Making an Impact in Architecture

An Update on Out-of-Autoclave

Composites Team Up with Traditional Materials
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About the Cover:
The ONEOK Boathouse on a three-acre pond in a park in Tulsa, Okla., shown in this rendering, will feature a composite canopy. Composites are ideal, says Bridgette Mont from Mack Scogin Merrill Elam Architects, because they can “produce exactly our design without sacrificing or simplifying the geometry.”

Photo Credit: Michael Van Valkenburgh Associates Inc. and Tulsa’s Gathering Place LLC
Composites Take Center Stage at Conferences

Spring is just around the corner. I hope your year is off to a great start. This issue of Composites Manufacturing magazine has a lot of great articles, including one that takes a look at how composites are used hand-in-hand with other materials, ranging from aluminum to concrete.

We know the benefits of composites over traditional materials, but sometimes the best solution is when composites work together with other materials. Not only does utilizing composites alongside traditional materials often yield the best product, but pairing materials is also a good way to introduce FRP into a new market and allow designers, engineers and other end users to get comfortable with composites. Check out the story on combining composites with other materials on page 21.

If you want to see composites in action in two different markets, consider attending two major upcoming events where ACMA and its member companies will have a presence. First, is NACE CORROSION 2017, held March 26-30 in New Orleans. For the first time, the convention will highlight how composite products offer superior performance in corrosive applications.

Next, is the American Institute of Architects’ Convention on Architecture 2017, held April 27-29 in Orlando, Fla. The most exciting part of AIA is the Composites Pavilion, an area on the show floor where you can find multiple composite applications in one spot. It truly is a magnet for architects and specifiers as they learn about the value proposition that composite products bring to their applications. Before you go, be sure to read this issue’s article on composites in architecture on page 12.

As always, thank you for your support of ACMA. Just as materials working together often bring about the best results, so too do industry professionals teaming up to make our industry stronger. Our association continues to make a difference for us every day. Together, we have the opportunity to ensure our voice is heard. Your participation and support is required and appreciated.

Jeff Craney
Crane Composites
ACMA Chairman of the Board
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ACMA is excited to announce its new career center, COMPOSITES JOB SOURCE. The resource was created to give employers and job seekers a better way to connect and to find their perfect fit.

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Getting the Proper Cure

By Dave Herzog

Getting the proper cure for a composite application is important to meet performance requirements, such as longevity, corrosion and fatigue resistance, low odor and more. Simply put, curing refers to hardening polymer materials by cross-linking the polymer chains. So how do you achieve the proper degree of cure, which can range from less than 90 percent to almost full cure at 99.9 percent? I like to think of it as getting the proper amount of energy into the part while it is being made.

Energy comes from the resin itself – the temperature of the materials used, the mold and the exotherm of the part – as well as ambient conditions during production and after making the part, like the post cure. The final source of energy derives from the peroxides used and the levels of those peroxides.

Let’s focus on two things that composite fabricators can control – temperature and peroxides.

Pay Attention to Temperature

Make sure the resin is stored and pumped within a reasonable temperature range. The ideal is 70 to 80 F, but anywhere between 60 to 90 F is acceptable. You can achieve this through simple strategies, such as holding resins in a temperature-controlled storage tank or in drums on a pallet so they are not sitting directly on a cold concrete shop floor.

If you plan to mix fillers and additives into the resin before use, they also should be at the proper temperature. Otherwise, the mixture needs to be adjusted to a reasonable temperature before it is used. Adjusting the resin or mix is a good way to control the temperature at the beginning of the process. One note of caution: If you use a high-speed mixer to adjust the temperature, be careful not to whip air bubbles into the resin.

The mold temperature also is very important. Once the resin or mixture makes contact with the mold surface, it starts warming or cooling to that temperature. A mold should be controlled to a narrow temperature window, otherwise the final cure of the resin can vary dramatically.

Some commonly used processes are spray-up open molding, pultrusion, resin transfer molding, sheet molding compound/bulk molding compound, infusion and centrifugal casting. The mold surface in these processes is a major factor in the energy put into the process to drive the cure. A colder mold surface, whether it is a spray-up mold or a die for a pultrusion, can make the resin gel cure slowly and lower the exotherm of the resin, making it unable to drive the cure to a sufficiently high level. If the surface temperature is also not uniform in temperature, the finished composite may have parts that are well cured and others that are poorly cured.

In addition, keeping the part at a reasonable temperature during curing is critical. Putting a part into a cold environment while it is curing can stop the cure, and even post curing after the fact will not push the cure to a high level. I have seen companies take a demolded part and move it into areas that were 30 to 50 F so they have room in the shop to make more parts. Unfortunately, the resin just would not finish curing, and even post curing the parts did not make an acceptably cured part.

Post curing parts shortly after making them is another source of energy. Consider it an insurance policy to overcome some of those variations in temperature or other factors that drive the cure. Normally, the sooner you can post cure a part, the easier it is to achieve a high degree of cure.

Select Peroxides Carefully

The selection of the peroxide and the level used is another energy source. There is a large range of peroxides that can be used in room temperature processes, including methyl ethyl ketone peroxides (MEKPs), cumyl hydroperoxide (CHP) and acetyl acetone peroxide (AAP), as well as blends of these. It’s important to note that these are not pure chemicals like some of the peroxides used in elevated temperature cure, such as tertiary butyl peroxysbenzoate (TBPB). Room temperature peroxides can have different carriers and other active ingredients that can change how they disperse in the resin and how the resin cures.

MEKP peroxides are not all the same and won’t perform the same on your production line. Some of the performance differences include changes in gel time, hardness development, exotherms, demold time, trim time, sensitivity to temperature, sensitivity to changes in thickness and/or combinations of these parameters. It’s been my experience as a resin manufacturer that even though people often claim that MEKP peroxides are equal, they are not. The differences may be minor and not detected on your production line, but some of them can wreak havoc.

Achieving a good cure requires a suitable amount of peroxide to initiate the reaction and push it to a higher degree of cure. Using too low a level of peroxide may give a good gel time, but it may not push the cure far enough, unless there is additional energy added to the system to compensate. This energy can come from the exotherm of the resin or outside sources of energy. For example, when a part is thick – like a marble matrix more than one inch thick
– blanketing the part with a thermal media to hold in the exotherm, heating the mold or putting the parts in under heaters can produce energy.

The recommended levels of peroxides are 1.0 to 2.5 percent, with 1.25 to 2.0 percent being the preferred range. Situations where the low side of the range would be used include in hot shop conditions, for thick parts, with high resin content and for parts where keeping the exotherm down is important. Some examples where higher levels would be used are in cool shop conditions, for thin parts, where fast demold times are required and for composites with high filler and high glass content.

Conversely, going too high in peroxide level (typically over 2.5 percent for MEKP) can hurt the cure, too. The higher levels in these systems have more molecules that form free radicals; the number of free radicals present at any time is higher, and the higher concentration means that they are in close proximity to each other. This allows them to more easily react with other free radicals rather than the resin. When they react together they basically eliminate those free radicals from participating in the curing reaction. The free radicals also can react with the resin free radicals forming during the curing process, and that changes the crosslinked resin so it forms shorter chains. The shorter chains form a stiff composite. Even though it is hard when tested with a Barcol gauge, it is not cured well.

There are many variables to consider in trying to achieve the proper cure. If you have questions, work with your resin supplier to ensure the best results.

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Advancements in the ability of FRP structures to resist delamination under heavy loads and withstand significant impact have led to a track record of success in the building of bridges and lock gates, especially in Europe. Last year’s installation of reportedly the world’s largest FRP lock gates on the Wilhelmina Canal has made an emphatic statement regarding the growth of FRP solutions for infrastructure projects.

