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About the Cover: Photo courtesy of Structural Composites
From the ACMA Chair

Serving Our Growing Industry

I am excited about starting my term as chairman of the ACMA Board. I have been active in the association for the last eight years and had the pleasure of serving on the board during that time. I have served as chairman of the membership and finance committees, as well as participating on the strategic planning committee, developing our future vision.

Our industry is in a very good place and growing. Our value proposition for composites across all of our markets has never been stronger. We continue to see specifiers and owners look to composites to solve their application problems. The association provides a great platform for us to address common issues and opportunities in our industry. Our vision is to be the “voice of the composites industry,” positioning composites as the material of choice.

Our mission has three pillars to help you prosper:

• Relevant and timely education and information
• Expertise and representation in legislative and regulatory affairs
• Market growth and development

All of us can find ourselves in one of these pillars. Whether you have a need for education and training in your organization, an interest in the regulatory side of the business or a desire to grow your markets, you will find expertise and support within ACMA. The key to finding this success is you. Your engagement with the association by participating on committees, attending the CAMX show or interacting with other members will bring the most value to your company.

ACMA is fortunate to have a strong staff dedicated to the association's success. They are all experts in their functional areas and bring a level of enthusiasm and energy to the organization that is contagious. Our association is in good hands with the team we have representing our industry.

I look forward to serving over the next two years and would welcome your input on how to make our association stronger.

Jeff Craney
Crane Composites
ACMA Chairman of the Board
jcraney@cranecomposites.com
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Composites parts are widely used due to their unique properties, including durability. Unfortunately, even the best designed and best made parts can be damaged by unforeseen circumstances either at the OEM or in service. The following steps cover best practices for repair of anything from gel coat gouges or scratches to damage penetrating through the entire laminate. Before starting, put on the appropriate personal protective equipment for the task, including protective clothing, safety glasses, gloves and a respirator.

Step 1: Evaluate the work area.
Make sure the work area is well lit, but not in direct sunlight. The temperature of the work area, part and all repair materials should be 75 to 80 F. Temperatures below 75 F can extend cure times of repair materials and result in under cure. Elevated temperatures speed up cure, reducing work time.

For cool conditions, heat guns or heat lamps can be carefully used to warm parts and repair materials. The area is too hot if you can’t hold your hand on it. Patching materials are flammable, so be careful.

Step 2: Determine the type and extent of the repair.
Inspect the part to determine the extent of damage and type of repair needed, which will also dictate your materials and tools. For minor defects, determine if any repair is needed by standing a reasonable distance away from the part. If you can’t see the defect, a repair may not be needed. If a minor defect requires repair, a spot or dab patch with gel coat may be sufficient. Deeper defects may need to be filled with putty prior to covering with gel coat. For defects penetrating into or through the laminate, laminate reinforcements and resin must be replaced. Any remaining voids must be filled with putty. For gel coated parts, the area should also be spray patched.

Step 3: Set up the equipment and obtain materials.
Gather your equipment and tools. Inspect all equipment before use to ensure operator safety as well as part quality. If anything is missing or broken, repair or replace it before proceeding.

Obtain all necessary materials. Make sure gel coats and resins have been thoroughly mixed prior to removing samples for repair. For repairs requiring gel coat, use the same batch originally used to spray the part whenever possible to achieve the best color match. When patching an older part, weathering may have occurred, so a tinting kit may be necessary. You can lightly sand and buff an area to see the true color.

Step 4: Prepare the repair area.
Remove the damaged material. For minor defects, hand sanding with a sanding block or a dual action sander may be sufficient. For laminate repairs, use a saw to cut away the damaged portion. Make sure to remove all damaged material so that the remaining material is structurally sound.

Once the damaged material has been removed, prepare the repair area by grinding or sanding to facilitate adhesion of repair materials. Remove all dust, oils, waxes and other contaminates. Keep the repair area as small as possible to minimize finishing work. Mask off the repair area to prevent damage to surrounding areas.
Step 5: Measure and mix repair materials.

It’s critical to accurately measure all repair material quantities, including resins, gel coats, patch aids and peroxide initiators. These materials must be used within specified ratios to perform properly and allow completion of a successful and durable repair. The preferred measuring method is by weight. Low-cost scales can be purchased from local pharmacies, laboratory/hospital supply firms or scientific apparatus suppliers. The next best method is to measure by volume using graduated cylinders.

Many repairs are small and require small amounts of patching materials. Be sure to prepare materials in quantities that can be measured accurately even if the majority of the material is discarded. It is cheaper to discard excess material than to redo a repair because of inaccurate measurement.

For gel coat repairs, patch aids are recommended. Patch aids are resin- or monomer-based solutions that improve the working properties of gel coat when patching. They lower viscosity for easier spraying and reduced “orange peel” – or uneven surface texture. This reduces the time required to finish the repair. Patch aids also accelerate cure so that patches can be finished sooner and reduce surface tackiness for better sanding. Thinning gel coat with solvents such as acetone is not recommended. Solvents slow the cure of the gel coat and can result in off-color, dull and/or hazy patches.

Step 6: Apply repair materials.

For laminate repairs, use a roller or squeegee to pre-wet the glass. If working from the laminate backside, create the needed contour using cardboard or aluminum covered with cellophane prior to applying the glass to the repair area. If working from the front side, make a plug from cardboard with wires through the center, apply the glass to the plug and insert through the hole. Use the wire to secure the plug against the laminate until the resin cures. Remove air voids with a squeegee or roller. Allow the resin to cure thoroughly before proceeding.

For gel coat spray repairs, use a precision touch-up spray gun to spray the catalyzed gel coat mixture onto the damaged area. Spray 8 to 12 mils wet thickness. If you are spraying an area where the gel coat was completely removed, apply gel coat until achieving good hide (minimum 12 mils) using more than one pass.

For spot patching, use a knife or spatula to dab the catalyzed gel coat mixture into the damaged area. Slightly overfill the area, including the area around and above, to allow for shrinkage. Puncture and eliminate any air bubbles that may be trapped in the gel coat. Allow the patch to cure thoroughly. The patch is not cured sufficiently if a thumbnail leaves an impression in the gel coat.

