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CM Online Exclusive
Does the sales team at your company use quality online content to draw in prospects? Todd Hockenberry, a frequent contributor to Composites Manufacturing magazine and the president and CEO of Top Line Results, shares methods for convincing salespeople of the power of inbound marketing in the online article, “3 Steps to Creating IM Believers.” Access the article at compositesmanufacturingblog.com and click the “online exclusives” tab.

About the Cover:
Photo courtesy of the University of Maine.
A message from the ACMA Chair

A Voice Among Lawmakers

Of all ACMA’s activities, the one that is nearest and dearest to my heart is government affairs. Composites manufacturers face so many compliance issues, from EPA requirements to OSHA standards. Thanks to the work of ACMA’s Government Affairs Committee, we can keep an eye on – and even influence – regulatory and legislative activity at the national, state and local levels.

As an association, we are a powerful group. When we go to Capitol Hill, ACMA is recognized as the leader for the composites industry and the voice of composites manufacturers. This is always evident when we meet with members of Congress, congressional staff or federal agencies. While not all U.S. composites companies are AMCA members, the association still represents their interests. As a result, we can tell leaders on Capitol Hill that our industry boasts more than 3,000 companies and 250,000-plus composites-related jobs. Those are numbers that Washington listens to.

ACMA has worked on many issues through the years and helped shape numerous regulations. You may be most familiar with the styrene issue, and of course it is a big issue for all of us. However, there are a host of other issues that ACMA works on, such as fire codes, combustible dust and architectural standards. Your association helped deliver workable standards for emissions and even developed the Unified Emission Factor system that we all use today for our air permits.

The latest issue ACMA is helping you understand is the Securities and Exchange Commission’s (SEC) “conflict minerals” ruling. According to a recent survey, most companies are just beginning or haven’t started preparing to meet the requirements of this important new law. ACMA anticipated the need for information and has already held a members-only webinar to support our members with more communications in the works. (This issue of Composites Manufacturing magazine includes information on conflict minerals reporting on page 26.) I encourage you to visit our website at acmanet.org/composites-advocacy and CM Online at compositesmanufacturingblog.com to learn more about our government affairs program and all the good work we are doing.

Earlier I mentioned the size of our industry. I believe that everyone in the industry gets real value from our legislative and regulatory efforts – whether they are ACMA members or not. If ACMA is not present and successful in Washington, we would run our businesses in a vastly different landscape. Instead of having a seat at the table, we would be relegated to taking what the regulators gave us and figuring out how to deal with it on our own.

If this is starting to sound like a pitch for membership, well, it is. I am sure that we all know a company in our town or region that is not a member of ACMA. It is time for us all to reach out and share the value that ACMA provides to them.

Jay Merrell
Norplex-Micarta, ACMA Chairman of the Board
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Two French companies, The EADS Group and Aero Composites Saintonge (ACS), have collaborated to create the E-Fan, a fully electric, general aviation training aircraft made from composites. It’s part of an initiative by aerospace company EADS to develop technologies that reduce aircraft carbon dioxide emissions.

Three years ago, EADS and ACS unveiled the first all-electric aerobatic plane and smallest manned aircraft with four engines. The plane took part in numerous performance flight tests where engineers gathered information on energy recovery and variable pitch propellers, which allow pilots to change the blade pitch during operation. This research became the catalyst for the E-Fan project.

Unlike most electric planes, which mimic conventionally-powered crafts, the E-Fan design was engineered from the ground up. “I designed the original structure of the aircraft from scratch and did the first calculations before approaching EADS and ACS’ owners,” says Didier Esteyne, technical director at ACS.

EADS was responsible for the electrical system, while ACS designed and built the rest of the aircraft, which can fly a maximum of 137 mph. “The lowest possible airframe weight is of critical importance for an all-electric aircraft,” says Esteyne. “And using carbon fiber composites was an obvious choice because of its better strength-to-weight ratio compared to aluminum alloys.”

The entire fuselage, including the fin and empennage, as well as the wings and main spar were made from composites. The E-Fan has a 31-foot wingspan and a maximum weight of 1,212 pounds, fitting inside the light sports aircraft (LSA) weight parameters.

The two-seat E-Fan was created for short training missions such as basic pilot training, glider towing and aerobatics. The E-Fan’s fully electric propulsion system features two electric motors with a combined power of 60 kilowatts, each driving a ducted, variable pitch fan. Since the engines are located near the center line of the aircraft, the E-Fan is easily controlled during single-engine flights. This propulsion system eliminates carbon dioxide or nitrous oxide emissions during flights, reduces the engines’ noise levels and reduces vibrations compared to aircraft powered by combustion engines.

Powered by multi-cell lithium ion polymer batteries, the E-Fan aircraft can fly for one hour before recharging. EADS expects to upgrade to batteries with higher energy density down the line, increasing flight time to one hour and 30 minutes.

The E-Fan’s landing gear is another innovative feature of this aircraft. It consists of two electrically-actuated retractable wheels – one in the front and one near the rear under the fuselage – plus two small wheels under the wings. The rear main wheel is driven by a six kilowatt electric motor providing power to accelerate up to 68 mph during take-off, which reduces the electrical power consumption in daily flight operations.

The French Directorate General for Civil Aviation, along with regional government institutions in southwest France, are financing the E-Fan project through the European Regional Development Fund.

The E-Fan’s first flight will take place this fall. The next step is commercialization and certification so aerospace training facilities can use the E-Fan, according to EADS. The company expects this to take three years, as current certification rules don’t cover electric propulsion.

Terin Bufford is the communications coordinator at ACMA. Email comments to tbufford@acmanet.org.