The Wilhelmina Canal in the Netherlands is an important waterway and a vital part of the country’s transportation system. Eight GFRP miter lock gates (four small and four large) were designed, fabricated and installed by FiberCore Europe using a proprietary product from sister company InfraCore Company. The smaller lock gates, installed in 2015, are 20.3 feet high and 16.4 feet wide. The larger ones are 42.3 feet high and 20.3 feet wide. The entire project was commissioned by the Dutch Ministry of Transport Infrastructure to replace three older locks with one wider and deeper lock comprising all eight lock gates.

The new lock accommodates larger (Class IV) ships and helps the country keep up with increasing water traffic. Since the new lock must hold off a water level difference of at least 25.9 feet, the lock gates needed to be strong and stiff to resist water in continued contact for more than 100 years. (Miter gates feature two leaves that close at an angle pointing upstream to work with instead of against the natural pressure of the water.) GFRP was an ideal solution because of its strength, durability and resistance to corrosion.

According to FiberCore Europe’s co-founder and CEO Simon de Jong, “To introduce a new technology to a market where safety is paramount, we had to conduct extensive testing. We also had to prove that our approach would be faster and less costly to build than traditional steel, wood or high-strength concrete.”

While FiberCore Europe holds the specifics of the technology close, Ronald Greffhorst, senior engineer with InfraCore Company, describes the technology as a fully fiber-integrated panel-type structure. “The worldwide patented technology was developed for the construction of extremely robust FRP panels to solve the delamination problem found in FRP sandwich structures, which is often problematic after an impact,” says Greffhorst. “This new material withstands fatigue and corrosion. Stress is not transferred between plies so that damage that may occur in the top layer will be isolated and resist further damage or delamination.”

The company produced the Wilhelmina lock gates using InfraCore® technology, standard e-glass and a three-step production process. “The most unique aspect of our concept is the production of individual pre-prepped, wrapped building blocks,” says Greffhorst.

In the second step, the fiberglass building blocks were placed within a...
predefined space in the company’s single flexible mold. Using a vacuum-assisted infusion process and an internally developed injection system, each lock gate was vacuum infused with Aliancys’ Synolite™ polyester resin from various positions within the mold.

The design was reviewed by the Netherlands’ Directorate-General for Public Works and Water Management (Rijkswaterstaat) and Royal HaskoningDHV. It took nine months and led to the development of regulations for the application of FRP for civil engineering structures in the Netherlands.

It took FiberCore Europe just one month to design the project, one week to build each of the eight lock doors and two weeks to equip them with a few steel parts, such as hinges. The four large gates were installed in early January 2016.

“Because the prefabricated gates weigh no more than 24 metric tons (53,000 pounds) – a 50 percent reduction in weight from a comparable steel lock gate – they were easily transportable to the site. We were able to install one door in 15 minutes,” says Grefhorst. The light weight also means that the lock gates are very fast to open and close. Maintenance requirements are further reduced as the lighter weight minimizes wear on the lock gates’ hinges.

“The client had to plan the project with a new mindset,” notes de Jong. “There was money to recover as the FRP lock gates were ten times stronger than steel gates but comparable in price. The fast installation meant inconvenience was limited and downtime to shipping traffic was eliminated. Disruption was minimized for neighborhood residents and businesses.” In addition, long-term maintenance is also reduced since GFRP gates don’t require repainting or treatment as would be required by steel gates.

Test results indicate that the Wilhelmina gates will have a lifespan of at least 100 years. “Ships can hit the doors, and the gates will withstand the impact and still keep about eight meters of water from flooding our beloved country,” adds de Jong. “Our Ministry’s choice of FRP lock gates, as well as many bridges, means they have confidence in the technology.”

Rijkswaterstaat presented the Wilhelmina Canal lock gates project at a Smart Rivers conference of water authorities in Buenos Aires in 2016, generating international interest and the formation of an international working group to further the use of composites for hydraulic structures. “The range for applications goes beyond lock gates and bridges,” de Jong says. “We are looking at offshore structures, ship building, LNG storage and military applications in the future.”

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For more stories like this, visit CompositesManufacturingMagazine.com and check out the Infrastructure articles under the “Market Segments” tab.
If you’ve ever seen a commercial by Red Bull, chances are you’re familiar with the catchphrase “Red Bull gives you wings.” In late 2016, the company lived up to its slogan when a prototype of the DNA F4—the world’s first foiling production catamaran over 40 feet, sponsored by Red Bull—flew on water 662 miles from New York to Bermuda in just 66 hours.

The “flying” refers to the way the catamaran reached extremely high speeds, which lifted it off the surface of the water, literally hovering a few feet on its foils.

The F4’s crew, known as Team Falcon, was led by ORACLE Team USA helmsman and two-time America’s Cup winner Jimmy Spithill. He was joined by sailor Shannon Falcone, technical supervisor of the 46-foot-long catamaran, as well as sailors Tom Loughborough, Rome Kirby, Cy Thompson and Emily Nagel.

While fast, Team Falcon’s journey was also turbulent, at times encountering winds over 40 knots and waves as high as 25 feet. At night, the team couldn’t see the moon while some of the waves were breaking, which made navigating very challenging and extremely dangerous. “We had a few close calls at night,” Spithill says.

“We experienced more than a lot of sailors experience in their whole career,” adds Falcone. “We had awesome foiling on the first day, but it turned to ultimate survival.”

According to Falcone, though, the team was equipped to handle those conditions due to the F4’s advanced CFRP construction. To design and build the DNA F4 prototype, Falcone teamed with DNA performance sailing, the high-performance sailing division of Netherlands-based advanced composite engineering and manufacturing company Holland Composites. In addition to its marine portfolio, Holland Composites is famous for its grand architectural façades—most notably for the Stedelijk Museum of Modern Art in Amsterdam.

As Falcone explains, the idea for the F4 came to fruition in 2015 when Loughborough reached out to let him know Red Bull was interested in doing a project focused on foiling. (Foiling in sailing refers to when the boat reaches high speeds and the hydrofoils under the hull lift it up and out of the water.) Falcone asked Holland Composites to design a new catamaran, explaining that Holland Composites’ current G4—a high-performance leisure catamaran—wouldn’t work for Red Bull. As luck would have it, Holland Composites was already planning to get Falcone’s feedback on a new variant of the G4 it was working on in its concept stage.

“When I told [DNA/Holland Composites] we needed to up the specs they said, ‘Well, actually, we were sort of already thinking about that anyway,’” Falcone recalls. From
there, with feedback from Falcone and Loughborough, DNA’s designers and engineers gradually transformed the G4 into what became the F4 – an offshore-ready catamaran built for nature’s worst.

“We didn’t want anything [bad] to happen out on that first mission,” says Falcone. “So we were very conservative, and I think rightly so because we ended up testing the platform in conditions that you wouldn’t wish on anybody and definitely were unexpected.”

Falcone adds that the conditions weren’t the only surprise. He says that historically, catamarans are not known for going upwind very well, but the F4 was an exception. He credits the boat’s uncharacteristic performance to the one-piece construction of the hull, which to him is perhaps the most innovative element of the F4.

“It’s not two separate hulls and beams where you lose torsional stiffness in the boat,” says Falcone. “All hands to DNA and Holland Composites for that construction method. That is, in my mind, the game changer.”

That construction method played a role in DNA’s ability to tackle its biggest challenge: time constraints. Red Bull had a tight production deadline.

“[DNA] started laying carbon in March [2016] … and the boat was out of the shed in August,” says Falcone. “It was a very quick build. They worked magic on the logistics.”

The F4 only weighs about 8,375 pounds. DNA constructed the F4’s platform with carbon fiber prepreg with Nomex® honeycomb, which was vacuum bagged and post cured at 110 C. The materials and processes were chosen to ensure the catamaran met its high-performance demands.
platform with carbon fiber prepreg with Nomex® honeycomb, which was vacuum bagged and post cured at 110 C. According to Holland Composites managing partner Thijs van Riemsdijk, that choice was vital to ensure the boat met its high-performance demands and that DNA could easily replicate future F4 boats with identical weights. Identical weights, according to van Riemsdijk, ensure a level playing field when future F4 boat owners race each other in the “One Design” class.

