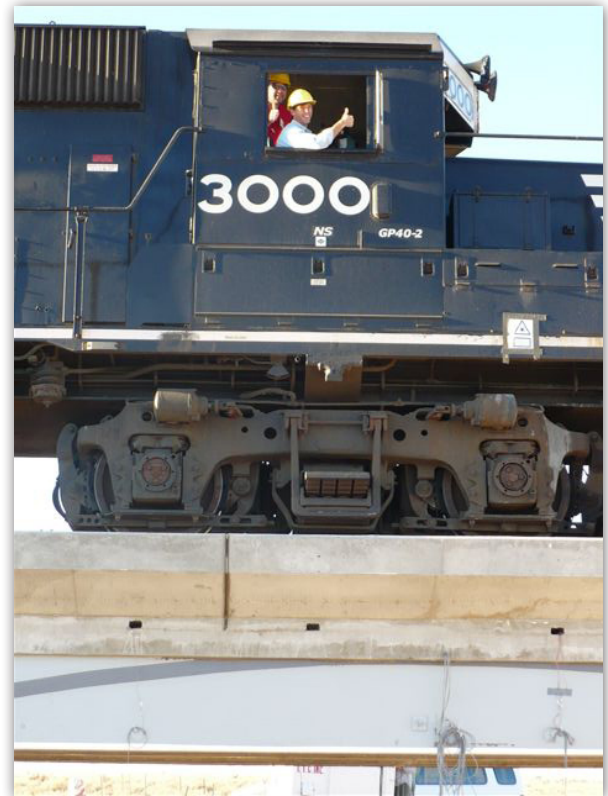
"The key to successful scale-up was to utilize our virtual infusion simulation called LIMS. We characterized the materials, conducted sub-element infusions and then optimized the processing conditions prior to our first full-scale fabrication. This reduced risk and allowed us to look at scalability of the process," said Assistant Director Dirk Heider, the resident VARTM expert at UD-CCM.

From there, the project was off and running, as Hillman spent a total of about six years working with University of Delaware staff. Hillman still has high praise for Shevchenko's addition to the team, saying, "Not only did Nick have the technical savvy and composite manufacturing know how to help us solve the tough problems, but he had the pragmatic skills, patience and perseverance to battle through the challenges of building a large composite piece."

In November of 2007, the culmination of efforts came to a head when the first locomotive engine pulling 26 cars weighing about 315,000 pounds each was driven across a complete Hybrid-Composite Bridge in Pueblo. Reflecting back on the experience, Hillman looks at his time spent with the scientists and researchers at CCM as an integral part in realizing his ultimate goal.

"The unique combination of resources at UD-CCM were essential to be able to address all the facets of developing a large scale composite beam for infrastructure applications," Hillman said. "This was not a high budget research project either, and Director Jack Gillespie and Prof. Dennis Mertz were very generous in their support and mentoring over the course of many years. I will always look back in fondness with the time spent in the lab at UD-CCM and I am forever grateful for the staff members that shared in the pursuit of my dream."

By Rob Kalesse

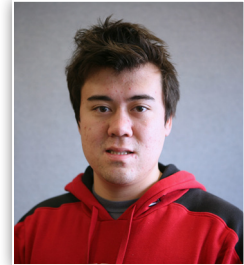


OTHER NEWS

CCM Students Receive Awards at SAMPE Student Night

John Gangloff, a CCM grad student and first-year Ph.D. candidate in mechanical engineering at the University of Delaware, was recently awarded first place at the SAMPE Baltimore/Washington Chapter's Student Night, for his poster presentation, titled, "Processing and Mechanical/Electrical Characterization of Carbon Nanotube-Based Composites for Multifunctional Applications."

Gangloff's poster submission, based on research he performed as an undergrad, focuses on the effects of adding carbon nanotubes to parts made of conventional composite materials, and in doing so, results in the ability to monitor an electrically conductive network. By tracking the electrical resistance as the part is stretched, deformed and loaded, Gangloff said, researchers can correlate the damage sustained to the part based on the changes in electrical resistance.



*John Gangloff
CCM grad student,
Mechanical
Engineering*



The **Spring 2010 CCM Research Review series** comprises weekly overviews of the Center's research focus areas. Each session consists of four brief presentations on specific topics within the designated theme area, followed by discussion/Q&A. The Research Reviews, which are free and open to the public, are scheduled Wednesdays at 11:30 in 106 CMSL unless otherwise noted. Lunch follows the session. Speakers include graduate students, post-docs, research associates, and visiting interns. Spring Research Reviews are hosted by CCM and the **SAMPE-UD Student Chapter**.