For more stories like this, visit compositesmanufacturingblog.com and click on the tab marked “aerospace.”
Please share with the entire Wisconsin Oven staff how satisfied Sewah Studios is with our new oven. Your product has exceeded our expectations in every way. I can now understand why Wisconsin Oven is said to be the best industrial oven manufacturer in the country. The grant procedures made this project a little out of the norm; however everything went on schedule and as planned; I attribute that to the fine folks at Wisconsin Oven. Again thank you and we look forward to working with you in the very near future.

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Made for Speed

Is it jet? A racecar? A rocket? No, it’s the Bloodhound Super Sonic Car (SSC). Designed to reach 1,000 mph, the Bloodhound SSC will attempt a new land speed record in the South African desert in 2015. When it does, composite materials will not only go along for the ride, but will be a key factor to the high-tech car’s performance and safety. The front third of the car from the nose to the air intake above the cockpit is made from composites.

The quest to create the world’s fastest car, led by British land speed veterans Richard Noble and Andy Green, has been underway since 2008. Noble was project director of the record breaking Thrust2 (1983) and ThrustSSC, which established the current land speed record of 763 mph in 1997 – the first supersonic record. Green, who is a wing commander in the Royal Air Force, drove ThrustSSC and will also be behind the wheel of the Bloodhound SSC.

The Bloodhound SSC, which takes its name from a British surface-to-air missile, is a car because it has four wheels and is controlled by a driver. It’s supersonic because it is designed to go faster than the speed of sound. Specifically, it is designed to reach 1,050 mph in 42 seconds. The car borrows from a range of industries, making it “a funny mix between a fast fighter jet, a Formula One™ car and a spaceship,” says Conor La Grue, engineering lead for the Bloodhound SSC.

The supersonic car’s 135,000 horsepower comes from a EUROJET EJ200 jet engine, normally found in the Eurofighter Typhoon fighter plane, and a specially designed hybrid rocket that is the largest of its kind in Europe. A Cosworth Group CA2010 Formula One engine provides auxiliary power for hydraulics and the rocket oxidizer pump, which must supply 800 liters of High Test Peroxide (HTP) in 20 seconds.

The Bloodhound SSC’s body is also a hybrid of auto and aerospace technologies. The rear section of the car is comprised of a metal frame and panels like an aircraft. The front portion, where the driver will sit, is a carbon fiber monocoque, like those found in race cars.

La Grue says composites were a natural choice for the Bloodhound. “When we first looked at the car, we explored making the whole car using composites mostly for weight, stiffness and mechanical performance,” says La Grue. Ultimately, the team chose aluminum and steel for areas near high-temperature components, such as the engines. “If you take away all those hot areas, basically everywhere else we can, we’ve used composites,” says La Grue. He says the composite content in Bloodhound will be the most ever in a land speed car.

Noting the successful use of carbon fiber monocoques in Formula One™ racing, La Grue says composites were also chosen for safety – which is paramount. “What we’re trying to do is make a very strong, safe car and make it go fast, not make a fast car and then try to make it safe.”

Employees at URT Group Ltd., West Sussex, England, lay up carbon fiber during construction of the Bloodhound SSC’s monocoque. The finished monocoque, approximately 20 millimeters thick, is lightweight and ultra-strong. “This will provide strength in the center of the car, which weighs six tons dry and 7.5 tons with fuel,” says Kevin Emmett, technical director of URT Group.

Employees at URT Group Ltd., West Sussex, England, lay up carbon fiber during construction of the Bloodhound SSC’s monocoque. The finished monocoque, approximately 20 millimeters thick, is lightweight and ultra-strong. “This will provide strength in the center of the car, which weighs six tons dry and 7.5 tons with fuel,” says Kevin Emmett, technical director of URT Group.
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The monocoque, which was recently completed and is now being bolted to the rear metallic section at Bloodhound headquarters in Bristol, England, was manufactured by URT Group Ltd. of West Sussex, England. It took 1,000 hours to fabricate using an epoxy prepreg carbon fiber system and three-stage autoclave curing process. (For a step-by-step account of the monocoque’s construction, visit bloodhoundssc.com/news/bloodhound-ssc-monocoque-manufactured.)

URT Group is using the same process to manufacture other components for the interior of the monocoque. These include the bulkheads and seatback, which are affixed to the monocoque using an epoxy adhesive manufactured by 3M. It has been a novel project for URT Group. The biggest challenge, says Emmett, was the car’s size. The finished monocoque weighs approximately 100 kilograms and is three meters long and 2.5 meters high. A full scale model takes up two thirds of the company’s assembly area. “We’re used to building sports cars and Formula One chassis,” says Emmett. “The Bloodhound is a big, big vehicle.”

A big vehicle with big goals: Stay tuned to see if the Bloodhound can beat the land speed record established 16 years ago.

Melissa Haley O’Leary is a freelance writer based in Cleveland. Email comments to mxh144@case.edu.
Composites Aid in Sandy Recovery

In late October 2012, Hurricane Sandy tore through the northeast coast of the United States. Liberty Island, home to the Statue of Liberty, was in the direct path of the destructive hurricane. The 12-acre island is normally protected from extreme weather by the confines of the New York Harbor. However, flood waters from Hurricane Sandy covered 75 percent of the land, according to the U.S. National Park Service.

“The statue and its pedestal and base were unharmed, but all mechanical systems, docks, the promenade and ancillary structures around the rest of the island experienced heavy damage,” says Andrew Swindell, outside sales representative of waterfront products at Creative Pultrusions Inc. “The island’s utilities, backup generator and power systems were destroyed, and the brick pathways were uprooted around the island as well.” The FRP manufacturer worked on the first phase of a recovery project to restore Liberty Island.

During the first phase, the National Park Service had to replace more than 200 timber piles from the ruined service dock, used for equipment and emergency transport access to the island. The Federal Highway Administration’s (FHWA) Emergency Relief for Federally Owned Roads program provided funding to the National Park Service for repair of roads, bridges, docks and pedestrian walkways on Liberty Island. The FHWA specifically requested the use of composite piles to repair the dock.

