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COMPOSITES TECHNOLOGY

AUGUST 2014 | VOL. 20 | NO. 4

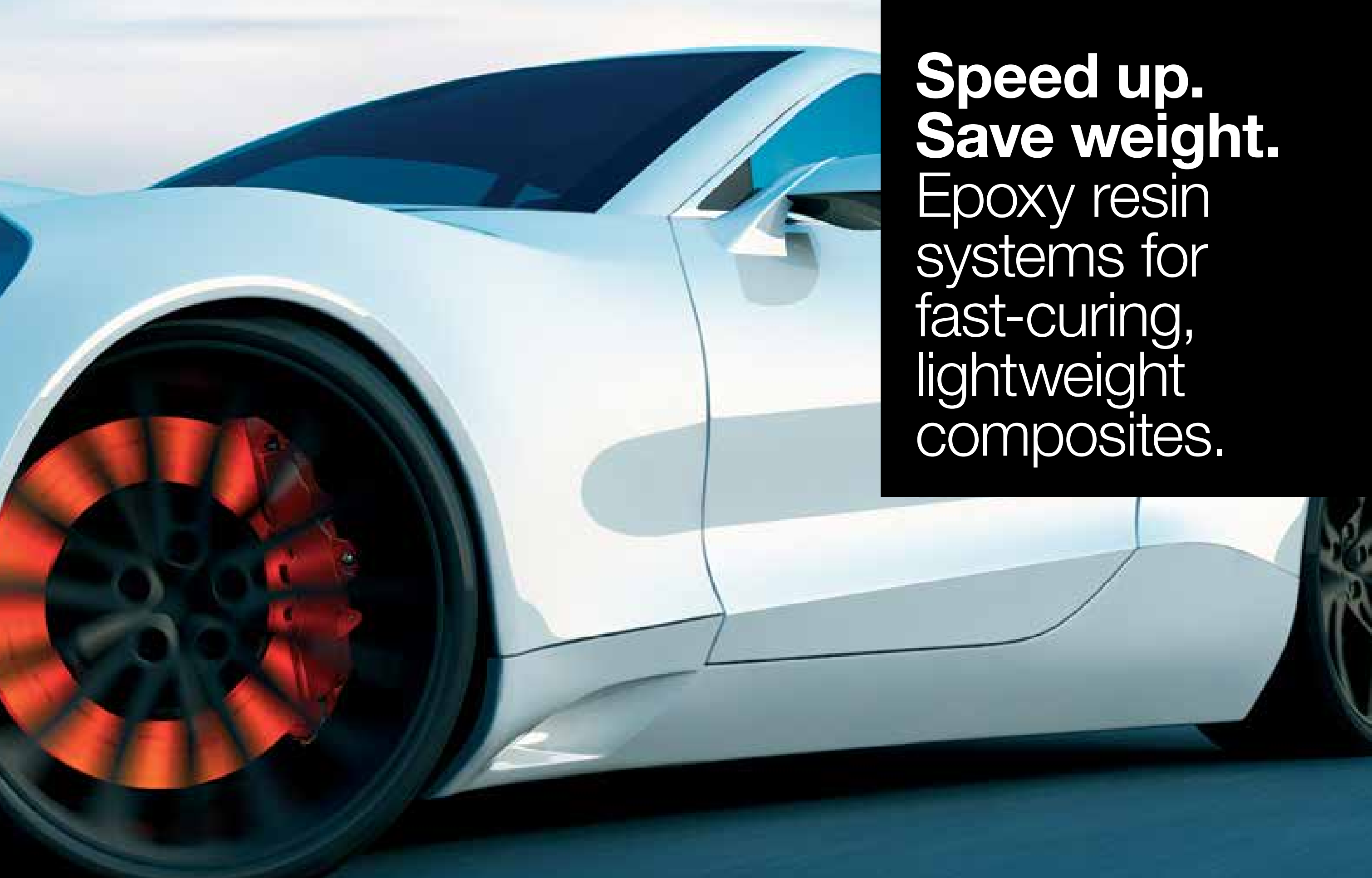
COMPOSITES BRANCH OUT

ARTIFICIAL TREES

FRP Framing for Disaster-Resistant Housing

Re-imagining Auto Seating in Composites

FRP Sandwich and CMC Panels in RVs



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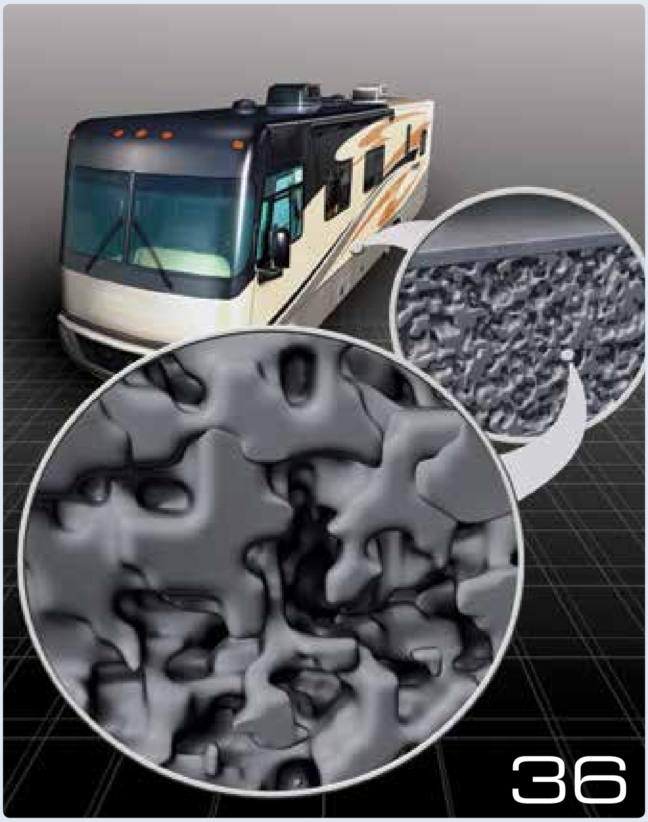

COMPOSITES TECHNOLOGY

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COMPOSITES WATCH

COLUMNS

FEATURES

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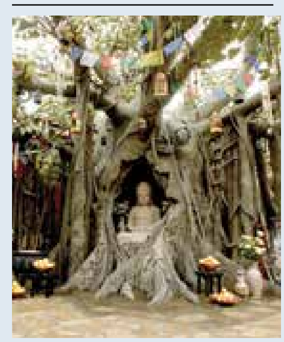
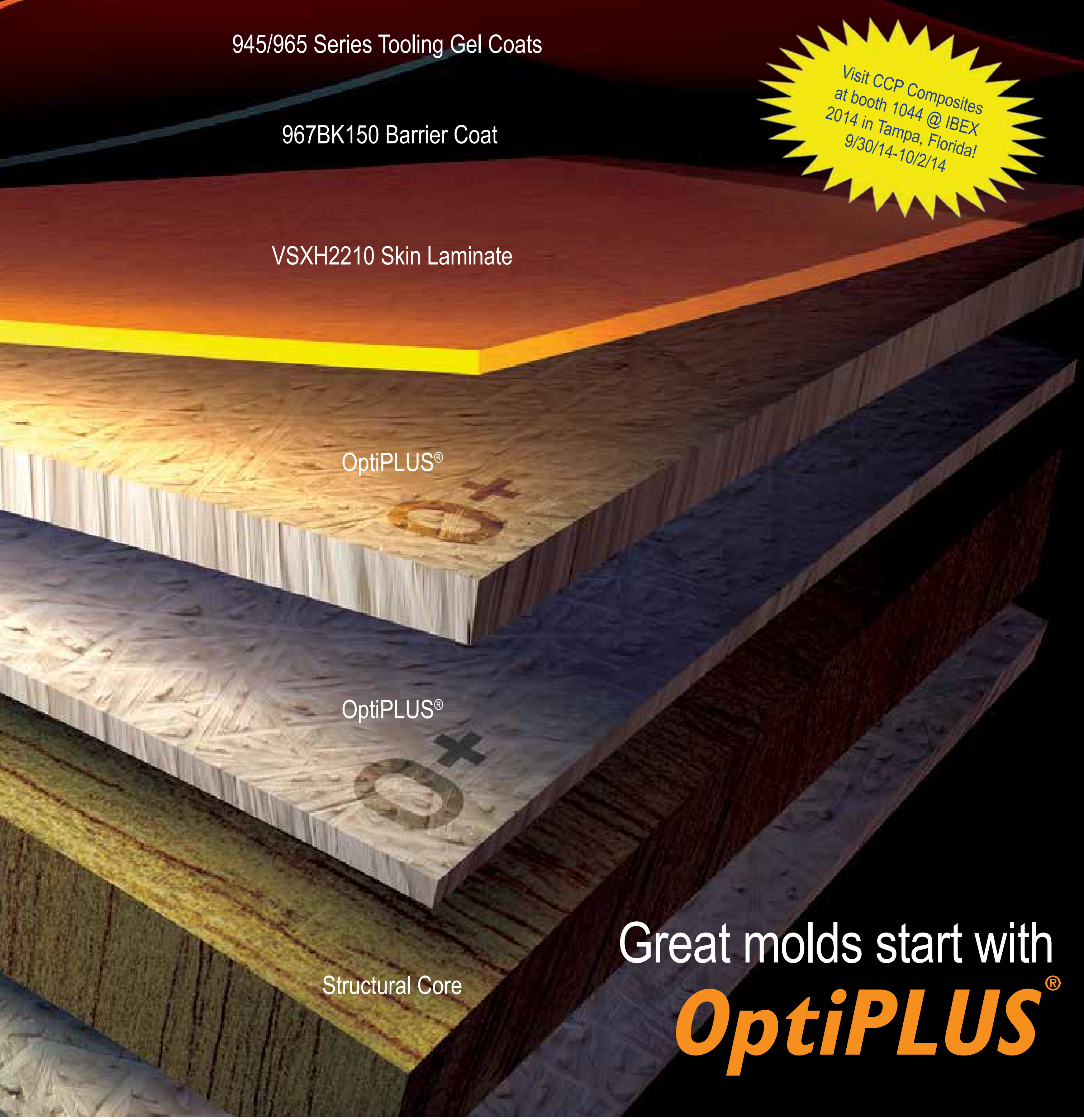
COVER PHOTO



Part of a "Walking with Buddha" cultural display on the north coast of Lantau Island (Hong Kong) near a collection of notable Buddhist monasteries, this artificial tree features realistic-looking branches molded and finished by aerospace composites manufacturer Matrix Composites (Rockledge, Fla.). For more about this change-of-pace application, see *CT's* story on p. 30.
Source | Matrix Composites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The Odd Couple

If you're reading this, it's very likely that you are a subscriber to *CT*. And if you are, it's also likely that you are involved in some way in the design and manufacture of composite structures that are typically reinforced with glass fiber, natural fiber or discontinuous carbon fiber, destined for end-use in automotive, marine, wind, construction, infrastructure and other markets.