“We are great believers of using carbon prepreg in lightweight constructions,” says van Riemsdijk. “When processed well, it ensures a high-quality laminate. Apart from that, we can build lighter, in part due to the use of honeycomb core. The prepreg process allows for a very controlled and … robust production process with great repeatability.”

Van Riemsdijk says that in the conditions the “highly stressed parts” of the F4 would face, the loads “are bordering to the ridiculous,” which is why the foils were constructed with carbon fiber prepreg and then processed in DNA’s autoclave. The mast and boom, which were made the same way as the foils, were made by Bristol, R.I.-based Hall Spars.

 “[In order] to avoid drag as much as possible, and thus create speed, the profile cannot be too thick, so a small section with a long lever has to be able to take a lot of loads,” he adds. “The foils lift the boat and also enable the boat to steer, [so] we cannot take any risk in these items failing when sailing offshore.”

DNA also partnered with Future Fibres, which provided composite rigging made of its flagship product, ECsix – a continuous, multi-strand CFRP cable. Future Fibres says ECsix’s bundles of separate pultruded carbon rods make the rigs extremely flexible, which helps them resist fractures from both bending, compression and impact.

Falcone says that the success of the F4 prototype should provide assurance to potential end users that a foiling catamaran can hold up in a real-world scenario. Ultimately, he adds, the target market for the F4 is amateur sailors and boat owners who want to get into foiling.

Spithill believes the experience with Team Falcon was exactly what he needed as he seeks to defend his America’s Cup title this year.

“The America’s Cup … will be tougher and harder-fought and more unpredictable than anything I have ever experienced, and so I wanted to push myself mentally and physically further than I’ve ever gone before,” says Spithill. “Ultimately, this will help me be a better sailor … when the America’s Cup is on the line.”

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For more stories like this, visit CompositesManufacturingMagazine.com and check out the Marine articles under the “Market Segments” tab.
When “A Gathering Place for Tulsa” opens in the Oklahoma city later this year, the nearly 100-acre park along the Arkansas River will feature sports courts, bike and skate parks, nature trails, large lawns for concerts and more. At the heart of the park will be the three-level ONEOK Boathouse, including boat storage on the lower level, educational programming space on the second floor and a restaurant and outdoor patio on the top. The ONEOK Boathouse will not only be functional, but also attention-grabbing thanks to an 8,000-square-foot composite canopy that will cover the patio.

“The boathouse was designed to be the focal point for the park, and the white, modernistic, composite roof will become a very iconic image for the park,” says Jeff Stava, executive director and trustee of Tulsa’s Gathering
Composites are increasingly finding their way into architectural projects – ranging from new construction to building restorations and traditional ornamental elements – because of their design flexibility, durability, corrosion-resistance and strength.

New Construction

The patio roof for the ONEOK boathouse comprises 130 sail-shaped, curved panels, which are being fabricated by Kreysler & Associates in American Canyon, Calif. When the company saw the design from Mack Scogin Merrill Elam Architects (MSME) more than two years ago, it thought it was a perfect project for GFRP, says Josh Zabel, vice president of business development at Kreysler. The company, which has been fabricating composites for the construction market since 1982, submitted a proposal. However, it didn't originally win the bid.

Initially, the project team opted to make the roof from polytetrafluoroethylene (PTFE) panels. “They went down that route, but found out it was going to cost just as much or possibly more. And they also discovered they would have to change the design to make it out of [PTFE],” says Zabel. “So, they came back around, dredged up our original proposal, and that’s how we got on board.”

Kreysler & Associates is using hand lay-up to fabricate the panels, all of which are different sizes and shapes. Each panel includes a top and bottom skin, made from polyester resin and fiberglass, and a balsa core. The molds are created on a 65-foot-long, 5-axis CNC machine. “One of the tricks we’re using is rather than creating separate molds for the top and the bottom, we’re making a mold for the bottom, fabricating the bottom panel, then using that panel as a mold for the top,” says Zabel. That reduces mold-making time – and just as importantly, cost – in half.

The finished panels will be attached to steel columns on site that hold up the completed canopy. In early 2017, Kreysler was creating small mock-ups of the panels to ensure they fit together properly prior to shipping. All the panels will be complete by the end of the summer.

More than 4,700 miles away in Paris, another new building was recently topped by composites, too. Sicomin supplied materials to produce both molds and parts for five gilded domes on the recently opened Russian Orthodox Cathedral and Spiritual Center. The French company Multiplast SAS, part of Groupe Carboman SAS, produced the domes using Sicomin’s SR8100/SD4772 epoxy infusion system and a specially-developed fiberglass reinforcement lay-up that includes a heavyweight quadaxial fabric with a woven fabric. After fabrication, craftsmen applied 86,000 leaves made from real gold to nearly 7,000 square feet of the domes.

Building Restorations

Composites were an ideal solution for the restoration of the Harris County Administration Building in Houston, built in 1978 to house government agencies and employees. From the beginning, the 10-story building suffered from poor construction practices. Reinforcing steel throughout the building was placed too close to the concrete façade, which contributed to premature corrosion and distress. Combined with shoddy workmanship, this led to spalling, cracking and honeycombing throughout most of the concrete. Conditions were so poor that the county erected scaffolding around the building to protect people from possible falling pieces of concrete.

Sika Corporation in Lyndhurst, N.J., was brought in by Norex Engineering and Johnston LLC Architects during the early
Composites Manufacturing

EDON Corporation provided the GFRP cornice at the top of Penn Avenue Place in Pittsburgh during renovations of the building, which was originally built in 1907.

design phase to offer recommendations. It then provided both concrete and CFRP repairs during the restoration, which began in 2015 and took more than a year.

A low viscosity epoxy resin was injected into the concrete to stabilize cracks, then a variety of CFRP solutions were used for additional reinforcement. Sika utilized a unidirectional fabric, which was installed along the top and bottom flanges on sunshade beams and interior corners between the sunshade and outrigger beams where cracking was widespread. It also used a ± 45 degree, double bias CFRP fabric on the middle section of I-shaped concrete beams for shear reinforcement. In addition, CFRP repairs were made in areas with post-tensioned concrete beams to strengthen overstressed and cracked sections.

CFRP is well-suited to repairs because buildings have varying degrees of stresses and strains in different areas, and composite materials can be customized as needed. “It’s not like using a steel plate or jacket, which is extremely heavy and prone to corrosion,” says David White, P.E., vice president of technical services at Sika. “With FRP, you can custom design the weight of the fabric and the orientation of the fibers so it’s truly an engineered solution.”

Nearly all of the 180,000-square-foot façade of the Harris County Administration Building was covered with CFRP, which was installed by Structural Concrete Systems LLC using scaffolds while the building was still occupied. “That’s where the FRP materials showed their true worth,” says White. “I couldn’t imagine trying to affix a steel plate on the outside of this building. The lightweight, non-corrosive nature and ease of installation made CFRP a perfect product for the situation.”

Ornamental Elements

One of the most common uses of composites in architecture, crossing over both new construction and restorations, is
ornamentation. EDON Corporation in Horsham, Pa., has supplied FRP architectural ornamentation since the early 1980s. It recently completed phase one of a cornice project for Penn Avenue Place in Pittsburgh. The three-piece cornice had to be done just right – and under a tight deadline – because hundreds of thousands of people would be gazing at it during the 2016 Christmas season.

The GFRP cornice runs along the sides of the building’s sixth story, meeting at the corner where Pittsburgh’s iconic Unity Tree is displayed each Christmas. The 100-foot artificial tree, which wraps around Penn Avenue Place, is decorated with 2,500 lights and 2,000 ornaments. The new cornice provided by EDON provides a beautiful backdrop.