“Composite piles filled with concrete are a viable alternative to traditional piles due to the increase in longevity and life,” says Raymond Sciahetano, vice president of the marine division at EIC Associates Inc., contractor on the project. Lee Composites supplied Creative Pultrusions’ SUPERPILE FRP pipe piles to EIC to serve as bearing piles for the renovated service dock.

Three years ago, Creative Pultrusions created SUPERPILE, a high-performance line of corrosion-resistant pultruded pipe piles for the marine and foundation pile marketplace. “There was a need for these piles in the marine industry and in the various Department of Transportation (DOT) units that would only receive 10 to 20 years
FRP pipe piles manufactured by Creative Pultrusions Inc. were used to restore a service dock on Liberty Island after Hurricane Sandy destroyed the dock in October 2012.

out of their current piles due to corrosion, spall, rust and decay,” says Dustin Troutman, director of marketing and product development at Creative Pultrusions. EIC had a very tight schedule to rebuild the service dock. Construction began in early May and had to be done by the July 4 reopening of the statue. In a press release, Ken Salazar, secretary of the U.S. Department of the Interior, said finishing the project by Independence Day was critical because the Statue of
Liberty is “such an important icon for New York and America.”

Using the high-pressure injection pultrusion process and a polyurethane matrix, Creative Pultrusions quickly produced 198 FRP pipe piles. “The pultrusion process is ideal for mass production, and we were able to produce these piles in under a week,” says Troutman.

The piles were 48 feet long, 12 inches wide and ½-inch thick and were fitted with steel pointed driving shoes. The shoes enhanced the drivability, increased the bearing capacity and kept the soil and water out of the piles so they could later be filled with concrete. An ICE I-8v2 diesel hammer was used to install the pipes.

The service dock was completed on June 30 – just in time for the reopening. Thousands of visitors flocked to Liberty Island to celebrate Independence Day. Work continues on projects around the island, including repairs to the visitor ferry dock and elevation of mechanical and electrical systems to protect them from future storms. Creative Pultrusions is developing additional pipe piles for the second phase of the Statue of Liberty recovery, focused on the visitor docks.

Terin Bufford is the communications coordinator at ACMA. Email comments to tbufford@acmanet.org.

For more stories like this, visit compositesmanufacturingblog.com and search the phrase “infrastructure.”
Composites on Campus

Researchers in university labs work on trailblazing projects to advance the composites industry.

By Susan Keen Flynn and Debbie Sniderman

Wind on the Water

Project: Offshore wind turbine
School: The University of Maine
Location: Orono, Maine
Director: Habib Dagher

People fishing or jogging alongside the Penobscot River in Maine on May 31 were eyewitnesses to a unique event. A tugboat towed a 65-foot-tall wind turbine nearly 30 miles from Brewer to Castine, where it was anchored off the coast of the Gulf of Maine in 80-foot water. “It’s the first offshore turbine in the world with a concrete hull and a composite tower,” says Habib Dagher, director of the University of Maine. “Hopefully we are helping take composites to new heights.”

The VolturnUS prototype wind turbine is the culmination of more than four years of collaborative research and development conducted by the DeepCwind Consortium. Led by the University of Maine, the consortium is a public/private partnership funded by the university, the Department of Energy (DOE), the National Science Foundation, Maine Technology Institute, the state of Maine and more than 30 industry partners. The VolturnUS is 1.8\textsuperscript{th} the scale of a 6-megawatt (MW), 423-foot rotor diameter design for a commercial installation. Such an installation could aid the state of Maine’s plans to produce 5,000 megawatts of electricity offshore by 2030.

The prototype – the first grid-connected offshore wind turbine in North America – features a floating concrete hull and composite tower, blades and nacelles. The university developed proprietary material systems that allow the hull and tower to survive in an aggressive, corrosive environment. “The advantage of composites is durability and reduction of topside weight,” says Dagher, leader of the DeepCwind Consortium. “In the long run, these composite towers will be very large – 300 feet long and 20 feet in diameter near the bottom.”

The University of Maine constructed the hull with
commercial partners, including Cianbro Corporation. The composite tower was fabricated by Ershigs in the university’s lab. The unit was then disassembled, taken to Cianbro’s facility in Brewer and reassembled with the tower placed onto the semi-submersible hull. In one lift, a crane placed the floating turbine into the Penobscot River for a 10-hour tow trip to the sea.

The VolturnUS will remain off the coast of Castine for up to a year collecting data on wind and wave environments. The unit has dozens of sensors measuring how much force the wind applies to the rotor, the motion of the unit in six different axis, the power and electrical output, how much force the mooring lines apply on the hull and more. The data is collected and reviewed daily by personnel in the Advanced Structures and Composites Center.

Dagher anticipates that the wind turbine’s design will increase the unit’s lifecycle. Typical offshore installations last approximately 25 years, he says. “Because our unit can be manufactured dockside, we expect to be able to tow it back to shore every 20 to 25 years, replace or work on the turbine, then tow it back to sea,” says Dagher. He expects the full-scale VolturnUS to have a lifespan of 75 to 100 years.

After this test deployment, the team will build two 6 MW floating turbines to be moored off Monhegan Island in 2016. Design is currently underway, funded in part by a $4 million grant from the DOE. The University of Maine is a finalist in the DOE’s Advanced Technology Demonstration Program for Offshore Wind competition, which will award $46 million to the winning project. Dagher expects the DOE to reach a decision in April 2014.

Dagher is excited by the potential impact of the VolturnUS on advanced materials. “This opens a big market for composites,” he says. “Blades already use composites. If we can go into towers, it presents a different exciting market for composites.”