What some of you may not know is that we also have a sister publication, *High-Performance Composites* (*HPC*) magazine, which, from its inception, has targeted composites professionals who serve aerospace, space, high-end automotive and similar markets where extreme strength- and stiffness-to-weight requirements typically make continuous carbon fiber the reinforcement of choice.

For many years these two "sides" of the industry that *CT* and *HPC* serve — "general purpose" and "high-performance," for lack of better terms — seemed like the Odd Couple — two people living under one roof, each with apparently different habits. Despite the common interest — manufacture of fiber-reinforced polymers — there seemed to exist little that could bring these two closer together.

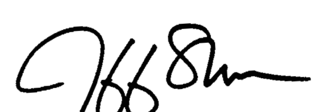
And then, a few years ago, funny things started to happen. First, the aerospace composites side, which had for so long relied on the autoclave to cure composite structures, started looking for autoclave-free options, which led it to the so-called general-purpose world and its developing resin infusion, resin transfer molding (RTM) and compression molding processes — and even to reinforced thermoplastics. Meanwhile, those general-purpose composites shops, seeking to reduce weight even further in wind blades, marine components and automotive structures, started using continuous carbon fiber. Today, it's much more difficult — and in many ways, unfair — to define sides anymore.

> It seems inevitable that as the composites industry evolves, people will seek out best practices *wherever* they can be found.

None of this should be surprising. You may not always sense it, but the composites industry is unusually, demonstrably and increasingly dynamic, creative and fast-changing, so it seems inevitable to me that as it evolves, we would see people like you seeking out best practices *wherever* they can be found.

A sign of this evolution — not to mention a good place to find those best practices — is the new Composites and Advanced Materials Expo (CAMX) trade show and conference, which will be launched this October in Orlando, Fla., hosted by the American Composites Manufacturers Assn. (ACMA) and the Society for the Advancement of Material and Process Engineering (SAMPE) — previously bastions in North America of the two "sides," if you're looking for context.

CAMX already is shaping up to deliver on its promise of presenting the industry as a whole and will, I hope, go a long way toward unifying the North American composites industry once and for all. In any case, we'll be there in force, keeping tabs on the continuing evolution, and hope to see you there.



Jeff Sloan

The reality of carbon fiber for the auto industry today

Bio | Greg Rucks

Greg Rucks is a manager in the transportation practice at Rocky Mountain Institute (RMI, Snowmass, Colo.). Currently leading RMI and Munro & Associates' Autocomposites project, he coauthored, in 2011, the transportation chapter of *Reinventing Fire*, RMI's roadmap for cost-effectively transitioning the U.S. completely off oil, coal, and nuclear energy by 2050. He has participated in cost- and energy-saving collaborations with automotive, industrial and building-sector clients and worked with communities to develop and implement integrated emissions-reduction solutions led by for-profit businesses.

Carbon fiber composites are too expensive for high-volume automotive production. The manufacturing processes can't yet meet stringent automotive requirements for repeatability and production speed. The myriad combinations of fiber grades, forms, tow sizes and resin types creates an overwhelming number of options that are, to date, inadequately understood and characterized.

I've heard these arguments too many times to count. Although there is some truth to each, I contend that with careful planning and application selection, the auto industry is ready for cost-effective, high-volume production … *right now*, at 100,000 units per year. I'll take each objection by turns, and explain why.

Manufacturing process maturity. At the U.S. Department of Energy's (DoE) Fiber-Reinforced Polymer Composite Manufacturing Workshop (Jan. 13, 2014, in Arlington, Va.), participants from the transportation, energy and industrial sectors identified five composites manufacturing processes that are at the highest possible technology readiness level (TRL) short of commercialization. Several manufacturers are approaching one-minute cycle times, using both thermosets (e.g., fast-cure resins and very-high-pressure resin infusion) and thermoplastics (e.g., long-fiber thermoplastic injection molding, overmolding, thermoforming or compression molding). At 100,000 units per year, generally considered the high-volume threshold, a *five*-minute cycle time will suffice, and many processes can already hit that target.

Bottom Line: Process immaturity is *not* a show-stopping barrier.

Material complexity. Composites introduce a wider array of material options than do metals — their dual-material nature alone doubles the options. One must also select and combine compatible fiber forms, grades, surface treatments and tow sizes. In the auto industry, only fast-forming resins and processes will cut it, so automakers face fewer options. Having some options can be a good problem to have, so long as those options are clearly understood from a materials science standpoint. Further, material suppliers that are advancing automotive-capable material systems have made a greater effort than in the past to understand how parts will be manufactured. You won't find material suppliers anywhere else, today, with such an intimate knowledge of material interactions and downstream part manufacturing.

Bottom Line: Composite material complexities pose some challenges for OEMs, but growing composites expertise among universities, government, and increasingly able suppliers can assist automakers in the selection of the best material options.

Material cost (vs. value). Often the automaker's first objection, material cost drives part cost more than any other manufacturing consideration. But finding the *right* material option and understanding the way it and the processes fit together is a key to identifying cost-effective solutions in the near term. By most accounts, equipment, tooling and nonmaterial variable manufacturing costs are *lower* with composites than with steel. No, they're not yet low enough to offset fiber cost, but our national labs and several carbon fiber manufacturers are hard at work trying to perfect lower-cost precursors.

That said, material cost is too often cited without regard to the *value* the material can bring to the end product. If customers are willing to pay for the value derived from carbon composites, or these materials enable cost reductions in enough other places in the auto production process, that can *offset* the upfront material cost premium and provide a feasible business case.

Car owners will pay for improved safety, for example, and composites offer some unique capabilities here. The challenge is *quantifying* the safety benefit via test methods and predictive computer-aided engineering tools. For the automaker, value includes part consolidation: reducing a subassembly from 50 to 20 parts has a big impact on assembly time and overhead and, therefore, part cost.

Bottom Line: Material cost is a real barrier, but it can be mitigated by value derived from a good application, design, material and process mix.

Supply chain fragmentation. Navigating material options is difficult because each company in a supply chain is typically focused on a highly specialized set of options and capabilities. To stay afloat in this volatile industry, automotive composites companies often had to pick a handful of material technologies (in the case of material suppliers) or manufacturing technologies (in the case of Tier 1s, equipment providers and toolmakers) and perfect them.

To ensure a company's viability in an uncertain marketplace, that choice is motivated, in part, by the need to ensure that their specialties also apply in aerospace, marine, wind energy and other sectors. That's why we don't find much vertical integration in the carbon composites supply chain, and when we do, it likely isn't optimized for auto applications. Few resin producers offer both thermosets and thermoplastics, for example, and tooling providers rarely have expertise in multiple manufacturing processes. As a result, carefully crafted, competitive supply chain partnerships are critical to kicking off successful automotive applications at scale.

But that gets to the heart of the real challenge: Supply chain candidates are typically specialists, not generalists, so some won't fit with others, and when partnerships *are* forged, they can limit ►

the technologies that are available for future (and unforeseeable) applications.

Yes, BMW has assembled a vertically integrated supply chain for its *i*-Series vehicles, but the composition of that supply chain is a case in point. Its capabilities are currently limited to a fairly specialized set of fiber forms and thermoset resin chemistry, and the high-pressure resin transfer molding process. Further, these choices had to be made years ago, during supply chain assembly. Debate continues: Were they the right choices? But one thing is certain. To take full advantage of carbon composites' unique properties, BMW will (likely soon) need to diversify its process capabilities and expand its material options. That could require forays into new territory for existing suppliers or a whole new set of supply-chain partnerships.

Bottom Line: Assembling a compatible and capable supply chain is critical to commercialization at volume, but automakers must avoid inflexible arrangements that hinder future adaptability.

TRANSFORMED VEHICLES AND THE CARBON FIBER END GAME

So what will building carbon composite manufacturing capabilities mean for future vehicles? That requires a nuanced response, especially when it comes to electric vehicles. Carbon composites maximize vehicle lightweighting potential (and, therefore, operational energy efficiency), but the emissions benefit of mass reduction is largely negated by the energy-intensity of carbon fiber manufacture. More energy-efficient fiber production would mitigate this. Powering the processes with renewable energy would help, as BMW has done via hydroelectric power at its Moses Lake, Wash., fiber facility. So would the use of alternative precursors (e.g., polyolefin). Further, recycling carbon fiber would reduce its lifecycle emissions and slash fiber cost.

In the longer term, the role automobiles will play in an increasingly urban world must be considered. If transportation systems shift, for example, to shared, service-based models in which drivers pay only for miles traveled rather than purchasing or leasing vehicles that sit idle most of the time, then actual vehicle use could be increased dramatically. Further, increasingly reliable electrified powertrains and distinctively durable carbon fiber composite construction could substantially prolong a vehicle's useful life. Increased utilization and extended life would mean a faster and bigger payback of the upfront investment in lightweight composite materials — and that would be true in terms of overall cost *and* emissions reductions.