Step 7: Finish the repaired area.

Initially sand with coarse grit sandpaper, followed by a succession of several finer grit sandpapers. The final sandpaper grit should make the patch flush to the part and remove scratches from the previous grit of sandpaper. Always use a clean shop rag to remove the sanding dust, oils, wax and other contaminates, especially when changing to a different sandpaper grit. Sand in one direction per grit size. For example, sand north/south with 400-grit and then east/west with 600-grit sandpaper.

Remove any remaining masking. Buff using a clean 100 percent wool pad with medium grit rubbing compound to smooth the surface. Wash the area with soap and water to remove the rubbing compound residue. Use a clean wool pad and a finishing glaze compound for the final buffing to remove swirl marks. Thoroughly wipe the area to remove all traces of the finishing glaze and residue. Wash the area with soap and water before waxing. Wax with a UV-stabilized exterior-protective paste wax.

By following these basic steps, you’ll be on the road to creating structurally sound, cosmetically appealing composites repairs.

The guest columnist for this issue’s “Best Practices” column is Linda Bergstrom in Technical Assistance with Polynst Composites USA Inc. Email comments to Linda.Bergstrom@polynst.com.
New York City’s subway is big, with nearly 450 miles of underground track. And New York City Transit, which manages the subway system, had a big – as in billion dollar – problem. As part of a public safety upgrade, the agency was blocking openings from one subway track to another. However, the traditional material of choice to do so, precast concrete, was degrading critical radio communications following installation.

If the precast concrete approach continued, a new radio system antenna would be required at an estimated cost of $1 billion. A much less expensive solution was a proprietary cast polymer that met mechanical and fire-resistance requirements. The second remedy is the one currently being implemented.

While the unit price of cast polymer materials are higher than conventional precast concrete, the installed cost of cast polymer can actually result in significant job cost savings. It weighs 75 percent less than concrete and is easier to work with. That was evident when the contractor did the first trial installation. “He did in a two-day weekend as many closures as it would have taken him 10 two-day weekends to do with concrete,” says Tom Lamb, chief of innovation and technology for New York City Transit.

The ease of installation benefited the installer and the transit agency. Closing the connecting openings between tunnels requires the subway to be shut down, which disrupts passengers and costs money. Being able to complete the project in a shorter time and for less labor saves money and reduces customer disruptions.

None of that would matter, though, if the material didn’t meet basic specifications. It had to offer negligible interference to radio waves, be fire resistant to meet safety standards, not emit toxic gases when exposed to flames, withstand pressure loads due to passing trains and not absorb moisture. The agency looked at four or five different materials as a replacement to concrete.

While in private industry, Lamb had worked with materials from Advantic. The Dayton, Ohio-based company leverages advanced materials for use in civil engineering and infrastructure construction. “The material systems that we commonly work in are unique proprietary polymers as well as polymers and composite systems produced by material manufacturers,” says President Brad Doudican.

He adds, “We’re looking to help the building and construction markets understand their opportunities in advanced materials.” In particular, Advantic and its parent company, Cornerstone Research Group, have invested a decade researching and developing a family of proprietary cast polymer products. To meet flame, smoke and toxicity requirements, the subway panel incorporates glass microspheres, an epoxy resin, proprietary processing aids and additives for filler. The result is a material that has the strength of concrete at a significant weight savings.

For example, to cover a 7 x 3-foot opening the conventional precast concrete panel with a 4,000 psi compressive strength weighs 850 pounds. An Advantic cast polymer panel solution of the same strength tips the scales at 66 pounds. When the steel mounting structure is included, the weight of the concrete solution tops 1,200 pounds. The polymer solution, in contrast, weighs only 67 pounds.

The last point of comparison is critical. When cast polymer was first contemplated as a replacement, the impulse was to simply swap out the concrete for the new material. But the concrete mounting hardware ran to hundreds of pounds per panel, which meant that a large crew and special lifting devices were needed. Advantic redesigned the connection detail so the panels could be bolted directly to the subway wall. The difference in stiffness between the wall and the cast polymer meant that there would be movement of...
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one relative to the other. This had to be handled without causing undue stress in the panel.

“We designed a connection detail, which we ended up patenting, that involves an incorporated rubber bushing to permit deflections to occur,” Doudican says. “We took out all the steel, thereby eliminating all the steel crews needed to do the installation.” The resulting panel assembly could be installed in 30 minutes, versus many hours for the concrete solution. The savings in labor costs can be substantial. Thus, while the polymer material may cost more than concrete, the total cost of the project is much lower with the new material.

Once the concept was proven, Advantic had to rapidly ramp up to produce many polymer panels. This included procuring sufficient capacity in mixing, casting and curing equipment, as well as acquiring a five-foot wide band saw, drill presses and other machining tools. To date, the company has delivered more than 32,000 square feet of panels, all manufactured from ¾-inch to ¼-inch thick.

The polymer replacement could go into water, waste water and surface transport infrastructure. However, building codes heavily regulate allowable materials. Consequently, it takes time and some ingenuity to get a polymer composite onto the list of acceptable materials. The subway panel project illustrates this challenge. Because the panels are non-load bearing, the danger would be for fire impingement from the side. The tests for concrete that were in place, however, assumed the application was load bearing, and the resistance had to be for fire from above or below.

Fortunately, Lamb’s team found 19 UL tests for composite materials and panel structures for fire impingement from the side. After going through a selection process, the group came up with updated tests for the new material. That process holds a lesson, Lamb says. “You've got to look not just at the material and the use of the material, but how it’s being qualified and how the other materials have been qualified. You don’t want to change the game with a new material and not test it properly. But on the other side, you don’t want to change to a new material and have it be subject to old tests that have nothing to do with that material.”

Hank Hogan is a freelance writer based in Albuquerque, N.M. Email comments to hank@hankhogan.com.

During the first weekend of installation in March, workers mounted 225 cast polymer panels extending along approximately 2,000 linear feet of track.