**A One-Mold Winged Wonder**

**Project:** Dynamically soaring high-altitude aircraft  
**School:** Lehigh University  
**Location:** Bethlehem, Pa.  
**Director:** Joachim Grenestedt

Researchers in Lehigh University’s Composites Laboratory are developing an unmanned aircraft designed to fly indefinitely at high altitudes powered by jet streams. That’s a significant undertaking. “It’s high-hanging fruit, but fruit that somebody should pick,” says Joachim Grenestedt, a mechanical engineering professor. “It’s a really cool concept.”

Perhaps even more noteworthy is how Lehigh engineers are manufacturing the glider, called the JetStreamer. They fabricated the 6.5-meter carbon fiber wing in a single molding process, complete with wing planks, spar caps, six internal webs to carry shear loads and a trailing edge to accommodate wing flaps and ailerons. “As far as I’m concerned, this is the holy grail of composites – building a wing in one piece,” says Grenestedt.

Grenestedt and John Spletzer, associate professor of computer science and engineering, lead the project, which began nearly four years ago with a small seed grant from Lehigh. The two professors, along with a
co-principal investigator from Penn State University, were awarded more than $1 million in 2011 to fund the multi-year project. So far they have fabricated five wings in the Composites Lab and conducted structural tests to ensure the wings can withstand 20 G loads. To put that in perspective, the average roller coaster tops out at approximately 3.5Gs.

Carbon fiber is the ideal material for the glider for several reasons, including strength, stiffness and the geometry of the aircraft. To remain airborne, the JetStreamer requires very low drag and long, slim wings. The wings need to be rigid to prevent flutter, divergence and aileron reversal—three phenomena of flight that are critical at high speeds. Wing strength is important for the glider to perform hard, fast turns.

“The biggest benefit of composites is probably the manufacturing process,” says Grenestedt. “Making the glider out of, say, aluminum would be very difficult because of the material’s inability to conform to compound curvature, surface imperfections, etc. Laying carbon is fairly easy.” Researchers at the university streamline the process further by cutting female molds. “A lot of places cut a male plug, make the female mold and then build inside it,” says Grenestedt. “We get rid of one step by cutting the female mold directly.”

Plies of 0.3 millimeter unidirectional carbon fiber prepreg are cut to shape using templates. The first wing skin plies are laid on the top and bottom molds, then vacuum debulked. The process is repeated, followed by spar cap plies and the last skin plies. Next the team prepares internal vacuum bags and Styrofoam placeholders. The internal web plies are laid on the placeholders and debulked. Aluminum inserts are placed into the mold to create the trailing edge profile. Final internal bags and a peel ply are added before the top and bottom mold are sealed together and cured in an oven at 194°F for more than 24 hours. The finished wing weighs only 7 kilograms.

Creating the wing in a single molding process has many advantages. There are no glue joints or weak points. It eliminates trimming, grinding surfaces, fitting parts and aligning parts using complex jigs. “If you can get rid of all those steps and just have molds, when you pop open the mold you have your finished part,” says Grenestedt. “You save a lot of time, weight and mess.”

The team has also built ailerons, flaps and a motor pod for the glider. (While the unmanned aircraft will be powered by jet streams, a motor will be used for the initial testing.) Next, it will construct the rudder and elevator. Grenestedt hopes the JetStreamer will be ready for flight by the end of the year.

Researchers at Lehigh aren’t focused on possible applications just yet. “If you asked the Wright brothers their ultimate goal, they probably wouldn’t have said supersonic flight,” says Grenestedt. However, one application where he sees potential is for monitoring weather. The unmanned glider could move in and out of the jet stream, track it and perform local measurements.
Tough Little Fibers

Project: Continuous nanofibers
School: University of Nebraska
Location: Lincoln, Neb.
Director: Yuris Dzenis

Yuris Dzenis, professor of mechanical and materials engineering at the University of Nebraska – Lincoln (UNL), and his group in the Advanced Nanomaterials and Nanomanufacturing Laboratory may have found the key that will soon enable nanofibers to be used in many more applications. Their work is part of a large research effort in advanced nanostructured fibers supported by the United States Army, Air Force Office of Scientific Research, National Science Foundation and research groups at several other universities. Dzenis’ group is investigating continuous nanofibers formed by the electrospinning process – a method of obtaining composite fibers from solutions as a liquid jet accelerates through an electric field.

“In testing hundreds of individual nanofibers with different diameters, we found a very unusual size effect,” says Dzenis. “Not only do strength and modulus increase dramatically when the diameter decreases (as expected), but also the toughness increases.” says Dzenis. Typically when a material’s strength increases, it becomes brittle.

UNL is studying several nanofibers with diameters ranging from $\frac{1}{10}$ to $\frac{1}{1000}$ of the diameters of conventional fibers such as carbon and Kevlar. While electrospinning can produce continuous nanofilaments in the single nanometer to micron diameter range, the group found the largest increases in strength, ductility and toughness in ultrafine fibers with diameters below 250 nanometers. These ultrafine fibers are also different from other nanomaterials because their continuous fibers are endless. “Most nanomaterials, including popular carbon nanotubes and graphene, are discontinuous particles,” says Dzenis. “While researchers projected a big future for nanotubes in structural materials 15 to 20 years ago, much of that promise is yet to be realized because they are difficult to align and process into composites or fibers. In contrast, it should be possible to process continuous nanofibers into composites using techniques similar to the ones used in industry, such as textile processing.”

The group at UNL demonstrated and published results producing fibers from polyacrylonitrile (PAN). Dzenis says that even this medium grade polymer – which wasn’t necessarily expected to be high performing – can yield high performance mechanical properties in fine continuous fiber format. His group is currently working on several other systems. Dzenis says all three major
classes of reinforcing fibers – polymers, carbons and ceramics – can be processed by electrospinning into nanofibers with diameters much smaller than those of conventional microfibers.

Electrospinning has been around for decades, but there was little interest in using it to create nanofibers for structural applications. “They were considered too small for practical application and industry concentrated on traditional fibers that they knew how to produce more economically,” says Dzenis. In the last 10 to 15 years, companies have begun working on applications ranging from sensors to biomedical. There wasn’t as much interest in the composites industry, says Dzenis, because high mechanical properties hadn’t been demonstrated.