When the original metal cornice on the 110-year-old building began deteriorating, netting was added to the building to protect pedestrians from potential falling debris. EDON was hired for the restoration. “It was a historic cornice and had to be reproduced to match the original,” says Matt Axel, president of EDON.

The contractor provided original pieces of the cornice to EDON, which sent them to its pattern maker in Boston. Once the fabricator received the patterns back, it created fiberglass molds and then manufactured the cornice sections using a spray-up process. The cornice pieces are made from OptiSpray™ chopped GFRP from Owens Corning and Hetron™ fire-resistant polyester resins from Ashland. The cornices, which are approximately 8 feet, 9 inches high and project more than 4 feet out from the building, include an upper acroteria band, a cornice with molded coffers and a lower cornice with molded brackets and decorative elements nicknamed “elephant toes.”

Aside from working under a time crunch, another challenge of the project was ensuring the new cornice fit into the original framing on the building, which was being retained. “The framing has metal brackets that stick out from the building, so based on the configuration we had to make sure the brackets lined up with a gap in our molded dentils,” says Axel.

Glassline in Plymouth, Mich., also understands the challenges of restoration projects on old city buildings. The company is in the midst of a three-year renovation on Detroit’s Book Tower, a 38-story Renaissance-style skyscraper in the city’s Washington Boulevard Historic District that opened in 1926. The 13th floor of the building is adorned with 12 caryatids – sculpted maiden figures that provide architectural support. One of Glassline’s tasks was to replace the original 2,500-pound terra cotta caryatids with much lighter GFRP ones. The first challenge was to accurately reconstruct the detailed figures from one of the originals, which was broken into many pieces upon removal from the building. Glassline, which had previously taken field measurements of the figures, received the pieces in four large boxes. The only fully intact piece was the 250-pound head.

“We dug through those boxes and reassembled the components, which were fairly identifiable body parts,” says Guy Kenny, president of Glassline. “Then we pinned them altogether, applied a plaster coat, sanded it, prepped it and used it to make a silicone mold.” It took about a month to make two sets of molds – one for six maiden figures facing right and the other for six facing the left.

Next, Glassline fabricated one 13-foot-tall caryatid for approval from the building owner. Once the company received the green light, it manufactured the remaining figures using a U.V.-resistant gel coat and a fire-retardant polyester resin reinforced with fiberglass chopped strand and hand laid mat. While most of the fabrication utilized hand lay-up, some of the detailed parts – such as toes and fingers – required cast polymer molding. Each figure took about five days to make. The finished maidens weighed only 600 pounds each.

Another challenge was making sure the finished caryatids attached correctly under an eave on the Book Tower. A steel frame runs from the building wall on a 45-degree angle through the eave. Construction workers install one of 12 GFRP maiden figurines on the Book Tower in Detroit.
Advice for Penetrating the Architecture Market

“There’s tremendous opportunity for future growth in the architecture market, but I think it’s longer term,” says Andy Bridge, vice president of industrial markets and director of research and development for Janicki Industries. If you plan to stick around, try the following:

Understand everyone’s role.
“Working in the architecture industry is different from making boats or wind turbine blades,” says Josh Zabel, vice president of business development at Kreysler & Associates. “The people who work on a project – and how they interact – tends to evolve as the project moves from schematic design to construction. The influence in decision-making often shifts.” That’s why it’s important to get familiar with what architects, contractors and building owners are responsible for at various stages of the project.

Get involved in projects early on.
“The most successful projects we’ve had are the ones where we’ve been involved early enough to offer our expertise about fabrication and influence decisions on materials and design,” says Zabel.

Expect changes.
“You have to be prepared for a lot of field changes,” says Guy Kenny, president of Glassline. “You can’t get too far ahead of the game until you’ve installed one or two components because there are always changes – even in the same walls or areas.”

Lobby to change building codes.
To be broadly utilized across the architecture market, composites must be included in building codes. Several years ago, ACMA’s Architectural Division spearheaded activity that led to the creation of section 2612 of the International Building Code for non-structural applications for interior and exterior cladding. Now the group is planning a strategy to develop sections on FRP composites for structural applications. The initiative requires involvement from composites professionals in the areas of testing, standards development and education of building officials. For more information, contact John Busel, vice president of ACMA’s Composites Growth Initiative, at jbusel@acmanet.org.

Think locally.
“The best thing to do is focus in your geographic area,” says Bridge. “Get to know contractors, developers and architects, find out what their challenges are and see if you can offer solutions.” New construction in Seattle must adhere to recently-enacted strict energy building codes, so Bridge is selling prospective clients on the thermal energy management benefits of composites.

Educate architects.
“You have to make architects aware that composites are a viable material good for applications other than restoration,” says Kenny. “We have some new buildings in Detroit that are considering fiberglass skins, but it’s a challenge to get someone building a new $400 million building to go out on a limb with a new material.” Sika Corporation’s project sales representatives frequently hold box lunch educational seminars for engineers and architects.

The Future Outlook
While opportunities abound in architecture, composites companies admit they’ve only just begun to dip their toes into the market. “The construction market is enormous,” says Andy Bridge, vice president industrial markets and director of research and development for Janicki Industries in Sedro-Woolley, Wash. “Composites only need to penetrate one quarter of one percent and that would dwarf all the other markets we work in.”

Bridge sees future opportunities in combining 3-D printing technology with structural elements. “I compare it to what they’re doing in automotive – a multimaterial approach,” he says. “They are not wedded to any one material.” He cites the BMW 7 Series with its mix of CFRP, high-strength steel, aluminum and other materials as an example. “Combining materials and using them where they make the most sense – that’s an exciting area where we’re going to see more growth in the architectural and construction space,” says Bridge.

Zabel at Kreysler & Associates is thinking big, too. “We’re very focused on getting past decorative applications,” he says. “We’ve certainly done structural applications with FRP, but they have been small projects – a house with a structural monocoque FRP shell. But a tall building where the structural façade or some part of it is made from composites, that’s part of the future in my mind.”

Susan Keen Flynn is managing editor of Composites Manufacturing magazine. Email comments to sflynn@keenconcepts.net.

Visit the Composites Pavilion at the AIA Show
ACMA will hold its fourth annual Composites Pavilion at the American Institute of Architects Convention April 27 – 29 in Orlando, Fla. The pavilion will feature Composites Central, a forum for presentations on composites technology in architecture, as well as the second annual Composites in Architecture Design Challenge. To register, visit conferenceonarchitecture.com. For more information, contact Sarah Boyer at sboyer@acmanet.org.
Quality was the big driver when aerospace manufacturers began incorporating composite parts into their aircraft 25 years ago. With the basic resin systems then available, autoclave was the best way to compress the laminate’s plies and produce a part with very low voids. While autoclaves have worked well, the equipment is expensive and it limits parts size.

Out-of-autoclave (OOA) technology is solving these problems for some applications. “OOA is considered to be a cost effective way to produce a part, and it also avoids the financial investment in purchasing autoclaves and freezer storage,” explains Henri Girardy, Hexcel’s business development manager for new processes. “Other advantages of OOA technologies are the potential for a higher degree of part integration: for example, the co-molding of skin, stiffeners and spars in the same operation, which leads to an overall reduction in the total process cycle, with increased production rates.”

In the broadest sense, OOA includes any composite production technology that doesn’t use an autoclave. That definition encompasses thermosets and thermoplastics and processes such as resin transfer molding.

But some companies in the aerospace industry prefer a narrower definition. “We’re talking about thermoset prepreg under vacuum bag only (VBO) curing,” says Michael Cichon, director of product marketing at TenCate. There are variations within OOA processing technology that could be considered out of autoclave, including the use of hydrostatic pressure, resin film infusion, bladders for pressure intensifications and SQRTM (same qualified resin transfer molding). In SQRTM, for example, the prepreg is placed in a closed mold, and the same resin used in the prepreg is injected into the mold.