Although many questions remain about the ultimate "end game" of automotive carbon fiber composites, their unparalleled potential for lightweight construction, durability, safety and simplified part production/assembly leave little question about their significant future role in vehicles.

The ultimate bottom line: There *are* winning pathways for carbon composites in high-volume auto production. Auto OEMs and their supply chains don't necessarily need to know which future scenario will ultimately play out. The key is to get started now. | CT |

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DATE AND TIME:

August 13, 2014
2:00 PM EDT

PRESENTER

Steve Cunningham
Global Assembly Segment Manager - Aerospace

Composite Surfacing and Lightning Strike Protection

EVENT DESCRIPTION:

Surfacing films are designed to improve the surface quality of honeycomb-stiffened composite parts. They also provide a barrier for dissimilar materials, decrease surface preparation time and provide protection of structural fibers. But this is not all: Laminated films composed of a surfacing film and a conductive metal foil protect the composite structure from damage caused by lightning strikes.

PARTICIPANTS WILL LEARN:

- Surfacing films for aircraft
- Lightning strike protection
- Out-of-autoclave solutions
- High thermal fatigue resistance
- Process labor reduction

PRESENTER'S BIO:

Steven Cunningham has more than 35 years experience in the aerospace materials business. He has worked in a variety of roles including research and development, technical support, engineering, operations, quality and marketing. His experience includes the development and use of epoxy adhesives for a wide range of aerospace applications including aircraft structures and interiors. His materials experience is centered around epoxy structural adhesives as well as lightning strike protection for composite structures. He received his BS degree in Business and MBA in Operations Management from Golden Gate University.

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Reshoring, right shoring and innovation: Implications for composites

Bio | Dale Brosius

Dale Brosius is the head of his own consulting company and the president of Dayton, Ohio-based Quickstep Composites, the U.S. subsidiary of Australia-based Quickstep Technologies (Bankstown Airport, New South Wales), which develops out-of-autoclave curing processes for advanced composites. His career includes a number of positions at Dow Chemical, Fiberite and Cytec, and for three years he served as the general chair of SPE's annual Automotive Composites Conference and Exhibition (ACCE). Brosius has a BS in chemical engineering from Texas A&M University and an MBA. Since 2000, he has been a contributing writer for *Composites Technology* and sister magazine *High-Performance Composites.*

In May, the U.S. Bureau of Labor Statistics reported that the U.S. economy had recovered all the jobs lost during the global financial crisis and the "Great Recession" that followed, matching the peak employment of January 2008. Although this was encouraging news, there are certainly structural elements that have kept wages stagnant and growth rates restrained, so more progress needs to be made. Economies in Europe are still recovering, and the shifting global landscape continues to impact decisions about where things are made and the technologies used to make them. Throw in the increasing emphasis on reducing carbon emissions and the future gets even more complicated. All of these factors have implications for composites. Some thoughts:

The offshoring trend may now be in reverse. In the late 1990s and through most of the 2000s, large global companies rushed into China and other countries with low labor costs, seeking to produce existing product designs for less, and thereby maintain or grow margins. Called "offshoring," this transfer of production from Europe and North America to Asia led to large drops in manufacturing employment and the closure of many tool-and-die shops and numerous small molders, particularly injection molders. Today, wages are increasing at the rate of 15 percent per year in China, and we see rising logistical costs and more competitive prices for natural gas and plastics in the U.S. and in Europe. The savings previously gained through offshoring has eroded considerably. Molders I have talked to clearly note that they feel less competitive pressure from Asian suppliers. Anecdotal evidence indicates that a number of companies are "*re*shoring," that is, bringing work back to the U.S. and Europe.

> The savings previously gained though offshoring has eroded considerably. Molders ... feel less competitive pressure from Asian suppliers.

Manufacturing for local markets makes sense again. Although exports always have been a basis for a country's competitive advantage in the world, the rise in living standards in formerly low-wage countries has created local demand for products ranging from mobile phones and other electronics to durable goods, such as appliances and automobiles. China's wage hikes have created buying power: China produced more than 22 million motor vehicles in 2013, virtually *all* of them for domestic consumption. According to statistics published by the Organisation Internationale des Constructeurs d'Automobiles (OICA, Paris, France), that number is almost twice as much as U.S. production and *ten times* the number China produced in 2000. As reinforced plastics grow in importance for automobile fabrication, this represents great opportunities for composites. And data provided by the Global Wind Energy Council (GWEC, Brussels, Belgium) indicates that Asia, led by China, is far and away the world's largest market for new wind turbine installations, generating significant sales of composite materials. Further, increased automation in manufacturing has reduced the impact of labor in countries where wages are high, and the desire to customize products for local markets is driving companies to invest in factory capacity close to the markets they serve, all over the globe. I have seen the term "right shoring" appropriately used to define this trend.

Innovation is driving growth in composites and doing so on a global basis. The pressure to reduce greenhouse gas emissions is rising in Europe, Japan and the U.S., pushing OEMs to find ways to reduce energy consumption in the manufacturing and use of products. This has pushed development of lighter, more fuel-efficient automobiles and aircraft, creating opportunities for composites. The latest aircraft from Boeing, Airbus and Bombardier are much more fuel-efficient than their predecessors and incorporate significant percentages of advanced composites. Increased use of hybrids and all-electric powertrains in ground vehicles is creating a demand for aluminum and composite structures to offset the weight of battery packs and, thus, improve driving range. Composites manufacturing processes are rapidly advancing to meet the higher rates required for true mass production. Although Germany currently leads in this area, significant investments in R&D are planned elsewhere in the world (including China) to make high-volume composites production a global reality. Development of larger wind turbines and more efficient solar panels will rely on composite materials reinforced with carbon fiber and on nanocomposites to push the proportion of energy generated by renewables to much higher levels than exist today.

All of these trends promise greater use of composite materials. The biggest challenges may be educating a sufficient number of engineers, designers and manufacturing workers who will make these opportunities into realities, and then ensuring that they have access to an adequate supply of materials in high-demand markets. I believe we will rise to meet this challenge, just as we are doing to improve material performance and raise manufacturing rates, ushering in sustainable growth for the next several decades. | CT |

Composites Business Index 54.5: Growth remains strong

Bio | Steve Kline

Steve Kline is the director of market intelligence for Gardner Business Media Inc. (Cincinnati, Ohio), the parent company and publisher of *Composites Technology* magazine. He started as a writing editor for another of the company's magazines before moving into his current role. Kline holds a BS in civil engineering from Vanderbilt University and an MBA from the University of Cincinnati.

The U.S. Composites Business Index for May, 56.8, saw every subindex contribute to a faster growth rate. New orders jumped dramatically, reaching their third highest level since the CBI began in December 2011. Production continued to expand significantly. Backlogs expanded at their fastest rate since March 2012 — 18.5 percent higher than one year earlier. The accelerating annual rate of change in backlogs indicated higher capacity utilization and capital spending for the remainder of 2014. Employment expanded at its second fastest rate since the Index began. Exports contracted for the second straight month. Supplier deliveries continued to lengthen at a slightly faster rate.

THE COMPOSITES BUSINESS INDEX						
Subindices	**June**	**May**	**Change**	**Direction**	**Rate**	**Trend**
New Orders	58.8	63.4	-4.6	Growing	Slower	7
Production	59.6	61.5	-1.9	Growing	Slower	6
Backlogs	47.5	53.1	-5.6	Contracting	From Growing	1
Employment	57.7	60.1	-2.4	Growing	Slower	16
Exports	51.1	49.6	1.5	Growing	From Contracting	1
Supplier Deliveries	52.5	53.9	-1.4	Lengthening	Less	31
Material Prices	67.4	68.5	-1.1	Increasing	Less	31
Prices Received	51.8	53.5	-1.7	Increasing	Less	3
Future Business Expectations	75.2	76.2	-1.0	Improving	Less	31
Composites Business Index	54.5	56.9	-2.4	Growing	Slower	7

Material prices increased at their fastest rate since February 2013. Prices received increased as they had done in five of the previous six months. Future business expectations improved and remained at a historically high level.

Most fabricators saw improved business conditions. Most dramatically, shops with 19 or fewer employees, after contracting for two months, saw their index soar to 58.6 — their fastest growth since the Index began. After contracting in April, midsize facilities (50 to 99 employees) expanded slightly in May. Facilities with more than 250 employees grew at their second fastest rate since July 2012.

Regionally, the West grew at the fastest rate of any region since the Index began. It was followed by the Northeast, which has grown for six straight months. The North Central – East region had grown at a consistently strong rate for three months. The Southeast and North Central – West continued to expand.

In May, future capital spending plans had been above $1 million six of the past seven months. Compared to one year ago, spending plans were up 14.9 percent, while the annual rate of change had grown at a relatively constant rate the previous four months.

June's CBI of 54.5 showed growth for the seventh straight month. Although the rate decelerated compared to May, June still saw the third fastest growth since May 2012. Compared to one year earlier, the CBI was up 12.1 percent. May was the ninth consecutive month the Index had increased compared to one year earlier, and the second month in a row of more than 10 percent month-over-month growth. The annual rate of change had grown at an accelerating rate for five months in a row.

In June, every subindex but exports contributed to the slower growth rate. For the seventh month in a row, new orders expanded, continuing a trend begun in August 2013. Production showed strong growth for the sixth straight month. Backlogs contracted for the second time in three months but were still 7.7 percent higher than they were a year earlier. The annual rate of change in backlogs continued to accelerate, indicating higher capacity utilization and capital spending through 2014. Employment continued its 2014 expansion at a rapidly accelerating rate. Exports increased for the second time in 2014. Supplier deliveries continued to lengthen at a steady rate.

Material prices increased at a slightly slower rate in June, but the rate was still among the fastest since February 2013. Prices received increased for the third straight month. Future business expectations dipped from the peak level attained in February.

All fabricator groups expanded or the first time since February. The growth rate remained strong at facilities with more than 250 employees (>60.0 for three of the previous four months). There was significant improvement at plants with 50 to 249 employees, but growth slowed dramatically for those with fewer than 50 employees.