Now Dzenis’ group is evaluating all fundamental and applied aspects of the electrospinning process. Through systematic experimentation and modeling, they’re aiming to improve the process itself and the alignment and mechanical properties of the fibers. “With these further improvements, we may be able to generate a new generation of reinforcement fiber components that are both strong and tough,” says Dzenis. That would be useful in safety critical applications in aircraft or aerospace structures, bridges and other civil infrastructures.

“Normally, all structures have a trade-off,” says Dzenis. “Most high-performance fibers have high strength and modulus, but not high toughness. If we can get both, we will enter a new structural generation.”

Sunny Outlook for Student-Built Car

Project: Solar powered car
School: Nelson Mandela Metropolitan University
Location: Port Elizabeth, South Africa
Director: Clive Hands

Students at Nelson Mandela Metropolitan University (NMMU) in South Africa are building a solar-powered car for the 2014 Sasol Solar Challenge, a two-week race through difficult terrain in South Africa covering more than 3,300 miles. This is the team’s second straight entry in the biannual race. Clive Hands, a lecturer in mechanical engineering, serves as project leader.

Undergraduate students from Nelson Mandela Metropolitan University use fiberglass, carbon fiber and epoxy resin for their solar car’s body and monocoque, as well as fire-resistant resins for its battery box.
The novice car builders cut their teeth constructing the first car, called the Photon, for the 2012 challenge. “We are a very new solar car team and are basically trying to catch up to other teams that have a lot more experience,” says Josef Groenveld, a mechanical engineering student and the team’s mechanical head. “Our last car gave us lots of ideas where to improve.”

The Photon, which featured composites in its monocoque and body, was nearly 16 ½ feet long and powered by six square meters of silicon solar panels. It competed in the Technology Demo class in the 2012 Sasol Solar Challenge and completed approximately 185 miles.

More than a dozen students at NMMU are currently designing the car for the 2014 race, so a car name and many details haven’t been determined. But the team is considering using composites in more components – such as suspension members, the battery box and even rims – primarily to reduce weight. The Photon weighed 533 pounds – more than 220 pounds heavier than most international entries in the race. NMMU would like its car to weigh approximately 400 pounds. “It’s an ambitious target, but most of our team now has over a year’s experience building a solar car,” says Groenveld. “So we have a good chance of achieving what we want.”

While some teams use an aluminum space frame for the chassis, NMMU relies on carbon fiber to make its chassis extremely strong and rigid, yet lightweight. The body of the car also features carbon fiber, in part “because it’s relatively easy to shape to a mold,” says Groenveld. He explains that pressing the body from sheet aluminum would create a structure that was too heavy to be competitive. The tooling would also be too expensive, he says.

Another lesson learned from the Photon was that the car’s chassis and suspension were over-designed, says Groenveld. “We could get away with using a lot less material in some parts,” he says. “We visited a few companies that use composites to learn more about different layup techniques.” The team also discovered it used too much resin in the last car, which added a significant amount of weight. “So we’re investigating how we can saturate the carbon without using too much resin,” he says.

Charged Up Materials
Project: Multifunctional materials for electromagnetic applications
School: University of Delaware
Location: Newark, Del.
Directors: Dr. Shridhar Yarlagadda and Dr. Mark Mirotznik

Lots of hybrid fabric research has focused on increasing toughness and durability. But researchers from the University of Delaware (UD) Center for Composite Materials are evaluating composite materials in hybrid fabrics for electromagnetic (EM) applications.

The military is interested in how EM waves propagate through custom textiles and controlling EM behaviors when joining them with structural components. But there is also commercial interest. Research into EM materials could lead to “ships of the future” with antennas integrated directly into their load-carrying structures or enclosures for aircraft or cell phone towers that protect against lightning.
Shridhar Yarlagadda, assistant director of research at UD's Center for Composite Materials and project director, explains that the team working on this U.S. Navy-funded project plans to create custom layers of two-dimensional fabrics and evaluate EM properties of fabrics.

The researchers answer the basic question of “what to make” by creating analysis software and other design tools that can predict performance. The group is currently in the design stage. It has built models to predict properties of fabric architectures and validated them using carbon fiberglass.

The team is now checking if the models still work when they add other fibers for hybrids. They hope to eventually model all types of fibers, but are developing the model using two major fibers – carbon and polyethylene.

The team at UD is also performing basic research to understand what kind of wave propagation they can design into a material, how to tailor EM properties in a structure and what level of tailoring they can accomplish. Of mechanical interest are the fabric’s stiffness, strength, weight and durability.

On the electromagnetic front, the group focuses on dielectric properties and conductivity at multiple scales, depending on the architecture of the devices created. They look at hardness patterns, changing the ordering of the

ACMA Highlights Student Research

A dozen university students entered the “Best and Brightest Student Poster Competition” at COMPOSITES 2013 last January in Orlando. David Branscomb from Auburn University, shown here, won the competition with his entry “Design Process for Open Architecture Composites.” His poster described the process for design and manufacture of a very high strength-to-weight composite truss structure using 3D CAD, FEA modeling and conventional braiding technology.

All 12 student posters were on display at COMPOSITES 2013. The poster competition, sponsored by CCP, was such a success it will be repeated at CAMX, the Composites and Advanced Materials Expo. Co-produced by ACMA and SAMPE, CAMX will take place at the Orange County Convention Center Oct. 13–16, 2014.
fibers and mixing carbon and glass in different directions and in different ratios.

“Not only is understanding what is happening at the fiber level important, but as EM waves propagate in a material, the size and geometries of what they travel through – and how the fibers are arranged – also matter at most frequencies,” says Yarlagadda. “We are creating interesting architectures of dielectric and conductive fibers to observe what EM behaviors we can control.”