An Evolution in Prepreg OOA

OOA prepreg has gained widespread acceptance in the aerospace industry because it produces quality parts at reduced cost.

“OOA properties are now equivalent with autoclave materials and are no longer a deciding factor,” says Gary Bond, Boeing research & technology technical fellow. “There are a number of factors that go into deciding which material and process are used to fabricate Boeing composite parts, including the part geometry, thickness, production rate, number of parts required, tooling budget, etc.”

Boeing is currently using both thermoset and thermoplastic OOA prepreg materials, as well as resin infusion OOA processes. It is working closely with material suppliers both to qualify current generation OOA composites and to develop the next generation of OOA prepregs. Bringing costs down is a significant focus of this work, Bond says.

Quickstep’s Qure process uses a heat transfer fluid (HTF) system for curing OOA parts. The company says the process works with both prepreg and infusion manufacturing, speeding the heating process and reducing costs.
The Cirrus Vision SF50 is made using TenCate’s TC275 out-of-autoclave/vacuum bag only epoxy.

Advances in resin chemistry and a better understanding of lay-up processes made OOA technology feasible. For example, resins are more latent in OOA processes. “You could have them at a 250 F temperature, where the resin viscosity is low, for up to six to eight hours,” says Cichon. “During that time, under vacuum bag pressure, air will naturally start to find its way out if you have a really robust process.” Manufacturers can manipulate several variables, adding breather plies, glass tape and fabric, and varying the frequency of debulking to make those processes more robust.

There are tradeoffs when using OOA instead of an autoclave. OOA requires more process study, more parts fabrication work, more investigation to ensure that the resins work properly and often more nondestructive (NDT) inspection on critical parts.

“OOA, especially VBO, is generally a longer lay-up process before you get to the cure, and the cure cycle can be longer to get all of the air out,” adds Sean Johnson, thermoset project manager at TenCate. “So you save a lot of operating expense, but labor time is money as well. If you increase labor on the front end, you may not save as much money as you think.”

Improvements in OOA technology tend to be more evolutionary than revolutionary. TenCate is working to make its resins more robust and tougher. “With some of our latest technologies, the resins have very low moisture absorption so that they retain their strength under hot/wet conditioning. Other developments involve formulating resins that have a longer tack life and a tool life/out time of 25 to 30 days to facilitate larger parts,” Cichon says.

TenCate will introduce a new prepreg system (TenCate TC380), whose combination of hot/wet properties can produce a composite with good mechanical strength and high compression and open-hole compression strength. “These are the key allowables that you have to address when you’re designing aircraft or aerospace structural parts,” Johnson says. The resin must also have good handling and manufacturability characteristics.

TenCate is now producing resins that can be adapted for both autoclave and OOA processes. With automated tape laying and automated fiber placement becoming more prevalent in the aerospace industry for OOA processes, companies that produce the materials for OOA will have to tailor them more specifically for these processes, Cichon says.

Enhanced Controls Improve Parts Quality

Better ovens have helped improve the quality of OOA parts. Aerospace customers in particular are requesting ovens with more flexible systems and more accurate, higher-end controls, says Mike Grande, sales manager/senior applications engineer at Wisconsin Oven Corporation.

Ovens now offer improved monitoring capabilities. Manufacturers can bag parts individually, embedding thermocouples in each part throughout its thick and thin sections. After the vacuum is drawn and the heating begins, technicians can monitor all the points inside each part, looking for the hottest and the coldest.

“Suppose they have to heat everything up to 350 F, with an allowable range of 340 F to 360 F,” says Grande. “They might start the oven up from cold and run it at 400 degrees for the first half hour while monitoring all points. After they see the hottest points come in and start to approach 360 degrees, the control system senses that, brings the temperature down to 350 degrees. So you have the quick heating without any chance of overshoot because of this advanced control system.”

High-end controls also permit manufacturers to place slightly different vacuum levels on each part in the oven. “Rather than having to compromise and settle for one vacuum level – which might be OK, but not exactly what they want – they can individually tailor it to each part,” Grande said. This improves part quality.

While most ovens have sidewall ductwork that blows heat toward the center, Grande says a few customers have requested ovens with directed hot air impingement. These ovens contain several hoses with nozzles that the manufacturer can clamp into place to direct extra air to certain areas.

Hot air impingement could be useful with a C-shaped part. With the two sides of the C heated by the sidewall ducts, the hot air from the nozzles can be directed into the center of the C. This arrangement allows for faster and more even heating of the composite part.

Moving Out of Oven

Some companies are working outside of both the autoclave and the oven. Australian composites manufacturer Quickstep says its fluid-based Qure process provides faster curing and lower cost through the use of direct contact heating of materials instead of the convective heat transfer used in an autoclave.

In the Qure process, the heating chamber contains a heat transfer fluid (HTF) with a floating laminate sandwiched between a rigid or semi-rigid mold (also floating in the HTF) and a flexible membrane or bladder. The HTF can be rapidly heated and then cooled for curing.

“We can substantially increase the heat up rate of composite structures,” says Tim Olding, executive general manager, systems. “The system allows for fully controllable ramp rates and dwells under closed loop temperature and pressure control, all the way up to 190 degrees C (374 degrees F). Because the bladder is in direct contact with the composite, the heat transfer rate is higher and more uniform.” For some applications the heated bladder is placed on both sides of a thin shell tool, enabling highly uniform heating of the material through thickness. Faster heat transfer rates result in faster curing times, higher productivity and greater tool utilization, Olding says.

The company recently commissioned its first isothermal
machine, which will provide the flexibility to preheat the fluid and do a hot flush of the tool to get fast ramp rates.

Manufacturers can use the Qure process with different material types and with either resin infusion or impregnation processes. There is no theoretical limit on part size, since the equipment can be scaled up as needed.

"Qure has been successfully used to cure laminate stacks up to 50 mm thick without any controlled exotherm. The largest Quickstep machine we have made to date is used to make parts for the satellite launch industry. This machine has a working tool area of 6,000 x 4,000 mm (19.6 feet x 13.1 feet),” says Olding.

Quickstep first used the Qure technology in the aerospace sector as an alternative method for curing prepreg materials. Now it’s also used for non-aerospace applications, including the production of carbon fiber housings for the medical imaging industry.

**Advances Beyond Prepreg**

Hexcel uses the broader definition of OOA in describing its technology. “OOA is what we call a ‘direct process,’ where the resin and reinforcement are combined and cured in the same molding operation,” says Girardy. Hexcel developed HiTape® for use in the manufacture of dry preform for aerospace applications.

HiTape is a dry carbon fiber reinforcement combined with a thermoplastic veil. It enables manufacturers to use an automated lay-up machine to make the dry preform, with laser heat or infrared heat directed at the location where the tape is laid down. The automated lay-up permits faster production.

With the high-performance liquid epoxy resin system Hexcel developed for HiTape, the tape can meet the performance levels required for primary aircraft structures, including impact resistance, Girardy said. The standard curing process for HiTape is low pressure or vacuum infusion at relatively low temperature, followed by an increase in mold temperature to cure the thermoset resin.

NONA Composites (short for No Oven, No Autoclave) is testing OOA vacuum infusion technologies with an eye to reducing costs. “It's not as far along as the OOA prepregs and RTM and similar types of processes, but it is coming along,” says Ben Dietsch, company president.

One area they're investigating is non-prepregs. “There's definitely significant cost savings that can be had, more than 50 percent on materials in some cases,” Dietsch says. But with so
many different OOA technologies available, including curing with radiation or microwaves, RTM and infusion molding, comparing the cost of processes can be difficult. “It’s hard to say if you do microwave curing you will save 20 percent over autoclave prepreg,” Dietsch adds.