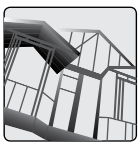
Regionally, the West grew fastest (>65.0) for a second straight month. The North Central – East followed, above 56.0 for four straight months. The Northeast also posted growth, but the Southeast and North Central – West contracted after expanding in May.

Future capital spending plans reached their second highest level since July 2013. Compared to a year earlier, June's spending plans were up 30 percent. The annual rate of change returned to double-digit growth for the first time since January. | CT |

Composites | WATCH

Potential breakthroughs for composites in residential construction and high-rise architectural cladding.

CONSTRUCTION



Composite FOUNDATION WALL SYSTEM unveiled at AIA convention

Poured-concrete foundation walls have been the industry standard for residential homes in the U.S. for more than 100 years. But that could change with the introduction of patented Epitome composite foundation walls from Composite Panel Systems (CPS, Eagle River, Wis.). The wall system is fabricated by Fiber-Tech Industries Inc. (Cadillac, Mich.), using fire-retardant Modar resin supplied by Ashland Performance Materials (Dublin, Ohio). CPS launched the composite foundation solution during the American Institute of Architects (AIA, Washington, D.C.) Convention and Expo in Chicago, Ill. (June 26-28), where the composites industry had a significant presence in the Expo's Composites Pavilion.

Source | Epitome/CPS

The foundation wall concept consists of a foam-cored fiberglass composite panel (7 inch/178 mm thick, 24 ft/7.4m long and 9 ft/2.8m tall) with integral cavities for structural studs and mechanical installation. Shaped connection flanges on each panel enable attachment of adjacent panels. Currently approved for use in Wisconsin, the wall system is on track for compliance on the national level with the International Code Council's (ICC) *International Building Code* (*IBC*) and *International Residential Code* (*IRC*) by October of this year, says the company. Installation is reportedly fast, simple and requires minimal training for anyone already skilled in the building trades. The lightweight panels for a complete basement can be delivered in one trip, and typical installations take *less than two hours*. Walls include integral top plates and vapor barriers that decrease moisture and mold issues common with conventional foundations, reportedly offering occupants a warmer, drier, more energy-efficient and ready-to-finish basement. Plus, the 9-ft walls are taller than typical foundation walls, permitting higher finished ceilings.

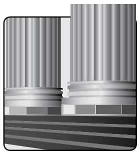
"Because there are so many benefits associated with our foundation walls for builders and homeowners alike, we believe this is the most exciting thing the residential building industry has seen since the introduction of plywood," says Glenn Schiffmann, founder and president of CPS. "Composites offer incredible performance, and having gained the trust of engineers in aviation many years ago, we knew we could develop a better-performing system for basements as an alternative to concrete."

Epitome's inherent R-16.5 insulation value and an airtight transition between the home's ground floor and foundation combine to offer energy efficiency far greater than concrete foundations. The panels also pass the NFPA 286 room corner burn test and, therefore, do not require thermal barriers, such as gypsum drywall, prior to occupancy. This allows homeowners the opportunity to finish their lower level at their leisure and save money upfront.

"The composite technology is designed to withstand six times a sand backfill load, and can be installed in any soil type suitable for backfilling," adds Andy Beer, global business leader, Ashland Performance Materials. "Each 24-ft section of foundation panel can withstand 600,000 lb of downward force resulting in a maximum allowable house load of 8,900 lb per linear ft after the safety factor is applied."

Editor's note: See CT's *related residential-construction article, "Disaster-resistant housing: Framing the future," in this issue, on p. 26.*

ARCHITECTURE



Code-compliant FRP cladding for HIGH-RISE BUILDINGS

Kreysler & Associates (American Canyon, Calif.) has introduced a new glass fiber composite cladding material, called Fireshield 285, that its designers say solves the riddle of fire code compliance on high-rise structures. The cladding panel system recently passed one of the construction industry's most stringent fire tests, NFPA 285, which involves testing a full-scale mockup of a multi-story façade system to gauge its flame-spread characteristics.

Kreysler & Associates believes its cladding is the first to pass muster under NFPA 285. Kreysler & Associates president William Kreysler says his company's patent-pending process involves a "proprietary blend of synthetic resins and natural aggregate that provides an attractive but extremely durable, environmentally efficient and highly fire-resistant product."

Source (both photos) | Kreysler & Assoc.

Fireshield reportedly turns designers loose to use the light weight and versatile plasticity of shape and texture afforded by composites reinforced with glass fiber or carbon fiber to create large façades of almost any shape, contour and texture, yet also meet all requirements under the *International Building Code* (*IBC*). Kreysler notes, "Shapes that have never existed outside of a computer model are now possible, both unique and repetitive designs."

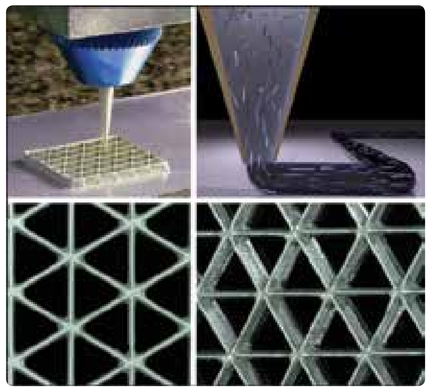
Panels can be merged to create large, seamless façades, such as the sculpted 10-story façade (see photos) on a new expansion at the San Francisco Museum of Modern Art (SFMOMA). Designed by Norway-based architectural firm Snohetta in collaboration with local urban design firm EHDD, the SFMOMA expansion's Fireshield cladding will present a rippling horizontal texture said to be reminiscent of California's San Francisco Bay just a few blocks away. Fabricated by Kreysler & Associates, the façade's 700 panels have a skin thickness of only 0.1875 inch/4.8 mm and weigh, on average, only 5 lb/ft² (24 kg/m²). Some of the project panels are as large as 5.5 ft by 30 ft (1.7m by 9m).

ENERGY

WIND BLADES: 3-D printed, fiber-reinforced epoxy honeycomb mimics balsa

Balsa wood as a core material offers a relatively inexpensive solution that yields high stiffness at minimal weight. But natural variations in the grain and, in outdoor applications, the risk of water uptake in the event of structural damage, can be an impediment to achieving the increasingly high performance requirements of sandwich structures, such as the outer skins of wind turbine blades.

As turbine makers demand ever-larger blades, those blades must meet increasingly demanding specifications, and operate in the field virtually maintenance-free for decades. Blademakers, therefore, are searching for new core material options.


Source | Harvard SEAS

Using fiber-reinforced epoxy resins and additive manufacturing technology (3-D extrusion printing), materials scientists at the Harvard School of Engineering and Applied Sciences (SEAS) and the Wyss Institute for Biologically Inspired Engineering (both in Cambridge, Mass.) have developed cellular composite materials that mimic balsa and exhibit unprecedented stiffness-to-weight ratios.

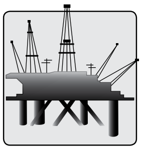
"Balsa wood has a cellular architecture that minimizes its weight since most of the space is empty and only the cell walls carry the load. It, therefore, has a high specific stiffness and strength," says principal investigator Jennifer A. Lewis, Hansjörg Wyss professor of biologically inspired engineering at Harvard SEAS. "We've borrowed this design concept and mimicked it in an engineered composite."

Until now, 3-D printing has been used mostly with unreinforced thermoplastics and UV-curable resins — materials that are not typically considered for structural applications. "By moving into new classes of materials, like epoxies, we open up new avenues for using 3-D printing to construct lightweight architectures," says Lewis. "Essentially, we are broadening the materials palette for 3-D printing."

Lewis and Brett G. Compton, a former postdoctoral fellow in her group, developed inks of epoxy resins, spiked with viscosity-enhancing nanoclay platelets and a compound called dimethyl methylphosphonate, and then added two types of reinforcement: tiny silicon carbide "whiskers" and discrete carbon fibers. Key to the versatility of the resulting fiber-filled inks is the ability to control the orientation of the fillers.

A video of the 3-D printing process is available at: http://www.youtube.com/watch?v=pnGPYwNM4rE&feature=youtu.be.

ENERGY



MFG's new composite water tank company to serve OIL & GAS sector

The Molded Fiber Glass Cos. (MFG, Ashtabula, Ohio) announced on June 18 that its newest spin-off company — MFG Tank — has launched a proprietary product aimed at the oil and gas exploration market in North America. Its trademarked TortisTank line of aboveground fiberglass storage tanks is designed specifically for saltwater containment in environments where human and environmental safety is at risk.

In 2012, MFG was made aware of leakage problems with current-generation tanks. The leaks were requiring costly repairs and additional post-leak cleanup problems in the oil exploration community. Safety risks — and losses — from electrostatic hazards also were cause for concern.

Source | MFG Tank

MFG Tank's TortisTank, the result of a two-year engineering effort to produce a saltwater (brine) tank, was specifically developed to address leak-related problems and reportedly raises the standard for safety, strength and productive lifespan. Improvements in the tank design, the resins, the glass reinforcement and the manufacturing process are said to have yielded a fiberglass tank that is expected to hold up in extremely harsh environments for 20 years or more without fractures or delamination — a significant improvement compared to conventional tanks.

MFG Tank uses the filament winding process to ensure maximum control of fiber placement and uniformity of the overall tank structure.

A proprietary resin formulation and Owens Corning's (Toledo, Ohio) corrosion-resistant Advantex E-CR glass are said to be the keys to the TortisTank's superior longevity. MFG says it meets or exceeds all pertinent oil and gas industry standards, including API Spec 12P. MFG Tank is headquartered and manufactures its products in Gainesville, Texas at a facility colocated with MFG Texas.