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Nearly a decade ago, BC Hydro, an electric utility serving British Columbia saw that its transmission line stretching across 40 rugged miles along the northwest coast was nearing the end of its useful life. The wooden crossarms supporting the conductors that transmit electricity were beginning to rot. Furthermore, the utility realized it needed a better option to carry the additional electricity required for the region's growing industry. It investigated a composite solution.

BC Hydro approached Grant Lockhart, CEO of Transmission Innovations Inc. in Vancouver, Canada, who remembers the conversation: “They said, ‘We have a problem. Wood is failing in certain areas along the coast … and steel is increasingly harder to get. It’s expensive, it’s got a huge carbon footprint, you can’t put it in energized – there is a world of problems with it. Can you come up with an idea that could help us?’”

Transmission Innovations proposed a GFRP transmission crossarm capable of carrying up to half a million volts. After performing finite element analysis to prove that the product would support the needs of the new line, Transmission Innovations contracted with Creative Pultrusions Inc., an Alum Bank, Pa.-based manufacturer of FRP composite profiles, to create 24 46-foot long samples for testing at Power Tech Laboratories. The products underwent more than five years of laboratory and real-life applications before approval was given.

The final product, now being installed in the Canadian mountains, features a 6 x 14 x ½-inch C-channel shape for each transmission arm, which range from 46 to 50 feet long. “It is unique that they’re using FRP for transmission arms,” says Dustin Troutman, director of marketing and product development for Creative Pultrusions. “It’s been done in the past, but I don’t think it’s been done to this magnitude or for this size voltage.”

According to Troutman, an additional factor that makes this transmission arm unique is the custom fiber architecture designed by engineers from Transmission Innovations and Creative Pultrusions. “It incorporates a lot of stitched fabrics, roving and continuous filament mat, but the big difference is it’s made out of a polyurethane matrix,” he explains.

Polyurethane resins are well suited for applications with extraordinary requirements for robustness, impact strength and longevity. Those characteristics are needed for a transmission line that must resist high wind and ice loads and the possibility of critical stress should a component break. “The polyurethane is a very forgiving resin in terms of its ability to help distribute stresses,” Troutman explains. “It drastically increases the interlaminar shear strength, which increases the bond strength between the layers of mat and roving – and it’s very, very tough.”

The polyurethane profile is reinforced with E-glass and features a polyester surfacing veil to give it added protection from the fiber blooming that can result from long-term UV exposure. Creative Pultrusions used high-pressure injection molding technology to push the polyurethane through a series of custom dies.

Troutman expects the crossarms to last 75-plus years, unlike their wooden counterparts. “In areas that are swampy or have high moisture, wood degrades relatively fast,” he says. “Wood has a tendency to rot, so utility poles and crossarms in those types of environments may only last 20 years.”

The performance of the composite poles will be put to the test as up to 1,000 GFRP crossarms will be installed on existing poles in one of the world’s largest temperate rainforests, the Great Bear Rainforest between Vancouver and southeast Alaska. Installation in such a remote area requires helicopters to bring products on site – another reason composites were a good choice. Because the GFRP crossarms are
Installation in the remote mountains of northwest Canada required helicopters to transport GFRP crossarms.

Lighter than wooden or steel ones, the installers are able to use a smaller helicopter. In addition, the helicopters could fly in the top section supporting the crossarms of each transmission tower with one lift rather than five, which is typical for heavier products. “Because the helicopter has to climb fewer times than traditionally necessary, the chopper overhead time for the linemen is greatly reduced, improving not only fuel costs but also worker safety,” says Lockhart.

Years of testing the composite crossarms are finally paying off for Transmission Innovations and Creative Pultrusions as work continues on the large installation project in northwestern Canada. And it’s not a one-time success story: More and more utilities are expressing interest in composite solutions.

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For more stories like this, visit CompositesManufacturingMagazine.com and check out the Infrastructure articles under the “Market Segments” tab.
NASA's new ISAAC project moves laboratory research into the real world.

By Mary Lou Jay

With its shiny black and white surface and wide range of motion, the new 7-ton robot at NASA's Langley Research Center in Virginia has something of a Star Wars feel to it. That's appropriate, since researchers will use the machine to produce stronger, more efficient composite parts and prototypes for the agency's aeronautics and space exploration programs. But the robot, currently equipped with an automatic fiber placement (AFP) end effector, has another role as well, one that is particularly important to the composites industry. It will enable NASA to conduct research that bridges the gap between the laboratory and real world applications, speeding the adoption of new techniques and new materials for composites manufacturing in the aerospace industry.

Built by Electroimpact of Mukilteo, Wash., NASA's robot is an adaptation of commercial systems currently used by two private companies (Orbital/ATK and Boeing) for the manufacture of advanced composites. It is part of the ISAAC project – the Integrated Structural Assembly of Advanced Composites. Although the press sometimes refers to the robot itself as ISAAC, the acronym actually refers to the entire composites manufacturing capability, encompassing all of the upstream and downstream activities involved in fiber layup, from design and 3-D modeling to curing and final production stages.

New Directions for AFP

The 21-foot-high ISAAC robot, in operation since January, moves back and forth on a 40-foot-long track. The robot's AFP end effector holds up to 16 spools that carry ¼-inch wide tows of fibers. A CNC system dictates the movement and spin of the robot's huge arm as it lays the carbon fibers and epoxy resins over complex forms and molds. The robot can build a composite part as large as 35 feet long, 10 feet wide and 12 feet high. Repositioning the mold allows for construction of larger parts as well.

One of the first projects that ISAAC researchers will undertake is an exploration of how the directionality of fibers in tow-steered composites can affect the strength of parts. Composite manufacturers currently lay fibers at angles of 0, 45 and 90 degrees to each other; the strength and stiffness of the composite structure varies with the number of plies of each angle used.