Dietsch believes manufacturers could improve the quality of OOA parts with better control over curing processes. Technologies like directed hot air impingement or induction heating can provide that improved control, but they can also be expensive due to equipment costs. NONA, which currently uses a well-defined exothermic cure for its vacuum infusion OOA processing, is investigating some of these other options as well.

New curing methods could enable faster OOA production, making it more competitive in the automotive parts industry. “The material vendors are working in this world, too. How do they develop materials that cure very quickly but don’t have the same problems that traditional materials would have if you tried to cure them very quickly?” says Dietsch.

Expanding OOA Markets

OOA is not a magic bullet, it is just another tool composite manufacturers have at their disposal to make products at a desired quality and price. “We have seen large parts being made with OOA, but we have also seen people that are well-versed in OOA techniques choose to go autoclave for structural thick parts because the risk is too high and doing multiple debulks every six to 10 plies – along with added NDT inspection costs – is just too much work,” Cichon says. He does see continued opportunities in unmanned aerial vehicles, sport aircraft and business jets.

Boeing believes that OOA will continue to grow and will both replace currently autoclaved parts as well as open up opportunities for other types of parts, including replacement of metals, according to Bond.

Outside of aerospace, manufacturers are using OOA to produce aftermarket auto parts, consumer electronics, recreational and industrial equipment, and tooling. “When you’re fabricating industrial parts, users might be able to live with void contents higher than one percent (a current aerospace standard) since the part may not be as weight critical as aerospace. As such, if they have strength knockdowns from using OOA processes, they can offset those variations by making the part thicker or stronger,” says Cichon.

Dietsch believes there could be market opportunities for OOA in trucks, heavy transportation and infrastructure. “But the cost has got to come down, and people have to get comfortable with it,” he says.

Autoclave will not disappear. “There’s an adage that we have in the aerospace industry that pressure is cheaper than brains; I think we will always have autoclave or pressurized technology processes,” Dietsch says. “I really see things like OOA and some of these other technologies that we are working on as maybe not displacing something that exists. It’s more creating new markets and growing the use of composites in those markets.”

Mary Lou Jay is a freelance writer based in Timonium, Md. Email comments to mljay@comcast.net.

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While a growing number of industries are coming to recognize the vast benefits that composites present, in many instances it’s still a traditional material’s world. Whether it’s a focus on initial costs over long-term return on investment, a lack of production technology in place to handle the integration of composites into established manufacturing processes or plain old misconceptions, some industries still need to be convinced that composites have a place in their plant.

Mixing composites with traditional materials, such as steel and aluminum, doesn’t necessarily address these drawbacks. But mixed-material applications can produce such benefits that many industries are rethinking their approach to include composites in new ways. By combining lightweight, highly durable composites with other materials through a variety of processes, manufacturers are able to add needed rigidity, engineering predictability and other advantages.

Here’s a closer look at how companies in three industries – infrastructure, automotive and marine – are making the most of mixed-material solutions.

Better Together
Three industries explore how mixed-material solutions can maximize composites’ benefits.

By Megan Headley

While a growing number of industries are coming to recognize the vast benefits that composites present, in many instances it’s still a traditional material’s world. Whether it’s a focus on initial costs over long-term return on investment, a lack of production technology in place to handle the integration of composites into established manufacturing processes or plain old misconceptions, some industries still need to be convinced that composites have a place in their plant.

Mixing composites with traditional materials, such as steel and aluminum, doesn’t necessarily address these drawbacks. But mixed-material applications can produce such benefits that many industries are rethinking their approach to include composites in new ways. By combining lightweight, highly durable composites with other materials through a variety of processes, manufacturers are able to add needed rigidity, engineering predictability and other advantages.

Here’s a closer look at how companies in three industries – infrastructure, automotive and marine – are making the most of mixed-material solutions.

Extending the Life of Infrastructure
Composite Rebar Technologies LLC (CRT) in Madison, Wis., has designed a hollow GFRP rebar – capable of fitting a metal rod when increased shear strength is needed – that Tom Hershberger, CRT’s vice president of marketing and sales, says could replace the poor-performing epoxy-coated steel concrete reinforcements being used in highways across the country. He says the CRT Long Life™ dowel provides significantly better performance at the same or less cost.

“What I’m hearing from places like Virginia, which has essentially outlawed epoxy-coated steel for their bridge decks, is that they don’t want to use FRP rebar because it costs too much. But they’re wrong,” Hershberger says. “Like a lot of Department of Transportation officials, when they hear ‘composites’ they’re thinking of exotic applications where composites are phenomenal but very expensive.”

While this hollow rebar product is in the pilot stage, CRT has evidence that a blend of composite and metal can boost the benefits of composites alone: The company’s GFRP sleeved-
Steel dowel bars are being used today to provide load transfer in jointed concrete pavement. Rebar is used to prevent cracking in highways. Typically epoxy-coated steel, welded into place in metal “baskets,” have been used to keep the 15-foot slabs of concrete from shifting every time a tire passes over the edge. However, Hershberger says, the 40-year-old corrosion-resistant solution can cause its own problems. Over time, the epoxy coating develops fissures that actually lead to accelerated corrosion at the site of these micro-cracks. A typical lifespan for these bars is anywhere from 20 to 30 years, depending on the environment, while today’s roads are built to last 40 to 50 years, at a minimum. That can be a costly disconnect: As Hershberger puts it, “A typical dowel bar costs about $5, and it costs $150 to replace an in-service dowel.” CRT’s steel GFRP-wrapped dowel bar, which the company says has an infinite service life, is designed to reduce concrete cracking by applying less bearing stress and corner pressure on the concrete as compared to today’s steel bars, says Hershberger.

“Our sleeve is not just a coating, it’s actually a structural component of the dowel, which serves to completely eliminate corrosion,” Hershberger explains. Because the steel is hermetically sealed within the composite material – a blend of corrosion-resistant vinyl ester resin and ECR glass – highways gain a truly corrosion-resistant product, with the same load transfer as a 1½-inch piece of steel for about the same price as those steel bars, he adds.

“We conservatively estimate that two-thirds of dowel bars are in corrosion areas. So not only will ours be cost competitive, but they will have better performance in terms of lower concrete cracking, and they will also never corrode,” Hershberger says. However, one of the chief benefits of using a steel-GFRP hybrid is the engineering predictability. “Anybody in the industry who has tried to get composite products adopted knows the biggest challenge is getting the engineers to design with it,” Hershberger says. The reason, he explains, is that “composites can do what steel does in many cases, and a lot better – but the problem is that composites often do it in a different way. So, for example, FRP rebar has greater tensile strength than steel, but it’s not as stiff.”

The result is that the end product would need a slightly different design when using GFRP rebar in place of steel. “But for our dowel bars, it’s a swap out. It performs the exact same function as the steel. If you want to use CRT’s Long Life dowel instead of steel, you don’t have to change anything,” Hershberger says.

**Improving Fuel Efficiency and Crash Resistance**

It’s a similar desire to add composites into the mix without shaking up in-place manufacturing processes that is challenging the automotive industry today.

Composites experts working in the automotive industry have seen a car with a fully composite frame – the BMW i3 – but they don’t expect to see one again anytime soon. As Ana Wagner, global strategic marketing manager for Dow Automotive Systems, points out, “Full composite vehicles like the BMW i3 probably won’t be the norm. In fact, BMW had to build assembly plants specifically to build this vehicle because the manufacturing processes are very different from the traditional processes. But the use of carbon composite parts is definitely going on.”

In this industry, it’s clear that right now the biggest benefits come from the combination of composite and aluminum components.

Wagner explains that composite products are used in a multitude of automotive applications already. In some cases these materials can improve durability and even crash resistance, but their lightweight is particularly critical.

Composites are expected to play a crucial role in producing the lighter weight vehicles that will be able to achieve an average 54.5 miles per gallon, per the Environmental Protection Agency’s deadline of 2025. But combining these materials in broader applications than seen today has its challenges.