If all goes as planned during the design phase, the team at UD will build the hybrid fabrics and test them later this year, weaving architectures in 2D on a small-scale industry standard prototyping loom, purchased through a grant from the Office of Naval Research. The automated and computer-controlled loom allows users to mix and hybridize fabrics and create custom stacks.

With the tools developed in this project, Yarlagadda is confident the team will be able to design useful multifunctional structures. “The loom allows us to make a broad array of custom composite fabrics,” says Yarlagadda. “Just about anything we can design, we can make with this piece of equipment.”

Susan Keen Flynn is managing editor of Composites Manufacturing magazine. Email comments to sflynn@keenconcepts.net. Debbie Sniderman is CEO of VI Ventures LLC, an engineering consulting company. Email comments to info@vivllc.com.

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The 2007-2009 recession, dubbed the Great Recession, caused major hardships for numerous businesses and industries. Many companies within the marine market struggled to stay afloat. The U.S. recreational boating industry suffered its worst contraction in nearly 50 years, which caused a number of bankruptcies among industry suppliers and dealers, according to The Freedonia Group study, *Recreational Boating*.

But the market is looking up. According to the Lucintel report, *Global Recreational Boating Industry Analysis and Forecast 2010-2015*, annual sales for recreational boats are projected to reach $27.8 billion by 2015. Marine manufacturers that persevered through the hard economic times point to three main reasons why – and look forward to a brighter future.

**Business Diversification**

In 2008 as the recession gained steam, marine companies were faced with deciding the best way to maintain business. Some opted to move into other markets.

One of those companies was Marine Concepts, a composites tooling and fiberglass parts manufacturer in Cape Coral, Fla., that supplies everything from large hulls to small detailed parts. In the mid-2000s, it tried to diversify into truck parts, aerospace, wind energy and other markets. But marketing under the Marine Concepts name was tough. In 2005, the owners opened a sister company, JRL Ventures Inc.

“We regrouped and revisited each market, but this time as JRL Ventures,” says Matt Chambers, president of JRL Ventures and Marine Concepts. During the recession, the companies spent several months focusing on non-marine work such as business in the wind energy and simulator sectors.

Ian Kopp, president and COO of Maritime Marine Group LLC, in Augusta, Maine, also believes that diversification was the key to maintaining his company.

“Boat-building makes up about 25 to 30 percent of the overall revenue, while technically advanced composites products for renewable energy, government, military and other industries make up the balance.”

Despite the declining economy, diversification didn’t prove necessary for Viking Yachts, a privately-owned company in New Gretna, N.J. “In November 2008 – as the recession was taking off – we launched a new flagship, an 82-foot convertible yacht priced at $6 million,” says Pete Frederiksen, director of communications at Viking Yachts. In July, the company delivered its 22nd hull.
Revenues for the global marine composites market were more than $940 million in 2012 and that figure is expected to reach approximately $1.5 billion by 2018, according to Frost & Sullivan.

**Introduction of New Products**

Adding product lines is essential to the growth of a company. Customers want to feel like they are investing in the highest quality boat or yacht. According to Chambers, when the marine market picked up after the recession, overstocked inventories and the used boat market inventories sold first. “As those products started to deplete after 2010, new product demands started to show life,” he says.

As new products were introduced, the stock market began to recover and employment rose. “People were starting to get out and enjoy the water again,” says Chambers.

“We strive to introduce new models and products regularly and our ability to do so even in the midst of a deteriorating economy is a clear sign of our strength,” says Frederiksen. Business has been steady for Viking Yachts, delivering 53 boats in the last fiscal year.

Maritime Marine’s products emphasize quality and craftsmanship. Its unsinkable hull designs and components are built by a team of skilled composite experts and the boats are outfitted by a crew of professional boat builders focused on improving Maritime’s reputation with every boat shipped. “We are launching new models and reintroducing Southport Boats, a division of Maritime Marine that is creating energy behind the brand,” says Kopp. Southport Boats specializes in fishing and family boat designs.

**Operation Makeovers**

Making major changes to a company’s facilities and manufacturing processes can be costly and time-consuming. However, some companies put their operations under the microscope during the recession to stay relevant.

“We dropped a few satellite locations and came back under one roof,” says Chambers. “Recently, we purchased a Wellcraft Marine facility in Sarasota, Fla., adding our 5th five axis CNC robotic mill.” Marine Concepts also developed ways to improve holding fixtures for many industries and improve molds for vacuum forming, which are now made from composites rather than more costly aluminum tooling. The company also relied heavily on its business improvement practices such as lean manufacturing, just in time inventory and process controls to build during the recession.

“We converted our entire manufacturing operations to closed molding during 2008-2009,” says Kopp of Maritime Marine. “While it was no less expensive at first, we used this slow time to optimize the process and that has paid tremendous rewards as production now increases.” Both Marine Concepts and Maritime Marine have experienced steady growth since altering their manufacturing processes.

Viking’s reputation is rooted in the company’s commitment to producing 90 percent of their boats in-house, including the fiberglass molds for hulls and decks, the fuel tanks and the interior furniture. Viking turned to green solutions in its facility that are not only environmentally friendly, but also have helped the company reduce overhead costs. “What has helped us tremendously is our facility, which now has its own wastewater treatment plant and solar powered buildings,” says Frederiksen.

**Poised to Grow**

If a company is forced to close locations, shift product lines and restructure operations, growth might seem
unlikely. But for the three companies featured here, steady growth and increased production were indeed possible.

In 2011, demand for recreational boats began to increase. Revenues for the global marine composites market were more than $940 million in 2012 and that figure is expected to reach approximately $1.5 billion by 2018, according to the Frost & Sullivan study Strategic Analysis of the Global Marine Composites Market. As the economy slowly bounces back, increases in the marine composites market will rely on renewed boat building activity as well as an increase in confidence of the use of composites.