“We've gotten to a point now where we can, depending on the load case, reliably design composite structures that are about 20 percent more efficient than metallic structures,” says Chauncey Wu, ISAAC project manager, who wrote his doctoral dissertation on tow-steered composites. “But if you look at the stiffness- and strength-to-weight [ratios] of metals versus composites, there's untapped potential there. There are more savings to be gained if we do something different, and one way we can do something...
different is to exploit the directionality of the tow steering.” The industry has used tow steering to place fiber on doubly-curved surfaces, Wu says. “But what we haven’t been doing is aggressively tailoring the fiber angles over the surface. Within a given ply we can actually steer the fibers to shift loads around.” With ISAAC, NASA researchers will be looking at ways to tailor the fiber angles and the strength and the stiffness of a composite to better match the load paths.

**Improving Manufacturing**

The fiber placement system is ISAAC’s initial operational capability, but far from its only one. One reason that NASA invested in this particular robotics system is its ability to work with end effectors designed and built by the ISAAC team and/or by third-party vendors.

Researchers at NASA’s Langley Research Center use this robot, which can extend 21 feet, to experiment with composite materials and manufacturing. Their work is part of the ISAAC project – the Integrated Structural Assembly of Advanced Composites.

“What ISAAC is really all about is being able to switch end effectors to do a myriad of things and advance the ball in many different directions,” says Wu. “We are looking at alternate things we could put on the business end of the robot – things like non-destructive evaluation, automated ply inspection and metal additive technologies,” says Brian Stewart, ISAAC integration manager. Automating the inspection process for composite products, for example, could allow composites manufacturers to make better
use of their AFP equipment. Several companies have told Wu that their AFP machines are only being used at 50 to 75 percent of their full potential because of process roadblocks. He cites the example of Spirit AeroSystems, which is building the fuselage for Boeing’s new 787 aircraft.

“It takes them roughly a week or so to make one of those fuselage sections using their fiber placement machines,” says Wu. “But if you look at the total cycle from the time they start that process until it actually goes into the autoclave, it’s about a month. There’s a large manual inspection component in there – two to three weeks.”

NASA is interested in automating the parts inspection process and decreasing the time it takes using vision systems, thermography and other electromagnetic technologies. “We want to do that inspection as the material is placed,” Wu adds. The system could flag operators immediately if something goes wrong, allowing them to correct the problem during the manufacturing process. That would reduce the amount of time needed for post-production inspection. For Spirit AeroSystems, that could mean an increase in the throughput on its existing AFP machine, boosting productivity without additional investments in expensive equipment.

Using another type of end effector, the ISAAC team hopes to study the joining of metal foil laminates using high-frequency ultrasonic sound waves to create a fusion bond between layers.

Brian Stewart, ISAAC integration manager, stands next to the robot’s automated fiber placement end effector, which can carry up to 16 spools of ¼-inch wide tows of carbon fiber.

“One of the reasons we are very interested in that is that we can add reinforcing fibers into the materials to make metal matrix composite bands,” says Stewart. “That segues into making very large, metal matrix composites.”

The ISAAC team is unlikely to run out of research possibilities. At last count the team had a portfolio of more than two dozen possible and captured projects involving everything from flex walls for cryogenic wind tunnels to alternate material systems for fiber placement for space instruments’ chassis backbones.

**Accelerating the Path to Industry**

ISAAC is currently focused on two NASA projects. One is the Composites for Exploration Upper Stage (CEUS) project. “The intent of this project is for NASA as a whole to get smarter and more experienced with designing flight-rated composite parts,” says Wu. NASA will design, build, analyze and test a large composite skirt (a 5-foot-high by 27.4-foot-diameter cylinder) for a proposed future upper-stage vehicle. NASA’s Marshall Space Flight Center is the project manager, with the Langley and ISAAC teams working on producing and analyzing the skirt joints.

ISAAC’s other assignment is the Advanced Composites
Project, designed to accelerate the certification of new composite materials for use in real-world applications. The current length of the certification process makes it difficult for industry to employ the latest composite technology in new products. Boeing, for example, used the same type of composite in its 787 aircraft as it did in its 777 because getting a new material approved could have taken decades and millions of dollars.

“When you do AFP, you get gaps, laps and process-induced anomalies that need to be understood and better characterized,” says Wu. “So we will be using our machine to generate these kinds of imperfections and anomalies that are a normal part of the process and study their effect on part quality and structural performance.”

“Everything you don’t understand reduces confidence in the process and in the part, and certification is essentially about confidence,” says Stewart. “We want to attack these areas that have not yet been addressed in a formal and structured manner to get that confidence level up to where we can decrease the certification timeline.”

Another factor hampering the adoption of new composites is industry’s understandable reluctance to use revenue-generating production equipment for research purposes. “So what we see with ISAAC is an opportunity to vet some of these ideas in a research-oriented environment where the companies don’t have to take their equipment offline and they don’t have to interrupt their existing processes,” Stewart says. “Then they can infuse those ideas into their existing product lines – which is still a little risky – or better yet, be prepared when their next product comes down the line.”

As a national laboratory, NASA Langley is taking that low TRL (technology readiness level) R&D role and helping to move things along, Stewart adds. “Working with industry-scale equipment gives us a very good relationship with industry and with academia. Instead of living in a bubble, doing some research and then asking, ‘Can anybody use this new stuff?’ we are out there looking to work with people on problems that will have an impact downstream.”

The system is about as close as it gets to industry practice, adds Wu. “We can use it here as a research tool to mature our own work, to study it and shake out the bugs before we go to the industry and say, ‘Hey, we found this great idea, go put it on your production system.’”

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Wonders on the Water

Sometimes new boat designs create excitement in the marine market. Other times, advances in manufacturing technologies take center stage. But in the past year, a combination of the two – innovative designs made possible with inventive fabrication techniques – has made news.

**A CFRP Catamaran**

Gold Coast Yachts recently teamed with Formax, a supplier of multiaxial carbon fiber reinforcements, to develop a 53-foot, high-performance racer/cruiser made entirely of CFRP. The B53 catamaran’s main hull incorporates custom carbon fiber fabrics to achieve the aggressive weight reduction and engineering specifications required by Paul Bieker of Bieker Boats, who designed the catamaran.