“When you’re working with dissimilar materials, especially earlier in the manufacturing process, the materials expand at different rates,” Wagner explains. Per the coefficient of thermal expansion (COTE), composites and metals expand at different rates when heated and contract at different rates when cooled. “That’s going to lead to some residual stresses in the joints,” Wagner adds.

Today, Dow is exploring new structural adhesive technology that can account for the difference of COTE, as well as other issues, such as the potential for corrosion as a result of contact from dissimilar materials. The result, experts say, is a strong, durable joint.

“If it wasn’t for adhesives, you probably wouldn’t be able
to join the composites to the metal,” says Wagner. Currently, chemists are working to fine tune adhesives that can be worked in any area of the manufacturing process, Wagner says. “We will have some adhesives with accelerated temperature curing, some that cure at room temperature, etc., so we can tune and modify the chemistry to the very specific needs of any manufacturing process,” she says.

A case in point is the injection bonding technique Dow developed for its BETAFORCE™ bonding adhesives. The company describes this development as an example of the customizing capabilities of BETAFORCE to address customers’ specific production requirements, such as open times and cycle times, without affecting the adhesive’s mechanical properties. By adjusting parameters on a case-by-case basis, Dow Automotive aims to promote the wider use of CFRP parts in mixed-material assembly.

The injection bonding has been used to bond carbon fiber parts to metal in side-frame applications along the roof of the BMW 7 series. In this application, the carbon fiber component sits within a steel housing that runs along the A-pillar into the roof and down the D-pillar. According to Dow, this combination of materials, bonded by BETAFORCE structural adhesives, ensures the stability of the passenger compartment in the case of a side-pole impact or rollover, while also increasing vehicle stiffness and improving ride-handling and minimizing NVH (noise, vibration and harshness) at the lowest mass.

The challenge of integrating such long CFRP composite parts comes in managing the differential coefficient of linear thermal expansion during both assembly and the operative life of the vehicle. BETAFORCE technology helps address that challenge.

BETAFORCE, based on a two-component polyurethane structural adhesive technology, is characterized by a high modulus for needed stiffness and a high elongation factor that enables a high level of energy absorption and flexibility. This combination helps manage different levels of thermal expansion, according to Dow.
Creating a Strong, Comfortable Cruise

Although mixed-material applications are increasing in the automotive industry largely due to the 2025 fuel efficiency standards, manufacturers are building on these composite advancements in other industries, including marine.

In late 2016, Toyota launched a new sports cruiser, the Ponam-28V, a commercial version of a concept vehicle that had received the Good Design Award in 2016. Crucial to achieving the expected high-cruising performance and riding comfort is the Toyota Hybrid Hull, developed jointly with Yanmar Co. Ltd., a manufacturer of FRP boats and other products.

While aluminum hulls offer high rigidity, Toyota found those used in earlier versions of its sports cruiser could only be produced in limited quantities due to the advanced machining technology required for manufacturing. Therefore the company began to look into alternatives. Unlike in the automotive industry, Toyota found that integrating composites in marine applications could be pivotal in increasing production runs.

The manufacturer set performance targets for the hybrid hull based on the high-performance standards set by existing aluminum hulls. To meet such high targets, Toyota reviewed the FRP hull’s fundamental construction, a Toyota spokesperson reports. The end result is a sandwich structure that incorporates a combination of GFRP, aluminum and carbon fiber.

For Toyota, the ability to achieve large-scale production was a key reason to adopt composites, but because of the blend of materials it turned to an untried process. The company applied vacuum infusion molding, using the method for the first time in Japan for the mass production of the boat. The process enabled high-strength molding with improved material density. It was selected, according to Toyota’s spokesperson, for its ability to integrally bind the various components that make up the multi-layer hull.

During design, vessels using only aluminum had technical limitations. However, the hybrid hull opened up a great deal of freedom in terms of design, Toyota found. The mixture of materials was pivotal in gaining the desired combination of strength, comfort and maneuverability.

The design was unable to achieve enough rigidity of the hybrid hull simply through enhancing the rigidity of the FRP through the vacuum infusion process, according to the Toyota
spokesperson. By adding aluminum at the top of the stringer, rigidity was improved. Carbon fiber is used on the ship’s bottom, where waves would create the most shock, to improve riding comfort. Moreover, the vacuum infusion process allowed the manufacturer to mold more complicated curved shapes, which also improved maneuverability for the boat.

The end result was a hull that reportedly achieves seven times the rigidity of a standard FRP hull, while weighing roughly 10 percent less than a similarly-sized craft with an aluminum hull.

Exploring New Blends

Composites have played a role in each of these industries for many years. Long enough, certainly, to demonstrate that composites on their own can provide a good solution. However, they can often provide even greater levels of strength, durability and rigidity when combined with other materials. Moreover, fabricators may find that pairing composite solutions with traditional materials could improve the odds of adoption.

As these examples indicate, it’s often the engineering processes – and misguided preconceptions – that limit the use of composites. But over time, manufacturing processes will catch up, and tomorrow’s engineers will have successful installations and applications to study. By making predictable metals a part of the mix, fabricators gain added opportunities to demonstrate the benefits that composites can offer.

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Recapping Success: ACMA’s 2017 Infrastructure Day

By MJ Carrabba

In mid-February, ACMA held its second annual Infrastructure Day fly-in event in Washington, D.C. Nearly 40 composites company owners and managers headed to Capitol Hill for the three-day event. Participants conducted approximately 90 meetings with policymakers who represent major composites plant locations or serve on key House and Senate panels that direct federal infrastructure policies. This year’s event featured twice as many participants and more than three times as many policy meetings than last year’s inaugural event.

While policy development is deeply complex, our message can be boiled down to something very simple. We can continue building critical public assets the same way we always have and expect the same pitfalls our crumbling system currently faces, or we can use modern technologies to build 21st century infrastructure that lasts longer, performs better, has a lower environmental footprint and costs significantly less over the course of its life. As always however, the devil is in the details. So, let’s unpack a few of the industry’s key messages.

In 2016, both parties committed to a significant investment in modernizing America’s broken infrastructure during election campaigns. While many such promises are often broken, we learned through our engagement with Congress during Infrastructure Day that both parties are focused on advancing significant infrastructure legislation and that President Trump is equally committed to seeing this completed. As part of this effort, ACMA members put forth some specific proposals that were warmly received.

ACMA has proposed the creation of a new program out of the Department of Transportation that focuses specifically on the rapid deployment of pre-fabricated short and medium span bridges. One of the great benefits of composite bridge components is their ability to be fully fabricated offsite and installed in a way that greatly limits the disruption of traffic and economic activity. Projects constructed with traditional materials that once took weeks or months to install can be completed with composites in a matter of hours. This keeps installation costs lower and gets people moving faster, while capitalizing on the superior performance and durability of composite materials. We recognize composites are not the only materials in town, but such an effort allows us to play to our strengths and compete on an even field.

There’s more to our infrastructure agenda than just bridges, however. In coastal areas, due to environmental constraints and severe weather, virtually all critical infrastructure is at risk. ACMA has proposed a broad coastal infrastructure resiliency program. Water treatment and delivery systems, dams and other maritime structures, utility poles, crossarms and bridges need to be built to stronger performance requirements. Composites allow asset owners to meet performance demands and build structures that can last a century rather than a decade.

ACMA was successful in including language in a House energy bill last year that directed electric utilities to incorporate high-performance...
poles and crossarms in their resiliency efforts, but unfortunately that legislation never made it to a final vote. The industry used their meetings to press on House and Senate energy policy leaders to ensure this directive is included in this year’s energy legislation.

ACMA may be the industry’s voice in Washington, representing about 3,000 composites manufacturers on a daily basis, but the message is strongest when it comes from you. “The ACMA Infrastructure Day is a tremendous opportunity for our company to speak directly to Congress on the legislation and policies that will shape our future infrastructure,” says Scott Holmes, director of business development for Highland Composites, who attended Infrastructure Day. “This is a rare opportunity to educate our government leaders on the benefits of composites and create awareness of how our industry can help create a longer lasting infrastructure using American-made products, which is good for the economy and the country. Our message was very well received.”