“We had a very good 2012-2013 fiscal year and we have successfully introduced new models every year,” says Frederiksen. Viking will introduce a 52-foot convertible yacht and two 42-footers in 2014, just in time to celebrate its 50th anniversary. The company also will unveil a new 92-foot convertible yacht and a 75-foot motor yacht.

“Customers are finding us again!” says Kopp. Maritime Marine and Southport Boats are blending the offshore fishing boat with comforts a family seeks. “Owners need a boat that is versatile enough to be fishing in the morning, hitting the beach in the afternoon, and then pulling up to a dock for dinner in the evening,” says Kopp.

JRL Ventures prepares for the future by studying its changing customer base. “Baby boomers are retiring and a new generation of boaters will be different, meaning we must focus on fuel efficiency, lighter engines and plugs for iPads and iPhones,” says Chambers. “Lighter boats that perform well with composites is where we can make a great impact.”

Terin Bufford is the communications coordinator at ACMA. Email comments to tbufford@acmanet.org.

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Vacuum Infusion Processing (VIP) has been heralded as a great solution for replacing autoclave and open molding processes for various applications. There are several advantages to VIP, which is a variation of vacuum bagging where the resin is introduced into the mold after the vacuum has pulled the bag down and compacted in the dry fiber reinforcements to form the laminate. VIP is very cost effective for fabricating large components. With VIP, manufacturers can produce high-strength, lightweight structures using the same low-cost tooling as open molding and minimal equipment.

For several years, market research companies have predicted that composite manufacturers would move toward closed molding solutions such as VIP molding. Now composites suppliers are noting a shift to VIP molding. Suppliers are meeting the new demand by investing in infusion tooling technology and collaborating with one another to develop products that help manufacturers switch to VIP molding.

A close look at the VIP market reveals three trends in tooling: improved materials to create tooling molds, rapid prototyping of master models to build molds and online applications to share information and streamline manufacturing processes.

1. Improving tooling materials for infusion

A prime example of collaboration between industry leaders is The Closed Mold Alliance, which aims to offer a turnkey closed mold system for manufacturers along with education and consultations. The Alliance is comprised of composites distributor Composites One, equipment and systems manufacturer Magnum Venus Plastech and tooling and hardware manufacturer RTM North.

CCP Composites US, Kansas City, Mo., a supplier of gel coats and resins, has been working with the Closed Mold Alliance to develop new products. “We first researched the market and decided that most companies are focusing on fillers for injection,” says Rick Pauer, marketing manager at CCP Composites US. Research indicated the company’s vinyl ester lines were well suited for VIP. “Since vinyl esters work well out-of-autoclave, you don’t have to use carbon fiber prepregs and the composite product is significantly cheaper but with similar properties,” says Pauer.

CCP Composites offers a line of OptiPlus® tooling resins to quickly build molds for numerous applications. They do not require fillers to reduce the weight of molds. The company expanded the product line to include infusion molding. “We’ve taken a product we’ve been using for onwards of 13 years and made it accessible for VIP molders,” says Pauer. An industry partner recently beta tested the resins on more than 3,500 thermoformed acrylic bath tubs to protect...
the bath tub mold from cracking or aging. The company informed Pauer that the molds still look brand new.

CCP Composites US isn’t the only company to develop resins for injection molding this year. Many different types of tooling resins are now being modified to lessen cure time and improve surface appearance to compete with autoclave, including Hexcel’s HexFlow® infusion resins.

Pauer believes more companies are switching to VIP molding because the technology for creating new tools has drastically improved. “Compared to 25 years ago, the technology for making molds has been shortened from weeks to days – or even hours,” he says. “We expect to see more demand for these products as the technology continues to improve.”

2. Building molds more quickly

mouldCAM in Bristol, R.I., engineers and manufactures large-scale composite structures and high-precision CNC tooling. “We’re a small CNC machining shop, but we’ve been busy,” says John Barnitt, president of mouldCAM’s U.S. operations. “In this economy, fewer customers want 200 orders of the same product or they order a few of one product and they can pull a production mold off of the model.”

Barnitt has witnessed a sales increase for male plugs in production tooling this year, specifically for VIP jobs. “We can do the VIP process for the customer or they can do it themselves,” he says. “We’re starting to see more and more people becoming comfortable with the VIP process. It’s well suited for polyester, vinyl ester and epoxy resins.”

mouldCAM’s design and machining technology is especially popular with marine companies, traditionally an open molding market. The company recently finished a project using CNC machining to create a direct-to-mold surface for Hodgdon Yachts. This enables the company to efficiently manufacture a larger quantity of boat hulls and redesign a new hull quickly.

The use of CNC machines for rapid prototyping has the potential to grow to meet manufacturers’ needs for a variety of molds. More companies are relying on CNC to make male molds and improve the efficiency of manufacturing prototypes. Even large companies such as Livermore, Calif.-based ACP Composites, which produces composite panels, tubes and rods for a variety of industries, are purchasing CNC machines to move more processes in-house. The trend toward CNC machining results in faster, more accurate manufacturing and less overall waste in the production of master models.

But CNC isn’t the only technology geared toward improving the speed of prototyping molds. Many industries are interested in using 3D printing to reduce the time it takes to prepare a prototype. In NASCAR, for example, Joe Gibbs Racing uses Fortus 3D computer software to quickly develop new composite parts before the cars are shipped to the racetrack. (For details, visit CM Online at compositesmanufacturingblog.com/2012/02/gentlemen-start-your-engines.) 3D printers are currently able to create small plastic parts in several hours.

Although 3D printing may be gaining popularity for single prototypes, the technology is not quite ready for larger parts such as boat hulls. Suppliers including mouldCAM and CCP Composites US are both working on ways to create molds quickly for VIP processes, improve the process for composite manufacturers and compete with 3D printing technology.