One of the toughest decisions for Gold Coast Yachts was selecting the best manufacturing technique. The company was concerned that it would not meet the boat’s specifications through wet bagging. It was equally concerned that carbon fabrics
could not be vacuum infused successfully. "The smoothness and smaller fiber diameter of carbon fiber filament causes the fabric to compress, making permeability difficult during the wetting process," says Philip Steggall, director of business development in North America for Formax. "But prepregs are expensive, along with tooling, production equipment and labor costs."

Vacuum infusion has gained a reputation for providing a cost-effective production method while maintaining a high level of performance. "If you have the proper fabrics and controls in place for temperature and resin viscosity, you can infuse a laminate of any size and thickness with minimum risk," says Steggall. "But it is relatively new in the marine industry, and people are still looking at it warily."

Gold Coast Yachts conducted a three-month testing program comparing wet bagging and vacuum infusion techniques. The testing demonstrated superior properties of the vacuum-infused panels, including a 15 percent increase in compressive strength.

Formax then created $+45^\circ/-45^\circ$ biaxial carbon fiber fabrics of 400 g/m$^2$ and 300 g/m$^2$ and a $0^\circ/90^\circ$ biaxial of 300 g/m$^2$ that were stitched rather than woven or hot-melt bonded. "Weaving and hot-melt bonding are not infusion-friendly," says Steggall. A light and open random monofilament polyamide (nylon) web called MicroWeb was stitched between the plies of carbon fabric. The combination of stitching and the MicroWeb layer provided a path for air to escape and resin to flow between the layers across the laminate.

"The fabric design allowed us to get air out ahead of the resin front instead of trapping it inside the laminate, as is done with wet bagging and even with prepregs," says Rich Difede, president of Formax. The 53-foot B3 catamaran is designed for both competitive racing and recreational cruising.
of Gold Coast Yachts. Typically, the void content for infused laminates is 1 percent or lower compared to 3 to 5 percent for prepregs and higher for wet bagged laminates, says Steggall.

The stitched carbon fiber fabric also improved the ability of the laminate to absorb impact by 18 to 20 percent over the laminate without the MicroWeb, says Steggall. This, in turn, improved the laminate’s properties for in-plane and short beam shear and flexural strength.

Smaller, less structurally loaded panels were produced in a one-shot process – skin-core-skin infused together. The team broke up the process to save weight and better control the larger parts with a complicated geometry by first infusing the inner skin using four layers of the carbon fiber matrix. Next came the foam core, which was affixed with an epoxy paste, bagged and vacuum infused. Finally, the outer skin laminate was applied, bagged and infused. “It was labor intensive, but we found it to be the most effective way to control the hull’s weight,” says Steggall.

The sleek B53 catamaran was delivered to its owners, a sailing couple in Seattle, and launched in early June. Having mastered the manufacturing process, Gold Coast Yachts is now working on another large boat.

A Maritime Surveillance Vessel

When the Mozambique government commissioned Nigel Irens Design and CMN Shipyards to design and build a vessel for maritime surveillance, it sought a fuel-efficient boat that could cruise for many hours and then accelerate quickly for pursuit. Naval architect Nigel Irens designed the Ocean Eagle 43, a trimaran offshore patrol vessel (OPV) with a long, slender main hull and two smaller outer hulls to provide stability yet remain lightweight and cause less drag than other hull forms.

At nearly 143 feet long, the Ocean Eagle 43 can cruise 3,000 nautical miles and reach a top speed of 32 knots (accomplished during sea trials) while burning around one-fifth of the fuel of an equivalent single hull OPV. The first boat was delivered last September, with two others since delivered.

French boat builder H2X constructed the glass fiber and epoxy sandwich laminate hulls, main deck, helicopter deck, pilot house and structural arms. The company used CFRP in high load areas, such as the stringer caps and arms that connect the side hulls to the main hull. H2X partnered with long-time supplier Sicomin to provide a range of resin systems.

The biggest challenge was constructing the 350-square-meter main hull. The initial design called for prepregs with a glass transition temperature (Tg) of 120 C to 140 C, but using prepregs would double the cost of the resin. The tooling and post-cure also was cost-prohibitive. Moving from prepreg construction to a resin infusion process allowed for an epoxy specification of 90 C Tg, reducing the cost of the resin by half, while avoiding the risk of print-through and loss of mechanical properties that could cause delamination or structural failure.

“For this giant piece, we had to penetrate the PVC foam core cell and e-glass fiber laminate over long distances. We needed very efficient saturation,” notes Pierre Lallemand, chief of the
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It’s a constant battle to optimize boat weight to maintain stability, yet design it to afford more people and equipment on board.”

composite department at H2X. “It was a huge risk, but we decided to use a vacuum bag infusion process for the entire main hull in one shot.” According to Lallemand, the Ocean Eagle 43’s hull is one of the largest sandwich epoxy hulls ever made in a one-shot infusion. It required more than 4,000 kilograms of epoxy resin. “There’s no room for error in this decision,” says Bertrand Fergelot, sales manager with H2X. “If it is not done well, all the work you have done to prepare goes down the drain.”

Lallemand says vacuum infusion allowed for better saturation of the core. “We were better able to control the amount of epoxy used for the part, resulting in very tight control of part weight,” he says. Vacuum bagging also mitigated emissions exposure for workers.

Sicomin supplied H2X with SR8100, a two-component epoxy system, for the hull infusions. The injection process took four hours, followed by four hours to ensure the glass fiber lamination was saturated. Afterward, the hull was post-cured for 16 hours in a 43-meter oven at 50 C to 60 C.

The result? “We were able to deliver the main hull within 0.3 percent of the estimated weight,” says Lallemand. “This would have been impossible to achieve if the hull was made by hand.”

Fleet Ready, Fishing Bound

The marine industry is calling for more aggressive lightweighting and cost-effective designs, and among those leading the charge is the U.S. Navy. “It’s a constant battle to optimize boat weight to maintain stability, yet design it to afford more people and equipment on board,” says Urich Gottschling, president and CEO of Willard Marine, a manufacturer of composite watercraft for the U.S. Navy for more than 30 years.