The congressional effort only accounted for the first day-and-a-half of the three-day event. The National Institute for Standards and Technology (NIST) also hosted a workshop to help the industry better understand the measurement and testing needs that will enable widespread use of composite materials in sustainable infrastructure and construction applications.

During the NIST workshop, the composites industry heard some very candid impressions of our industry from end users, architects and engineers. One of the key findings is that although composites manufacturers have many established guidelines and specifications, they are not always visible to the end users and engineers who specify materials. In fact, a consensus emerged that the composites industry needs a “clearinghouse” for composites guidelines and standards. Also, a few of these guidelines and standards that are commonly used require some additional work to complete formal adoption by the relevant governing body.

A formal roadmap, based on the results of the workshop, will be published by NIST within the coming months to inform the work of federal agencies and other stakeholders in the development and adoption of standards and guidelines. After publication, our work is just beginning to accelerate the development of standards and guidelines. With guidance from our end users and specifiers, we can target the highest leverage opportunities to focus on the standards and education that our customers need to incorporate more composites in their designs.

There is no question that ACMA’s Infrastructure Day and the accompanying NIST Workshop were great successes, but they cannot be seen in a vacuum. Now begins the hard work of turning ideas into law and key insights into actionable standards. We can break down the door and capture the infrastructure market, but we can’t do it without you. Get involved and help us advocate for a better future. After all, this is your industry’s – and more importantly your nation’s – prosperity and strength at stake. Are you all in?

MJ Carrabba is ACMA’s Director of Government Affairs. He can be reached at mcarrabba@acment.org.

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Executive Forum Recap

About 70 leading executives from the composites industry attended ACMA’s Composites Executive Forum in Washington, D.C., in January to gain insight into the new political landscape, emerging markets, innovations and applications that are setting the stage for growth of the composite industry.

Day 1 keynote speaker Dr. Robert Fry outlined trends in changing oil prices, the impact of President Trump’s policy proposals and future economic growth in manufacturing. Day 2 keynote speaker Herb Meyer touched on the rise of the global middle class and the world’s changing demographics and how they will impact businesses.

“I think the speakers were excellent,” said Mark Sickels, vice president of Superior Oil Company Inc. “There’s out-of-the-box type information that’s useful in planning our business in the future. Some of the macro and demographic trends from an economic standpoint were very informative and interesting.”

The forum also featured industry experts who provided insight into composites recycling and workforce development.

“Recycling is absolutely critical to achieve the goals that we want to see for our industry,” said John Gaither, president and CEO of Reichhold. “I think ACMA’s approach in working together with IACMI is really solid. It was really great to hear some experts on the topic.”

This event will be held again, and a planning committee is being formed to help develop the program. If you are interested in participating, contact Heather Rhoderick at hrhoderick@acmanet.org for more information. For more stories on CEF, visit CM online and search “Composites Executive Forum.”

ACMA Annual Report

ACMA has published its Annual Report for the 2015-16 fiscal year. ACMA has helped position composites as the material of preference relative to competing materials and has achieved some strong results. Below are some highlights from ACMA’s market development, legislative and regulatory affairs, and educational activities:

- Provisions that will ultimately open up the infrastructure market to members of the composites industry were included in the Fixing America’s Surface Transportation (FAST) Act and the Water Resources Development Act (WRDA).
- FRP composite poles and crossarms are on track to be listed in the final list of goods in the Environmental Goods Agreement, which will help our members remain competitive globally by creating an equal playing field for tariffs on composite products.
- Guidelines and Recommended Practices for Fiber Reinforced Polymer (FRP) Architectural Products to help architects better understand how, when, where and why to use composites was created and distributed to over 500 architects in the first few months of its release.
- ACMA continued to provide quality events and education to the industry through its annual CAMX event and Certified Composites Technician (CCT) program. CAMX saw a 5 percent rise in attendance, attracting nearly 7,500 industry professionals from all over the world. In CCT, ACMA sold 338 enrollments and granted 130 certifications and 58 recertifications.
- ACMA’s publications and digital platforms educated and informed the composites industry about updates in key market segments and trends by reaching thousands of readers.
year, both Composites Manufacturing magazine and CompositesLab received excellence awards.

Upcoming Pultrusion Conference
From April 4-5, 2017, ACMA, in partnership with the European Pultrusion Technology Association, will host the first ever North American Pultrusion Conference in Atlanta at the Atlanta Marriott Marquis. The conference will feature presentations from international industry leaders with forecasts on trends, new pultrusion applications and technologies, and new information about standards and quality. To register, visit acmanet.org/pultrusion. Thank you to our sponsors: Polynt Composites, Interplastic Corporation, Romeo Engineering Incorporated, Composites One, Owens Corning, Royce International, American Colors Inc., Chromaflo Technologies, PART Consulting and Kent Automation.

ACMA is Moving!
Starting April 3, ACMA’s new address will be:

ACMA Headquarters
2000 N. 15th St.
Ste. 250
Arlington, VA 22201

All phone numbers and emails will remain the same. Please update your records accordingly.
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Check out our programs at http://www.acmanet.org/opportunities/affinity-programs

CAMX Changes for 2017

CAMX is your best source for new solutions, technologies and ideas for your current and future projects. This year, we’re introducing new exhibit hall features, including an area designed to inspire innovation and networking, and a theater showcasing content and presentations on cutting-edge applications, materials, technology and industry best practices. For updates on CAMX – or to purchase exhibit space - visit www.thecamx.org.

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Upcoming Events

March 26-30, 2017
ACMA Exhibits at NACE CORROSION
New Orleans, La.

April 4-5, 2017
North American Pultrusion Conference
Atlanta, Ga.

April 27-29, 2017
ACMA Exhibits at AIA
Orlando, Fla.

September 11-14, 2017
CAMX 2017
Orlando, Fla.

New Members

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For more information on becoming a member of ACMA, email membership@acmanet.org or call 703-525-0511.

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When people think of electric vehicles, they probably envision a sleek vehicle, like a car from Tesla or perhaps the groundbreaking BMW i3, not something heavy duty. However, thanks to upstart green vehicle company Proterra that may change. In 2015, Proterra’s Catalyst XR electric bus drove 258 miles on a single charge under test conditions at Michelin’s Laurens Proving Grounds.

The company says the 40-foot-long Catalyst XR has already achieved the highest efficiency rating ever for a transit bus of its size, which is equivalent to a gas vehicle averaging 22 mpg. According to Joshua Stewart, senior manager of mechanical engineering at Proterra, the bus’ lifespan can be either 12 years or 500,000 miles, whichever comes first.

The Catalyst XR – Proterra’s second-generation bus – features composites, thereby cutting 2,000 pounds from the first-generation bus. Proterra selected Vectorply as the primary material supplier. GFRP is utilized in many areas of the main body of the Catalyst XR, with CFRP selectively employed in areas where the bus needs a high strength-to-weight ratio, such as the A-pillars, areas surrounding the window cutouts and some of the lower body structures.

The composite parts were made with vacuum assisted resin transfer molding (VARTM). Each structure is built with an upper and lower mold, which are fabricated and then bonded together. “Essentially the bonded upper and lower results in a monocoque intent, with the body shelf being the load bearing member of the vehicle in its entirety,” says Stewart.

He says the company’s goal is to show how composite technology can outperform what is currently on the market while still remaining cost effective. According to a 2015 press release, Proterra estimates Catalyst XR customers will save $135,000 in maintenance costs over the bus’ lifetime.

“It isn’t at a cost disadvantage, and that’s what we’re showing with real-world metrics as these buses gain miles every day,” says Stewart.
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