AUTOMOTIVE

Audi brings lightweight springs to production AUTOMOBILES

Automaker Audi AG (Ingolstadt, Germany) will introduce new, lightweight coil-type suspension springs made of glass fiber-reinforced polymer (GFRP) in an upper-end, mid-sized passenger car model before the end of the year. Developed in collaboration with Sogefi (Milan, Italy), the light-green spring "wire" is thicker than that in a steel spring, and it has a slightly larger overall diameter with fewer coils than a comparable steel unit. Most importantly, however, it is about 40 percent lighter. A steel spring for the new model weighs nearly 2.7 kg/6 lb, but a GFRP spring with the same properties weighs only about 1.6 kg/3.5 lb. Together, the car's four GFRP springs reduce curb weight by roughly 4.4 kg/9.7 lb, half of which pertains to the unsprung mass.

"The GFRP springs save weight at a crucial location in the chassis system," says Dr. Ulrich Hackenberg, a board member for Audi Management for Technical Development. "We are therefore making driving more precise and enhancing vibrational comfort."

For each spring's core, long glass fibers are twisted together and impregnated with epoxy resin. Then additional fibers are machine-wrapped around the core — which is only a few millimeters in diameter — at alternating ±45° to the longitudinal axis. These tension and compression plies mutually support one another to optimally absorb the stresses. The blank is oven-cured at >100°C/212°F.

Reportedly, the springs can be tuned precisely for each car model. Further, corrosion, even after stone chipping, isn't an issue, and the GFRP is also impervious to commonly used chemicals, such as wheel cleaners. Last, but not least, spring production requires far less energy than that required to make steel springs.

BIZ BRIEFS

Early in June, distributor **Composites One** (Arlington Heights, Ill.) signed a purchase agreement under which it has acquired essential composites distribution assets from **Nexeo Solutions LLC**, which had previously purchased **Ashland Distribution** from Ashland Inc. (Covington, Ky.) in 2011. Nexeo Solutions' dedicated distribution employees will join Composites One. The transaction is expected to enable Composites One to offer its product line, product delivery, technical support and other services to more customers in the U.S. and, from now on, across all of Canada.

Wisconsin Oven Corp. (East Troy, Wis.) celebrated the completion of its new 30,000-ft²/2,787m² expansion, which began operations on June 16. Wisconsin Oven says the facility was a necessary addition for the company after record shipments and record growth in 2013. The expansion is 120 ft wide by 240 ft long by 50 ft high (36.6m by 73.2m by 15.2m), making it the tallest building in East Troy. Wisconsin Oven has been manufacturing industrial heat-treating equipment for 40 years. The new facility is said to be suitable for manufacturing massive equipment for the automotive, aerospace, mining and energy industries, and is equipped with two 20-ton cranes and two 10-ton cranes.

Composites NEWS

Source | CT / Photo: Jeff Norgord

Report: Thermoplastics Composites Conference for Automotive 2014

CT and sister publication *Plastics Technology* hosted the first Thermoplastics Composites Conference for Automotive on June 11-12 in Novi, Mich. Speakers represented a wide variety of automotive material, machinery and technology disciplines and emphasized carbon fiber-reinforced thermoplastics in volume auto manufacturing. Hans Miltner, program manager at Solvay Specialty Polymers (Alpharetta, Ga.), discussed Solvay's work with low melt viscosities for improved impregnation. He pointed to the body-in-white (BIW) structure as the most promising target for weight savings and suggested that by 2020 the auto industry will see major structural parts made with thermoplastic composites. Mark Minnichelli, director of technical development at BASF Performance Materials (Ludwigshafen, Germany), reported on a thermoplastic composite seat back frame for a Toyota vehicle (see another on p. 54).

ENGEL (Schwertberg, Austria) Technical Center director Peter Egger reviewed ENGEL's efforts to develop an in-situ polymerization molding process with dry carbon or glass fiber preforms. Prior to injection, a catalyst and heat (50°C/122°F) are added to caprolactam which, in combination, react to form polyamide inside the mold in two to five minutes. Caprolactam offers viscosity so low that injection can be performed under relatively high pressures without deforming the fiber preform.

Paul Lagonegro, application manager, sensing technology, at Kistler Americas (Novi, Mich.) spotlighted the need for process optimization and control in resin transfer molding (RTM). Kistler, he said, believes that the same inmold piezoelectric/piezoresistive-type sensors the company makes for injection molding can be used in RTM, at pressures as high as 200 bar/2,900 psi, to ensure part quality. Next year, Kistler will introduce sensors for vacuum pressure and flow-front location.

Celanese (Dallas, Texas) technical marketing manager Duane Emerson reviewed a new Type IV pressure vessel for hydrogen storage in fuel-cell systems. Its liner is made with rotomolded polyoxymethylene (POM), filament wound with carbon fiber/POM prepreg. The vessel reportedly meets all tank standards.

SPE's ACCE 2014

PREVIEW

Automotive composites a hot topic in the Motor City.

The 14th annual SPE Automotive Composites Conference & Exhibition (ACCE) returns to its spacious new venue (left), The Diamond Banquet & Conference Center at the Suburban Collection Showplace, Sept. 9-11. Judges (on right) view several of the more than 50 entries in the ACCE's 2013 Student Poster competition.

Source | SPE / Photos | Pam & Mike Brady

The 14th annual Automotive Composites Conference & Exhibition (ACCE), organized by the Automotive and Composites Divisions of the Society of Plastics Engineers (SPE, Newtown, Conn.), returns Sept. 9-11 to the Diamond Center at the Suburban Collection Showplace in Novi, Mich., in the Detroit suburbs. This year's event, its second at what was a new show location in 2013, promises to be bigger and busier.

The SPE ACCE moved house last year after 12 years in its original location across town at Michigan State University's Management Education Center in Troy, Mich. The timing proved fortuitous because the 2012 show at MSU-MSE drew a record 636 registered attendees, and last year's event boosted that number to 903, who attended a new high of 96 presentations, and visited double the number of exhibitors. The 2013 event simply would not have fit in the old location. Automotive composites continue to be a hot topic as automakers scramble to find effective ways to take significant mass out of vehicles to meet new fuel economy and greenhouse-gas emissions standards pending in many parts of the world. Event organizers, therefore, predict that the 2014 show will easily draw more than 1,000 attendees.

Source | SPE / Photo | Pam & Mike Brady

Dr. Michael Connolly (left) of Huntsman Polyurethanes (Auburn Hill, Mich.) was honored last year with the SPE Composites Division's Composites Person of the Year Award by 2013 ACCE chair (right) Creig Bowland of Colorado Legacy Group LLC (Shelby, N.C.). Given annually to publicly acknowledge those who have given significant aid to the SPE Composites Division, the award has been conferred in previous years to a distinguished group that includes Dan Buckley of American GFM, John Muzzy of the Georgia Institute of Technology, James Griffing of The Boeing Co., Fred Deans of Allied Composite Technologies LLC, Peggy Malnati of Malnati & Associates LLC, Dale Grove of US Silica, Dale Brosius of Quickstep Composites LLC and Creig Bowland.

STRONG SPONSORSHIP, STRONG TECHNICAL PROGRAM

At *CT* press time, ACCE event organizers had already booked a record numbers of exhibitors and sponsors for this year's show — the exhibition area has been expanded twice — and expect another good showing in the student poster competition. They also report a strong technical track with a variety of papers on innovative composites applications as well as timely reports about materials, processing and equipment advances.

For a third year, the ACCE will feature a Tutorials track, designed to help attendees learn the fundamentals of various aspects of composites technologies — a feature that OEMs have requested to get younger staff members up to speed on the differences between composites and metals. This year's track will be held on the third day of the show and its focus will be on long-fiber thermoplastics and nanotechnology. Creig Bowland, president of Colorado Legacy Group LLC (Shelby, N.C.) and three-time SPE ACCE conference chair, and his co-presenter Vanja Ugresic, research engineer from the Fraunhofer Project Centre @ Western University (FPC, London, Ontario, Canada), will give a 90-minute primer on "Use of Long Fiber Thermoplastics in the Automotive Market." After a short ►

Source | SPE / Photo | Pam & Mike Brady

The SPE ACCE's lively panel discussions allow audience participation and provide opportunities for enthusiastic dialogue between transportation OEMs and the supply community. Last year's "Aluminum & Composites — Compete or Collaborate?" continued a dialogue started at the 2012 show on "the multi-material vehicle." Panelists included representatives of Alcoa Inc., Kaiser Aluminum, Ford Motor Co., the Center for Automotive Research (CAR), the Dow Chemical Co., and Ecole Polytechnique Federale de Lausanne, who discussed how and where aluminum and composites could best be used to meet OEM needs for mass reduction in passenger vehicles.

Source | SPE / Photo | Pam & Mike Brady

Between the 2013 technical sessions, keynotes, receptions and other conference activities, the more than 900 ACCE attendees and exhibitors had the opportunity to meet face to face, an important feature of the conference's enhanced exhibition space at the new venue.

Source | SPE / Photo | Pam & Mike Brady

One of the strengths of the ACCE has always been its close, friendly atmosphere, which is very conducive to networking. In 2013, conference organizers provided "conversation stations" to encourage dialogue between attendees, speakers and sponsors/exhibitors at the show. This area, adjacent to exhibits and equipped for "roundtable" style meetings proved quite popular, saw consistent use throughout the three-day conference and was the location for two evening cocktail receptions.

break, the focus will change. Three presenters will cover a range of nanocomposite technologies during a two-hour session. The tutorial will begin with a talk by Tie Lan of Nanocor LLC (Hoffman Estates, Ill.) on "Chemically Modified Bentonite Clays (Nanoclay) as Plastic Additives – Applications in Automotive," and will be followed by a talk by Prof. Lawrence Drzal, from Michigan State University (East Lansing, Mich.) on "Graphene Nanoplatelets: A Multifunctional Nanomaterial Additive for Polymers and Composites." Next up, Prof. Alan Lesser of the Polymer Science & Engineering Department at the University of Massachusetts-Amherst (Amherst, Mass.) will give an hour-long overview of "Engineering Nano-Reinforced Composite Materials." Tutorials will be recorded, so SPE members who are unable to attend the event can take advantage of the content at a later time by visiting the SPE's Web site (http://4spe.org).