Willard Marine and Structural Composites, a composites technology company that holds a Small Business Innovation Research (SBIR) contract, have designed, constructed and tested the 7M Fleet Ready (7MFR) rigid inflatable boat, a next-generation advanced combatant craft for the U.S. Navy. The goal was to provide the Navy a boat design with the durability and maintainability of solid laminate construction at a weight equal to sandwich construction, with cost reduction in mind.

The team began with a single skin construction. Structural Composites eliminated the sandwich foam core that would traditionally form the next layer, replacing it with a series of flotation-grade polyurethane foam ribs from Compsys Prisma. The ribs hold the fiberglass laminate in place and carry the load. “By replacing the traditional foam core and fiberglass
hull with preformed polyurethane foam ribs, we reduced the overall boat weight without sacrificing strength and durability,” says Scott Lewit, president of Structural Composites. The laminate surface comprises a fiberglass and vinyl ester layer made using hand layup.

In another innovative twist, the deck of the 7MFR is detached from the hull, affixed only at the edges, much like a trampoline. Decoupling the hull and deck structures is intended to help mitigate vibration and shock felt by Navy personnel on deck, especially in rough seas. The 7MFR is undergoing testing at Structural Composites and will be delivered to the U.S. Navy for further testing to evaluate the craft in operational conditions.

Hydrasports Custom, a manufacturer of high-end fishing boats, also was intrigued by the lightweighting benefits of a single skin transom and hull technology. Its Custom 53 Sueños, the world’s largest outboard powered, center console fishing boat, was developed with a similar single-skin frame construction from Structural Composites. The resulting 53-foot boat, which weighs about the same as Hydrasports Custom’s 42-foot model, was unveiled to accolades at the 2015 Miami International Boat Show.

Across the marine industry, from military to recreational markets, new boat designs and technologies are turning heads.
In 2004, the Gill Corporation landed a key account. The manufacturer, based in El Monte, Calif., began supplying honeycomb, high-performance floor panels for the Airbus A380. Launched a decade ago, the double-deck A380 is the world’s largest aircraft, seating up to 853 passengers depending upon the configuration. The Gill Corporation earned business with the French aircraft manufacturer in part because it operates European facilities.

“Through our facility in Belfast, we were able to get some work on the Airbus A380, which we might not have been able to do as an American company,” says Stephen Gill, CEO and chairman of The Gill Corporation, which specializes in composite products for the commercial aircraft and aerospace industries. “In this market, there’s a reason to be in Europe: You get consideration you wouldn’t get in the U.S. The Airbus was not established and financially supported by Europeans to support Americans.”

Composites companies are increasingly building or acquiring international plants, but often not for the reasons that give off-shoring a bad rap – cheap labor and lower operating costs. For many, it’s a strategic way to penetrate new markets, increase sales or gain business with global OEMs.

The Gill Corporation purchased Insoleq, a company in Belfast, Ireland, in the early 1990s. At the time, Insoleq was a customer and agent for Gill products. “It gave us a shot in the international market,” says Gill. “It was a stepping stone and a learning experience.” The company acquired Alcore Brigantine in Anglet, France, in 2001.

“We’d all be naïve to think the world isn’t getting smaller and smaller,” says Steve Rooney, president and COO of Continental Structural Plastics (CSP), a leader in composite materials formulation, advanced product design and manufacturing technologies. CSP operates four international plants – two in Mexico, one in France and the newest, set to open in October, in China.

“The North American market continues to expand into new lightweight materials and technologies,” says Rooney. “But other areas of the world, such as China, have an increasing need for composites, too. It makes sense for us to be there and take advantage of current market conditions.”
Taking Aim at OEMs

One of CSP’s primary areas of focus is transportation. It provides thermoset and thermoplastic components, including Class A body panels, structural parts, underbody parts and interior body panels. The company, headquartered in Auburn Hills, Mich., opened its first international plant in 2002 in Tijuana, Mexico, for one reason – to partner with Toyota. “It was all about location, location, location,” says Rooney. “We needed to be there to link up with a major OEM.”

In 2013, CSP purchased a French company out of bankruptcy that had a manufacturing plant in Pouancé. CSP now uses that facility for advanced research and development. Rooney says two reasons guided the acquisition: “From an R&D point of view, Europe has always been on the cutting edge of carbon fiber and other lightweight technologies. In addition, we needed to be overseas to be on global OEM platforms. Quite honestly, you can’t get on their source list if you’re not global.”

That’s true not only in automotive or aerospace markets. IDI Composites International (IDI) formulates and manufactures thermoset molding compounds for OEMs, most of which are in the electrical industry. The Noblesville, Ind.-based company opened a plant in the United Kingdom in 1995 and one in China in 1996. Both facilities produce bulk molding compounds and sheet molding compounds, primarily for OEMs.

“If an OEM makes a product in the U.S. and wants to assemble it in China, than they would like the same materials there,” says Jay Merrell, vice president of IDI and its sister company Norplex-Micarta. IDI’s molding materials are “live” products with a perishable shelf life, typically a couple of months. “If you have to warranty material for 60 days, you’ve easily used half of that just getting it to China,” says Merrell. “So we operate international facilities to support our OEMs globally.” IDI also has manufacturing plants in Puerto Rico and France.

Manufacturing materials or products locally isn’t just convenient for OEMs: It also saves them money, most notably transportation costs. Last August, CSP acquired five facilities from Magna Composites, including a manufacturing plant in Saltillo, Mexico. Having a plant in northeastern Mexico has allowed CSP to expand into the heavy truck industry.

“In the Class A truck market, where your facilities are located is key because freight is such a big driver,” says Rooney.

And there’s another reason U.S. composites companies open international plants: While business is global, selling is local. “Having a physical presence in the markets you serve and having local access to customers with local employees is critical to success,” says Eric Breiner, president of Dallas-based Fibergrate Composite Structures. The manufacturer of open molded and pultruded FRP grating products has plants in Texas and Querétaro, Mexico, and sales offices in 11 cities on six continents.

Fibergrate built the plant in Querétaro in 2008 to better support customers in Mexico and further expand into Central and South America. “It’s proven very successful,” says Breiner. The facility has 225 employees and is outgrowing its space. By the end of the year, Fibergrate will finish construction on a 40,000-square-foot addition to its 85,000-square-foot Mexican plant.