"What the poster essentially shows is that, by adding carbon nanotubing to composite materials, we are creating smart materials that will tell us when they're becoming damaged," Gangloff said. "This information is really powerful stuff, because it allows us to design parts with their own structural health monitoring."

The regional event, held in February at the University of Maryland-College Park, also saw Conor Keenan, a fellow CCM grad student and second-year Ph.D. candidate in materials science and engineering at the University of Delaware, placed third for his paper presentation, titled, "Polyurea Resins as Matrix Materials in Composites."



*Conor Keenan
CCM grad student,
Materials Science &
Engineering*

Keenan's paper presentation focused on the use of polyurea resins in air products, his main area of focus as part of UD's SAMPE chapter and their work in the Super Light Weight Composite Wing Contest.

Both Gangloff and Keenan competed against students from other schools, including University of Maryland-Baltimore County, University of Maryland-College Park and West Virginia University. For their efforts, Gangloff received a first-place prize of \$500, while Keenan received a third-place prize of \$300.

PUBLICATIONS

NEW

Journals

Simacek, P., D. Heider, J. W. Gillespie, Jr., and S. G. Advani, "Post-Filling Flow in Vacuum Assisted Resin Transfer Molding Processes: Theoretical Analysis," *Composites Part A-Applied Science and Manufacturing*, 40 (6-7), pp. 913-924, July 2009.

Leal, A. A., J. M. Deitzel, S. H. McKnight, and J. W. Gillespie, Jr., "Effect of Hydrogen Bonding and Moisture Cycling on the Compressive Performance of Poly-Pyridobisimidazole (M5) Fiber," *Polymer*, 50 (13), pp. 2900-2905, 2009.

Yoon, M. K., D. Heider, J. W. Gillespie, Jr., C. P. Ratcliffe, and R. M. Crane, "Local Damage Detection with the Global Fitting Method using Mode Shape Data in Notched Beams," *Journal of Nondestructive Evaluation*, 28, (2) pp. 63-74, June 2009.

Steggall-Murphy, C., P. Simacek, S. G. Advani, S. Yarlagadda, and S. Walsh, "A Model for Thermoplastic Melt Impregnation of Fiber Bundles during Consolidation of Powder-Impregnated Continuous Fiber Composites," *Composites Part A*, 41 (1), pp. 93-100, January 2010.

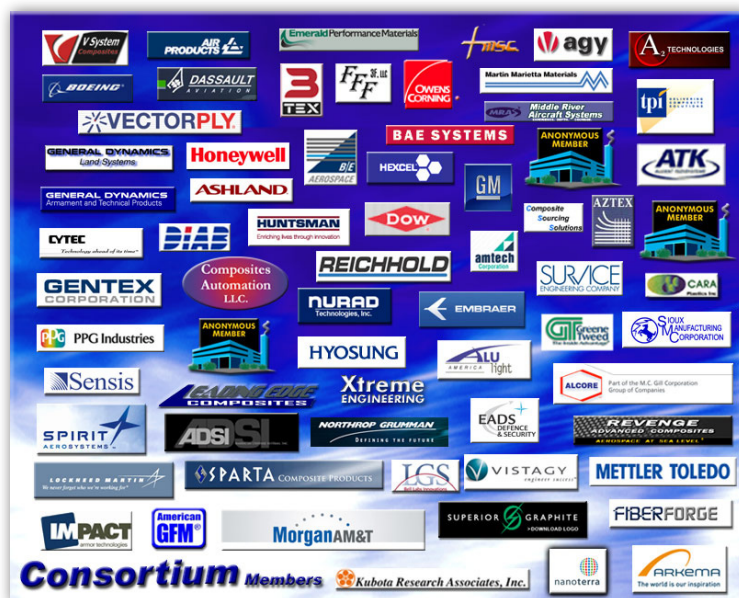
Conferences

McAllister, Q. P., J. W. Gillespie, Jr., and M. R. VanLandingham, "Nanoindentation of High Performance Fibers," *Conference Proceedings of the American Society for Composites*, University of Delaware, Newark, DE, September 2009.



A collection of CCM awards and books authored by CCM affiliated faculty members is proudly displayed in the lobby of the Composites Manufacturing Science Laboratory

MEMBER NEWS



We would like to thank **Morgan Advanced Materials & Technology**, St. Marys, PA, for becoming the newest members of our University-Industry Consortium. We also wish to thank **Kubota Research**, Hockessin, DE, for the recent renewal of their consortium membership.

To learn more about the benefits of becoming a member, please visit us on the web at **www.ccm.udel.edu/Consortium/benefits.html**

*Celebrating 35 years of
significant
contributions to
composites science and
technology, the
education of students,
and the creation and
transfer of technology to
industry.*

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