In addition to the Tutorials track, returning technical sessions include Advances in Reinforcement Technologies, Advances in Thermoplastic Composites, Advances in Thermoset Composites, Bio- & Natural Fiber Composites, Business Trends & Technology Solutions, Enabling Technologies, Nanocomposites, Opportunities and Challenges with Carbon Composites, and Virtual Prototyping & Testing of Composites. Speakers will cover topics ranging from new additives and reinforcements to broader use of thermoset and thermoplastic composites in ground transportation applications.

Enabling Technologies, a strong process-and-equipment session in three parts, will showcase advances in injection, compression and resin transfer molding processes. The perennially strong Virtual Prototyping & Testing session will cover the latest advances in computer-aided analysis and testing of composites, including new work on simulation advances with discontinuous reinforcements and with laminates and fabrics, as well as manufacturing corrections in simulations, new accelerated weathering tests for automotive composites, and adhesive applications in motorsports.

Papers in the Thermoplastic Composites session will discuss technologies for replacing carbon fiber/epoxy Type IV pressure vessels with new thermoplastic composite alternatives. Other presentations in this session will examine the latest advances in polyamides, polypropylene, additives and new polymers. On the thermoset composites side, sheet molding compound (SMC), polyurethane and epoxies will make a strong showing. For nanocomposites, an extensive, three-part track will feature carbon nanotubes, nanofibers, graphene, attapulgite and new assessment tools. In the reinforcements arena, speakers from PPG Industries (Pittsburgh, Pa.) and Owens Corning (Toledo, Ohio) will each introduce new fiberglass technologies, while a Johns Manville (Denver, Colo.) author will discuss a new generation of thermoplastic honeycomb, based on polyester spunbond. Additionally, presenters will discuss new polyurethane surface treatments for basalt fibers and work on the carbon fiber/vinyl ester interface. Additional talks will include the following:

- Advancements in bio-polymers and natural fiber reinforcements.
- A new report on the recently formed Society of Automotive Composites in Japan.
- A paper on substitution of virgin material by recycled material from Institut Supérieur de Plasturgie d'Alençon (ISPA), Pôle Universitaire de Montfoulon (Alençon, France).

Along with its perennially strong technical program, the SPE ACCE is well known for its lively panel discussions. This year, a three-hour executive forum organized by Jay Baron, CEO at the Center for Automotive Research (CAR, Ann Arbor, Mich.), will help the composites supply chain better understand OEM perceptions of issues with implementing composites in passenger vehicles. Panelists confirmed to date include Frank Macher, CEO, Continental Structural Plastics (Auburn Hills, Mich.); Nigel Francis, senior VP, Michigan Economic Development Corp. (Lansing, Mich.); and Harry Singh, program manager, EDAG USA (Auburn Hills, Mich.).

The ACCE also is known for its numerous and diverse keynotes, and this year won't disappoint. Prof. Jan-Anders Månson, Ph.D., head of lab, Laboratory of Polymer and Composite Materials (LTC), Ecole Polytechnique Federale de Lausanne (EPFL, Lausanne, Switzerland), will explain "Why Sport is Important for Automotive Composites." Månson will draw from his work consulting for the International Olympic Committee (IOC, Lausanne) on new technologies that improve performance as well as safety. Another keynoter, Prof. Habib Dagher, Ph.D., P.E., director of the Advanced Structures and Composites Center at the University of Maine-Orono (Orono, Maine), will speak about "Polymer Composite Materials in Infrastructure Applications" (see "Learn More"). Daniel Ageda, secretary general/chief operating officer at JEC Composites Group (Paris, France) will speak on "Overview & Dynamism of the Wordwide Composites Market." Matthew Marks, chair of the American Chemistry Council Plastics Div. Auto Team and senior business manager, Automotive and Mass Transportation at SABIC, will discuss the latest "American Chemistry Council Plastics and Polymer Composites Technology Roadmap for Automotive Markets." And Kestutis (Stu) Sonta, senior materials engineer, General Motors Co. (Detroit) will speak about "Novel Composite Developments on the Chevrolet *Spark* Battery Enclosure."

Also popular are free plant tours in the Detroit region. At press time, an hour-long tour of Century Tool & Gage (Fenton, Mich.) was set from 3 to 4 p.m. the day before the conference. A second will be announced.

CW LEARN MORE
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Read this article online | short.compositesworld.com/ACCE2014.

Read more about one of the Advanced Structures and Composites Center's recent efforts in "Bridge cost cut with inflatable arches" | short.compositesworld.com/DwM3fIIT.

Read more about SPE ACCE's Person of the Year | http://speautomotive.com/SPEA_CD/SPEA2013/pdf/about/Composites%20Person%20of%20the%20Year.pdf.

Source | SPE / Photo | Pam & Mike Brady

The conference saw a significant increase in the size of its technical program in 2013, with a total of 96 regular talks and keynotes. For the first time, a fourth parallel technical track was added, and a much larger tutorials session was offered at no additional cost.

A current conference information and presentation schedule can be found at http://speautomotive.com/comp.htm. Further, 13 years of ACCE proceedings can be found in the ACCE Archives at http://speautomotive.com/aca. Those with smartphones can download the free SPE Events app in their Android or iPhone/iPad app store to view schedules, author bios, and mini-abstracts for the 80-plus presentations, keynotes, and other event details. | CT |

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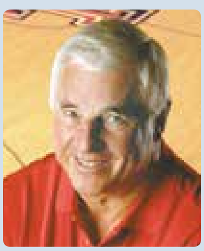
IBEX 2014 PREVIEW

After four years inland, boatbuilders head southeast to put in, dockside, in Tampa Bay.

When the International BoatBuilders' Exhibition and Conference (IBEX) gathers boat-manufacturing professionals in Tampa, Fla., Sept. 29-Oct. 2, 2014, the new location will be complemented by a number of other innovations. By popular demand, IBEX cosponsors *Professional BoatBuilder* magazine (Brooklin, Maine) and the National Marine Manufacturers Assn. (NMMA, Chicago, Ill.) have adopted a *rotating* show schedule. They'll sail into Tampa every other year to accommodate the large number of attendees and exhibitors who hail from the southeastern U.S., Latin America and the rest of the world. In alternate years, for the foreseeable future, they'll return to the IBEX show's second "home port" on the Ohio River, in Louisville, Ky. (Shows are scheduled through 2018. See "IBEX: Louisville/Tampa Rotation," below right.)

Source | IBEX or Source | ESPN



In college basketball, the name Bob Knight is still one of the most recognizable in the history of the sport. Fans and foes alike respected his ability to draw from his players winning performances rivaling that of other greats. Knight will offer the IBEX keynote: His motivational speech, titled "Winning," will be the centerpiece at the annual Industry Breakfast on Tuesday, Sept. 30, 2014, 7:30 a.m. to 9:30 a.m.

ON THE WATERFRONT

The alternating show schedule is just the beginning. For the first time in the show's history, IBEX organizers have reserved bayside dock space for On-the-Water Exhibits and Demonstrations. Already booked for display on the bay are on-boat exhibits from some of the marine industry's more recognizable names, including Elco Motor Yachts, Honda, JL Audio, JL Marine Systems, Mercury Marine, Nauticus, SeaStar Solutions, Simrad-Navico, Torqeedo Inc., UFLEX USA, Veedims, Volvo and Yamaha.

"We expect the IBEX docks to be very active," says Anne Dunbar, IBEX show director. "Having water access directly in front of the convention center is an incredible opportunity for IBEX exhibitors to show off their new products and technology."

In addition to the On-the-Water Exhibits, there will an outdoor demonstration area on a nearby 3,300 ft^2 (278m^2) patio. And inside the adjacent Tampa Convention Center, the show will boast a new Electronics Pavilion on the exhibition floor, a docket of pre-event IBEX Super Sessions (pre-conference workshops produced by exhibitors to review in-depth, hands-on technical topics) and a host of other educational opportunities presented in parallel to show floor activities.

The educational checklist will include the IBEX 3D Digital Workshop and the Material ConneXion. For the latter, IBEX has gathered what it calls "the world's most influential and prominent manufacturers from all disciplines, categories and market segments," who will showcase creative material solutions that are expected to have a big impact for marine applications. Attendees also will have access to more than 55 technical and pertinent education sessions — part of the IBEX Seminar Series, as well as free admission to the Exhibitor Workshop Theater, where attendees can hear from subject-matter experts employed by IBEX exhibitors about what's new and exciting from individual suppliers. (For more information on these new events, visit the IBEX Web site: www.ibexshow.com.)

Another new area, dubbed The Connected Boat, will feature the latest in electronics and system installations. And of course, builders of composite boat structures will enjoy the ease of navigating, again, the Composites Pavilion, a gathering of composites materials and services providers in a convenient, accessible area on the show floor. A third area, now a regular feature at IBEX, will gather exhibitors whose expertise is related to Compliance, Standards, and Education.

IBEX expects a total of 510 exhibitors to occupy space on the indoor show floor, which encompasses more than 100,000 ft^2 (9,290m^2), and the additional outdoor/waterfront display areas.

KEYNOTE AND NOTABLE AWARDS

In college basketball, the name Bob Knight is still one of the most recognizable in the history of the sport. Fans and foes alike respected

IBEX: LOUISVILLE/TAMPA ROTATION

IBEX 2015	Sept.15-17	Louisville
IBEX 2016	Oct. 4-6	Tampa
IBEX 2017	Sept. 12-14	Louisville
IBEX 2018	Oct. 2-4	Tampa
IBEX 2019	Sept. 17-19	Louisville

his ability to draw from his players winning performances rivaling that of other greats. Knight will offer the IBEX keynote: His motivational speech, titled "Winning," will be the centerpiece at the annual Industry Breakfast on Tuesday, Sept. 30, 2014, 7:30 a.m. to 9:30 a.m.