Barriers to Crossing Borders

Operating international facilities may be prudent and profitable, but it also can present challenges. Breiner says finding quality raw materials is problematic, so Fibergrate ships many of them to Querétaro. “Until the Mexican economy develops to the point where major suppliers have operations there, sourcing...
Composites Manufacturing

materials locally] has created some challenges for us and, honestly, a cost impact,” he says.

In addition, there can be customs-related headaches. Gill’s division in Northern Ireland contends with discrepancies in tariff codes between the United Kingdom and the United States. Gill is required to pick a tariff code for U.S. exports of raw materials to its Belfast plant. But the U.K. frequently challenges Gill’s classification of parts imported from the U.S. as “aircraft parts” and suggests various commercial classifications.

Having plants in other time zones and employees who speak different languages can be difficult at times, too. “We can’t all talk together at the same time without someone being up in the middle of the night,” says Merrell. “So we don’t have weekly conference calls or production meetings with the entire organization.” IDI relies on electronic communication, though there is some lag time: When someone from the Chinese plant sends an email, the recipient at the Indiana plant typically doesn’t read it until the next morning.

Companies also may face concerns surrounding the political climate of the countries where they have plants. “In the background, you may have political instability risks and issues,” says Merrell. “In U.S. politics we don’t have extreme differences, whereas in Europe you might have a conservative leader replaced by a socialist leader. You have to pay attention to political issues in your local marketplace.”

Perhaps the biggest challenge to operating an international plant is ensuring it adopts your company culture. Most composites companies institute the same policies and procedures abroad as they do in the U.S., but getting employees to buy in to their vision and values isn’t so simple. “You deal with different mindsets and workers’ perceptions of their potential,” says Breiner. “It takes a while to gain their confidence.”

When Fibergrate set up its Mexican plant, the company initially brought in an American management team. The company gradually identified people it could groom for management positions, and now the entire team is from Querétaro. But it took about four years to make the transition. “Having local leadership gives the workforce someone to look up to,” says Breiner. “They can align themselves with managers more so than expats running the facility. You break down those barriers.”

Advice from Abroad

While there are certainly hassles associated with operating overseas, the benefits outweigh the disadvantages for many corporations. And following the sage advice of composites professionals who have set up international plants can help ease the transition:

• Have a solid reason to go. Operating an international facility is a big commitment, so make sure you’re not just opening a
plant du jour. For example, building a plant in Brazil might make sense if you can land business with aerospace conglomerate Embraer in São Paulo. But opening a facility in China because of favorable exchange rates or hourly worker wages may not be a sound strategy. “Using short-term economic reasons to expand globally is a bad idea,” says Rooney. “As countries and companies come up in the world, these things change.”

• **Do extensive upfront research** on the business opportunities and potential partners in any foreign country. “Don’t rush into anything,” cautions Rooney. “The decision for us to go to China took three years of vetting and nailing down a partner.” CSP’s operation in Tangshan, China, is a 50-50 joint venture with Qingdao Victall Railway. The combination of CSP’s technologies and Qingdao Victall Railway’s customer base and local market expertise will enable them to tap into vehicle lightweighting opportunities in the automobile and heavy-duty truck markets.

• **Seek out international counsel** on legal, environmental and financial issues. “Your little hometown CPA firm that’s run your books forever is probably not sophisticated enough to help you set up a business, manage foreign tax credit and handle other issues,” says Merrell. There are several ways to find experts: CSP asked its global suppliers for recommendations on experts, IDI turned to customers in foreign countries for advice and Fibergrate relied on relationships developed by its parent company, RPM International.

• **Give it time.** “Once you’re willing to go and commit the time and money, you have to stick with it,” says Breiner. “It would be very easy to pull back when things are tough.” Fibergrate opened its Mexican plant right before the Great Recession hit in 2007, but rather than shutter the operation the company invested more into the business. Today the facility is thriving. “These are not short-term decisions,” says Rooney. “You don’t go to Europe or China for a couple years: You’re making a long-term commitment.”

• **Keep everyone in the loop.** “It takes an extra thought process when I’m communicating with the organization to include the Mexico facility,” admits Breiner. “It’s very easy to send a quick message across the U.S. facility, but the same message needs to be sent to Mexico, too.” The two plants stay connected through frequent in-person visits, too. For instance, the company’s vice president of operations recently traveled to Mexico to conduct internal auditing, training and a review of completed capital projects. He also shared information on environmental health and safety issues.

• **Beware of a laissez faire attitude.** “Keep an eye on everything,” cautions Gill. “You’ve got to operate international plants to your own standards.” When Fibergrate hires new managers at its Mexican plant, they spend six to eight weeks in Texas shadowing peers and learning about the company. In addition, employees from various departments in the U.S. make monthly trips to Querétaro to ensure everything is running smoothly.

Deciding to open a plant in a foreign country is not a decision to be taken lightly. “We’ve been extremely conservative,” says Gill. “We don’t take a lot of chances.” The Gill Corporation waited a decade between the time it purchased its first international plant in Ireland and its second in France. CSP also carefully considers opportunities to set up facilities outside the U.S. With its latest international venture slated to open this fall, CSP has no immediate plans to penetrate other foreign markets. But in the future? “We are certainly not done expanding our presence worldwide,” says Rooney. “It’s increasingly becoming a global marketplace.”

Susan Keen Flynn is managing editor of *Composites Manufacturing* magazine. Email comments to sflynn@keenconcepts.net.
Since the beginning of his career, Jeff Craney has worked for companies that value their customers, employees and innovation. With these priorities, it’s no surprise that he’s now the president of Crane Composites and the incoming chairman of the board of ACMA.

Craney is excited to lead the association. “The industry is very diverse, but its common thread is the desire to grow,” he says. “ACMA is all about supporting members in a way that grows their businesses to make the industry stronger, which presents opportunities for us now and for the future.”