3. Making VIP information more accessible

While VIP molding allows more flexibility in fabric and matrix supplies, it requires more overall research to create the new out-of-autoclave part. The industry is filling the gap between open and closed molding by sharing information through online applications (apps). Now manufacturers can download an app, such as i-Moulder from Imtech Design. The free app includes a materials process guide, injection molding problems and solutions guide and a materials search section where users can check a database to see if materials they use are compatible with VIP molding.

The i-Moulder app was one of the first on the market, but now several more have become available. A few weeks ago, Austrian-based company ENGEL released an app called e-calc designed to help manufacturers use the company software to complete composite research on a smart phone. “The smart phone is something you always have at hand,” says Dr. Georg Steinbichler, senior vice president of technology. “This permanent availability was what prompted us to develop an app for the first time.” Currently the ENGEL e-calc app is only available for Android phones, but the company is developing new apps for Apple and Windows products.

VIP – A Very Important Process

“VIP molding is now the fastest growing market in the industry,” says Pauer of CCP Composites US. His company, the Closed Mold Alliance and a host of other suppliers will continue to develop solutions to improve the process and educate manufacturers.

Angie McPherson is a freelance writer based in San Francisco. Email comments to mcphersonangie@gmail.com.

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ACMA’s Certified Composites Technician (CCT) program includes curriculum for the vacuum infusion process (VIP). Candidates for the CCT-VIP will learn about VIP methods and techniques, best practice rules, equipment, quality control, troubleshooting and more. For information on the CCT-VIP and eight other CCT programs, email cct@acmanet.org.
What You Need to Know About Conflict Minerals

By John Schweitzer

“Conflict minerals” mined in conditions of armed conflict and human rights abuses, particularly in the Democratic Republic of Congo (DRC) in central Africa, are likely to become very important for many composites manufacturers. That’s because Congress decided to cut off funding for warring factions in Africa by requiring publicly traded companies to disclose the use of four metals – tin, tantalum, tungsten and gold (also called “3TG”) and derivative compounds. Mining of 3TG funds an ongoing conflict there.

What does this mean for the mostly privately held companies in the composites industry? Briefly, any company selling composites raw materials or molded products that are used by publicly traded companies in the manufacture of their own products will be required to report their use of conflict minerals. This means many companies that thought they were exempt are not.

For example, 3TG or compounds present in showers or sinks for RVs or pre-manufactured housing, automotive and aircraft components, sporting goods, appliance parts, electrical equipment and many other composite products will have to be reported if these products are sold to stock issuing companies.

Rulings by Congress and the SEC

Section 1502 of the Dodd-Frank Wall Street Reform and Consumer Protection Act, passed by Congress in 2010, requires the Securities and Exchange Commission (SEC) to disseminate rules requiring stock issuers (publicly traded companies) with “conflict minerals that are necessary to the functionality or production of a product manufactured” to disclose annually whether any of those minerals originated in the DRC or an adjoining country.

The resulting SEC rule, published in the Sept. 12, 2012, Federal Register, requires publicly traded companies to reach throughout their supply chains to determine:

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• if any purchased products or materials contain 3TG or any compounds of these metals
• and, if they do, were they mined in the DRC or adjoining areas.

Reporting is only required for 3TG or compounds that are “necessary to the functionality or production of a product.” Tin present as a contaminant in steel used to fabricate plate or fasteners, for example, does not need to be reported. Conversely, organotin compounds widely used as stabilizers in plastics have a function in the product and are not incidental byproducts or contaminants and are considered by many publicly traded companies to be reportable under the Dodd-Frank requirements.

This illustrates one of the many challenges with the SEC rule. While tin compounds like organotin stabilizers seem clearly within the view of Congress to require disclosure if the tin was mined in the conflict area, the preamble to the SEC rule suggests organotin compounds are exempt. Many large publicly traded OEM manufacturers have told me they expect the SEC interpretation to eventually come into line with the apparent Congressional intent.

There is no exemption based on traces or small amounts of 3TG. Any use of 3TG or compound anywhere in the supply chain, at any concentration level, becomes reportable.

John Schweitzer is director of government affairs for ACMA. Email comments to jschweitzer@acmanet.org.
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Flying on Water

The oldest trophy in international sports will be awarded at the end of September to one of four yachting teams. The 2013 America’s Cup Finals will take place in the San Francisco Bay Sept. 7–21, 2013, pitting the reigning champion ORACLE TEAM USA crew against a challenger from either Australia, New Zealand or Switzerland. (The team that wins the America’s Cup Challenger Series in July and August will face the U.S. team.)

At the center of the race, which began in 1851, is a new class of yacht created specifically for the 2013 America’s Cup. Crewed by 11, the AC72 catamaran is a lightweight speedster measuring 72 x 46 feet and weighing 13,000 pounds. The boat speed can reach 43 knots – or 50 mph. And what helps these sleek catamarans fly through the water? Composites, of course. Pictured here is the ORACLE TEAM USA during a May training run with some of the AC72’s composite components highlighted.

Wingsail

The wingsail is made from a carbon fiber “skeleton” comprising a solid or cored nose cone and main spar. Behind this there is a hinged front element and four to six trailing edge flaps. The elements are made from very light Nomex cored ribs and covered with heat-shrunk Klysar film.

Carbon Fiber Rods

Structural loads are carried both through the main components, the two hulls and two cross beams, but also through a series of carbon fiber rods.

Hulls

Hulls are made of high modulus prepreg carbon fiber. The laminate schedule orientates fibers and a cloth matrix to load the case, combining a solid laminate and an aluminum core.

Dagger Boards

Dagger boards are one of the most highly loaded parts of the AC72. The boards are L-shaped, with the foils on the tip lifting the 6.5-ton boat (7.5 tons when you count the 11-person crew) above the water. Side loads exceed two tons. Dagger boards are a combination of solid and cored laminate.