"Coach Bob Knight is synonymous with greatness and winning, and we are thrilled to welcome this legendary basketball coach and avid fisherman to deliver the keynote address at the annual IBEX Industry Breakfast," notes NMMA president Thom Dammrich. "Bob Knight's impressive record on and off the basketball court illustrates his dedication to his team and the game, all values which will resonate with our attendees, who will be inspired by his drive to succeed."

Knight compiled quite a record (and courted some controversy) during his long career: Numbers and achievements that illustrate what Bob Knight has done for the game of basketball include 41+ seasons as a head coach of Division 1 teams, with a won/lost record of 902-371 — the most all-time at his retirement, and since eclipsed only by one of his former players, Mike Krzyzewski of Duke, and by Jim Boeheim of Syracuse.

Best known as the head coach at Indiana (1971-2000), where he led the Hoosiers to three NCAA championships, one National Invitation Tournament (NIT) title, and top honors in 11 Big Ten Conference seasons, Knight also coached at Texas Tech (2001-2008) and at Army (1965-1971). Notably, he boasted a 98 percent graduation rate among his players.

He received the National Coach of the Year honor four times and the Big Ten Coach of the Year honor eight times. In 1984, he coached the USA men's Olympic team to a gold medal, becoming one of only three basketball coaches to win an NCAA title, NIT title *and* an Olympic gold medal.

In addition to his impressive record on the basketball court, Knight was inducted into the Vince Lombardi Titletown Legends, which pays tribute to those individuals who possess the characteristics instilled by Lombardi in his pro football players: dedication, teamwork, respect, love, family and discipline.

Following Knight's appearance, Dammrich will deliver his annual State of the Industry address, outlining where the industry stands and how far it has come, as it continues its recovery from the long 2008-2012 downturn.

Other IBEX 2014 Industry Breakfast highlights include the following:

- The IBEX Innovation Awards presentation, which acknowledges the importance of technological advancement. Each year, all IBEX 2014 exhibitors are encouraged to enter new products in the IBEX Innovation Awards competition, considered one of the marine industry's most prestigious honors. Products entered for the 2014 Innovation Awards will be displayed during all three days of the show at Innovation Way, located inside the IBEX 2014 exhibit hall. The entry deadline is Aug. 29, 2014.
- The NMMA Hall of Fame, which was established in 1988 and recognizes individuals who have, or continue to generate, substantial and lasting contributions toward the advancement of the marine industry. According to NMMA, "It honors individuals whose names and deeds are ►

Source | IBEX

IBEX organizers expect a total of 510 exhibitors to occupy space on the indoor show floor, which encompasses more than 100,000 ft^2 (9,290m^2), and on the outdoor/waterfront display areas.

Source | IBEX

In 2014, the long popular IBEX Demonstration Area, located indoors on the Louisville show floor last year, will be moved outdoors to a large patio near a host of exhibits moored dockside, just outside of the Tampa Convention Center.

New opportunities for face-to-face interaction between attendees and exhibitors will include The Connected Boat, which will feature the latest in electronics and system installations. And of course, builders of composite boat structures will enjoy the ease of navigating, again, the Composites Pavilion, a gathering of composites materials and services providers in a convenient, accessible area on the show floor. A third area, now a regular feature at IBEX, will gather exhibitors whose expertise is related to Compliance, Standards, and Education.

synonymous with the pursuit of quality, innovation and perfection within their respective spheres of expertise." Excellence in the areas of product development, competitive activities, environmental protection, legislative support and arts and entertainment can be considered for the award. It is NMMA's most prestigious recognition.

- The 2014 Movers & Shakers award. Individual nominees for this honor can be from any company or group that does business in the boating industry. Nominations go to those who "are showing the vision and leadership to move the industry forward." The Mover & Shaker of the Year, along with finalists and other selected nominees, will be featured in the October issue of *Boating Industry* magazine and will be recognized at the IBEX breakfast.
- The Exhibitor Video Awards (EVAs) honors marketing efforts by recognizing the best product and company videos submitted by IBEX exhibitors. The goal of the EVA competition is to showcase the technology and innovation exhibitors are bringing to IBEX and to create an interactive way for IBEX exhibitors to promote themselves and their products or services. EVAs will be presented in three categories: Best Company Video, Best Product Video, and People's Choice.

The breakfast, sponsored by Steyr Motors GmbH (Steyr, Germany) and the Recreational Boating and Fishing Foundation (RBFF, Alexandria, Va.), "is an exciting way to begin your IBEX experience," says Dunbar. "We are thrilled to be rewarding innovation and recognizing the true leaders of the industry. We encourage people to register early, as this event will surely sell out."

IBEX organizers also report that the American Boat Builders & Repairers Assn. will offer four training and certification Super Session on Monday, Sept. 29.

SHOW INFO & REGISTRATION

Prospective attendees and exhibitors can find a plethora of general information about IBEX 2014 at www.ibexshow.com. Both groups also can register online for the Tampa event, and attendees can view a detailed Educational Conference agenda and get full pricing information for Seminar Packages at www.ibexshow.com/attendee-registration.php. Interested parties also can contact IBEX organizers via e-mail at info@ibexshow.com. | CT |

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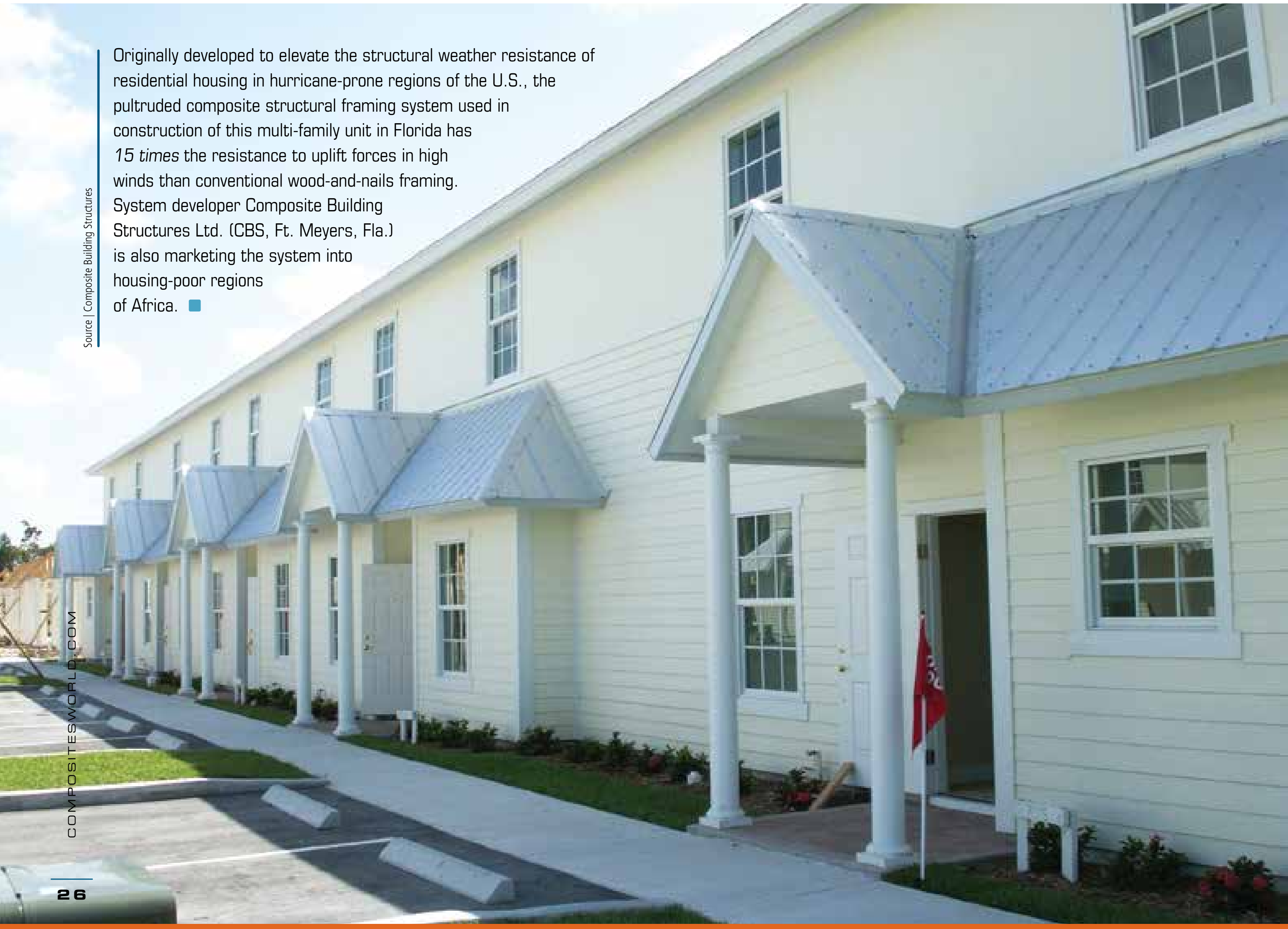
Disaster-Resistant Housing:

FRAMING THE FUTURE

This need in developing nations could be met by a composite structural framing system capable of producing both fortified dwellings *and* jobs.

Commercializing a new product is a venture fraught with risk and uncertain returns. Sources of funding, while necessary, are not always sufficient to ensure success, and entrepreneurs and their startup businesses frequently face the need to adapt both their product and business models on-the-fly to meet the demands of changing economic conditions. Such has been the case for Composite Building Structures Ltd. (CBS, Ft. Meyers, Fla.) and its pultruded composite structural framing system. Targeted to replace wood, steel and concrete block and dramatically shorten build times in the residential housing market, the system is touted as the means to create more damage-resistant structures in areas prone to hurricanes, earthquakes and termite infestation.



Originally developed to elevate the structural weather resistance of residential housing in hurricane-prone regions of the U.S., the pultruded composite structural framing system used in construction of this multi-family unit in Florida has *15 times* the resistance to uplift forces in high winds than conventional wood-and-nails framing. System developer Composite Building Structures Ltd. (CBS, Ft. Meyers, Fla.) is also marketing the system into housing-poor regions of Africa.