Dedication to the Industry

Craney began his career 28 years ago at Owens Corning, where he held a variety of positions in operations, sales, customer service and management. In 2007, he joined Crane Composites as president. Crane Composites, a subsidiary of Crane Co., is an FRP manufacturer serving three primary markets – building, transportation and recreational vehicles.

Craney’s commitment to customer service served him well during the Great Recession that began shortly after he joined Crane Composites. “That was difficult for all of us, but we were able to stay focused on those things that are most important to our customers ... and across markets we have been successful,” Craney notes.

Craney became involved with ACMA the same year he joined Crane because of a phone call with John Tickle, chairman of Strongwell Corporation. Craney shared with Tickle that he “wanted an opportunity to understand and participate in the industry beyond just what [Crane Composites] did” and contribute to the industry’s overall growth. Tickle, who was president of ACMA’s board of directors at the time, encouraged Craney to join the association. Two years later, Craney’s tenure on the board began.

Craney has held a number of positions on the board, including chair of the membership committee and contributing member of the strategic planning committee. Craney says these assignments bolstered his dedication to advancing the composites industry.

Craney’s board cohorts attest to his potential as the chairman. Randy Weghorst, chairman emeritus of AOC LLC, has served on ACMA’s board with Craney since 2010. He says Craney is a great communicator, has a diligent work ethic and will keep ACMA focused. “I am excited for Jeff’s leadership because he brings experience from both the supplier and manufacturer perspective,” Weghorst says. “He will have a balanced perspective for issues and opportunities facing our industry.”

Co-workers also tout Craney’s leadership skills. “One thing Jeff likes is inclusion,” says Robert Burton, vice president of human resources at Crane Composites. “He wants to hear all the opinions around the room. He’s looking for input to make sure we all make the right decision for the business. And not just the right decision for the moment, but the right decision for the future.”

Plans for the Future

Craney sees big potential for the industry’s growth. In particular, he is excited about recent partnership opportunities supported by ACMA, most notably the FIBERS Consortium led by University of Massachusetts Lowell, which aims to advance the manufacturing of polymeric-matrix composite materials in the United States. The consortium is one of 19 partnerships from across the country that have recently been awarded advanced manufacturing technology planning grants by the National Institute of Standards and Technology (NIST), an agency of the

About Crane Composites

Headquarters: Channahon, Ill.
Parent Company: Crane Co. (NYSE: CR), an industrial products company
Plants: Four manufacturing facilities in the U.S.
Employees: 700
Craney also hopes to better position composites in markets where traditional materials are used and advance the industry’s recycling efforts. “We need to find ways to recycle our products at end of life,” he says. “That’s something that’s becoming more of an issue for us, and it will continue to be in the coming years. As an association and an industry, we need to embrace recycling.”

Craney’s work ethic and desire to serve others extends beyond ACMA. He has also served on the National Insulation Association steering committee, as chairman of the United Way campaign and on the Owens Corning Business Conduct Council. He is a self-described sports enthusiast who enjoys playing golf. An Indiana State University alumnus, he cheers for the Sycamores basketball team.

Craney is ready to give back to the composites industry in his biggest role yet. “ACMA offers long-term benefits around growing markets, educating the industry and really providing legislative support that individual companies might not be able to do on their own,” he says. “Collectively, we can provide a more unified approach to issues that are critical to the industry.”

Mary Beck is a freelance writer based in Washington, D.C. Email comments to mary.beck125@gmail.com.
Composites Pavilion at AIA a Success

The ACMA Composites Pavilion at the American Institute of Architects (AIA) National Convention 2015 featured booths from 20 ACMA members and one industry council. The booths at the pavilion displayed the Plasticity Pavilion, an award-winning project by Justin Diles, assistant professor of architecture at The Ohio State University, sponsored by ACMA member Kreysler & Associates and coordinated by ACMA member Ashland Performance Materials. ACMA has re-established its prime location for next year’s pavilion at AIA 2016 in Philadelphia and has secured several booth spaces at the early bird price. These booths are expected to fill up quickly, so displaying at the pavilion will require your company to book soon. Interested members should contact John Busel at jbusel@acmanet.org.
ACMA Hosts Thermoplastic Composites Track at NPE

ACMA presented a special educational track on thermoplastic composites at NPE2015: The International Plastics Showcase. Senior representatives from Cargo Composites, Celanese, TenCate, Polysand and University of Alabama-Birmingham discussed materials, trends and applications such as aircraft, pressure vessels and transportation. More than 60 attendees learned how thermoplastic composites are gaining market share with new and exciting applications.

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2015-2018 Strategic Plan

ACMA has approved the strategic plan that will guide the direction of the organization through the next several years. You can read a summary version of the plan on ACMA’s website at acmanet.org/images/PDFS/ACMA-Strategic-Plan-Summary-2015-2018.pdf.

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A Seamless Ride

Lightweighting, a hot topic in the automotive industry, typically focuses on cars. But that doesn’t mean motorcycles can’t be part of the movement. The limited edition Harley-Davidson Super Sport Roadster (SSR) motorcycle uses carbon fiber throughout the body for aesthetics and low weight. “We want to be a part of the ‘old-school craze’ and offer a very high-level product with only the best parts on the market,” says Bertrand Dubet, pro-builder at Odyssey Motorcycles, the company responsible for the SSR’s carbon fiber bodywork and exclusive detailing on the gas and oil tanks.

Instead of screws, the motorcycle uses Huntsman’s Araldite 2031 epoxy adhesive to bond steel fuel and oil tanks to their CFRP shells. Leaving out screws reduces weight and gives the vehicle a smooth and seamless appearance. The materials were carefully chosen to “ensure the SSR withstands the high mechanical stresses, extremes of temperature and different chemical environments that it is likely to encounter,” Dubet says.

CFRP Shell Bonded to Fuel Tank
Using fibers, resins and adhesives that are resistant to chemicals, such as hydrocarbon fuels, is essential. Gas and oil could damage a non-chemically resistant composite after repeated contact.

CFRP Shell Bonded to Oil Tank
The epoxy adhesive resists vibrations, easing stress and fatigue on the motorcycle frame during use. This is critical because adhesives with less fatigue resistance could debond over time.
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