Source | Composite Building Structures

Source | Composite Building Structures

These condominiums in West Palm Beach, Fla., were constructed using wood floor and roof trusses and CBS's first-generation pultruded composite profiles (in white) for the wall framing — assembled with metal screws rather than nails — on the first and second floors. Seven identical buildings were erected, illustrating how composite structural framing can be integrated with traditional wood-building methods.

FRAMING A NEW CONCEPT

CBS president James Antonic says the idea for composites-based construction material evolved from his previous work as a consultant, helping to arrange distributorships, joint ventures and licenses for American manufacturers in 33 foreign countries. One consulting job was in connection with a project that entailed building a large panelized home factory in Japan. The houses were constructed using steel I-beam floors from Indiana and precut wood shipped from British Columbia. The project stimulated ideas for ways to fashion building walls from a few standard precut parts — something akin, says Antonic, to the interlocking building blocks in the popular toy construction set, LEGOs (The Lego Group, Billund, Denmark).

"When the opportunity came along to see what composites could offer as far as structural strength," Antonic recalls, "it was amazing and fit our needs for building to a higher standard like a glove." He observed that concrete has good load-bearing properties, but little flexural strength, while wood has much better flexural strength but much less load-bearing capability. Composites, he points out, could provide both.

In 2002, Antonic and several partners founded CBS Ltd. and set out to design and commercialize a composite structural framing production method based on the following three fundamental precepts:

- The use of the pultrusion process, because it is the most straightforward way to produce the framing member profiles and then cut them to desired lengths.
- The use of automotive-style assembly lines that feature layout jigs to simplify the construction of wall sections that are plumb and square.
- The use of a systems approach to turn out ready-to-erect, low-cost paneled walls that can be assembled quickly on a build site to form a complete house framing system.

The first task was to find a composite material with properties most suitable to the application. The search led CBS to the aerospace industry and engineers who had worked on the design of carbon fiber composite wing struts for a major commercial aircraft program. Substituting E-glass for carbon fiber, the fledgling company settled on a layup architecture for the profiles of its first-generation framing system, which comprised "a series of rovings, woven fabrics and veils" wet out with a polystyrene resin. This provided the desired load-bearing, flexural and shear-resistance properties. The initial system featured 14 separate profiles intended to replace the 2- by 6-inch and 2- by 4-inch wood studs used in today's conventional house framing systems. The first profiles were manufactured and precision precut as they were pultruded at two U.S.-based suppliers, and then were assembled into walls at the CBS facility in Ft. Meyers in order to demonstrate and validate the assembly system concept, which follows.

The wall's bottom plate, a C-channel, is secured in a two-sided production jig 26 ft long by 8 ft wide (7.9m by 2.4m) at the base, narrowing to about 6 ft/1.8m at the top (see photos, p. 28). The fixture permits four workers to simultaneously assemble two panels, one on each side of the jig. The jigs have male and female ends that permit linking jigs together to produce walls longer than 26 ft/7.9m.

Openings for windows and doors are built in offline jigs and then fitted into the wall panels. Following frame assembly, electrical receptacles, conduit for wiring, and plumbing access are added. Corner posts, H-column studs, end caps and 6- to 4-inch posts that connect exterior 2- by 6-inch walls to interior 2- by 4-inch walls are positioned in the bottom channel. A top plate, also a C-channel, is positioned and then each vertical component is anchored in the C-channels, top and bottom, with four screws.

The use of screws, rather than nails, dramatically increases the composite-framed houses' disaster-resistance compared to con-

The key element of Composite Building Structure's system for building affordable, disaster-resistant in developing nations is automotive-style assembly, using layout jigs like this one to build framed wall panels. This jig prototype is about 26 ft/7.9m long, by 8 ft/2.4m wide at the base. The trapezoidal shape enables four workers to simultaneously assemble two framed sections on opposite sides of the jig, using pultruded profiles.

Pictured here is a partly assembled wall panel on one side of the jig, prior to C-channel installation along the top. Pultruded studs (blue-green) are aligned on 24-inch/610-mm centers. The large gap is an opening for a French door. The doorway's horizontal "header" is temporarily clamped in place.

ventional wood framing. "In a windstorm, the integrity of the connections between the walls, roof and floor is only as good as the strength of the joints," Antonic explains. "A nail driven into the end of a wood stud has a pullout force of about 50 psi [0.34 MPa]," he contends, "whereas a screw inserted through the C-channel lip into the composite stud flange has a pullout of 750 psi [5.17 MPa]. With four screws for each stud, that's a total of 3,000 psi [20.68 MPa] pullout or about *15 times* better resistance to uplift forces when compared to two nails hammered into the ends of a 2 by 4."

In the spirit of continuous improvement, the company subsequently re-engineered the materials and the panel wall assembly system. The polystyrene matrix was replaced by a polystyrene/polyurethane blend that enhances the resilience of the pultruded profiles. "Polystyrene is stiff and splits," Antonic explains. "Urethanes are tough and flexible." Further, CBS simplified its production regime by reducing the total number of profiles necessary to frame any building from 14 to 6.

Pultruded profiles for what CBS terms, today, its fifth-generation system, are precision cut in two lengths, depending on the intended wall height in a finished room — 8 ft or 10 ft (2.4m or 3m), minus 0.25 inch/6.35 mm on the top and bottom to allow for the thickness of the C-channel web. The webs of I-beams are 0.125 inch/3.2 mm thick, and approximately 5.5 inches/140 mm wide from flange to flange, identical to the actual width of 2- by 6-inch lumber. Interior and exterior wall panel sheathing can be plywood, magnesium oxide sheets or other sheet materials.

It was CBS's fifth-generation composite system that was recently used to build an open-roof demonstration home in Florida and several houses for export to Africa.

RESCUING DISASTER RESISTANCE FROM DISASTER

Africa, however, was not CBS' intended end-market. Antonic says the original business model envisioned building houses and other structures mainly in the U.S. And early activity on that front was encouraging: In 2005, a major housing contractor used CBS's first-generation composite framing system to build two single-family homes in Naples, Fla., and several multifamily dwellings in nearby Palm Beach County. Antonic reports that all of these structures were subsequently exposed to hurricane-force winds and came through undamaged. What's more, the contractor subsequently requested 70 percent of CBS's production capacity and sought the exclusive right to CBS product in 62 other market areas. Unfortunately, these promising plans unraveled in the economic crash of 2008, Antonic says, forcing him and his partners back to the drawing board.

As the U.S. housing market collapsed, CBS refocused its business strategy, researching whether or not there were markets elsewhere for the product and, just as significantly, if they could turn a profit in them. CBS concluded that there were realistic opportunities in developing nations where there are severe housing shortages *and* international aid committed to alleviating those shortages.

This stimulated marketing efforts at international trade shows and conferences that appear to be bearing fruit. According to Antonic, the Ivory Coast, where there is an estimated shortfall of nearly 450,000 houses, is seeking to secure funding to build more than 5,000 units with CBS's composite framing and wall-assembly system. Additionally, agencies in the Dominican Republic and Haiti are working to iron out the final financial and logistical details to manufacture and build 2,000 CBS-framed houses on the shared island of Hispaniola.

The disaster-resistant design is, of course, an appealing selling point of the framing system, but a value-added feature with great appeal in developing communities is its potential to create new jobs. Initial plans for the housing project in Haiti, for example, call for wall panels to be manufactured using the company's jigged panel assembly process in an industrial park in Northwest Haiti. The park, as envisioned, also will serve as a hub for suppliers of windows, doors and other parts needed for assembly of the panels. Completed panels will be transported to a building site in the Dominican Republic, where the house shell can be assembled in three to four hours using local labor. The net result, Antonic claims, is industry and job creation that is sustainable, providing for economic development as well as disaster-resistant housing.

CBS has received requests from companies located in a number of countries for licenses to assemble its pultruded profiles locally, and Antonic anticipates having the first portion of $40 million (USD) in total funding for the project in Haiti by the end of this year. For the project in Africa, he says CBS received initial payments that will finance feasibility studies and redrawing of blueprints to accommodate the company's framing system. | CT |

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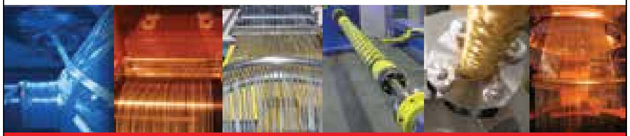

COMPOSITES BUSINESS ~~DOESN'T~~ DOES GROW ON TREES

This advanced composites contractor welcomes down-to-earth opportunities to bring aerospace quality to fantasy foliage.

How does a full-service manufacturer of tight-tolerance, complex composite parts for the aerospace and defense industries find itself in a specialty niche, molding exotic artificial trees? Precisely because it is a manufacturer accustomed to aerospace challenges.

For Matrix Composites Inc. (Rockledge, Fla.), this obvious departure from its regular line of work isn't as radical as it appears at first glance. In fact, when the company was approached by a major theme park in 1997 and asked to bid on its first tree-building project, the artificial tree in question was *not* what one might encounter indoors at a shopping mall. It was, instead, massive and a bit magical, and would be on display out of doors in all types of weather. Additionally, it had to meet fire codes and withstand live structural loading conditions that, given its Asian-Pacific location, could include hurricane-force winds. Designing and manufacturing the com-

Source | Matrix Composites

Part of a "Walking with Buddha" cultural display on the north coast of Lantau Island (Hong Kong) near a collection of notable Buddhist monasteries, this artificial tree features branches molded by Matrix Composites (Rockledge, Fla.) from glass fiber composites.

ponents of that tree ultimately required all the company's expertise in building parts with demanding performance specifications. And although Matrix Composites had long traveled a carefully charted path, technically, its engineering crew soon discovered that everything else about what would be the first of several artificial-tree projects was new ground.

FROM RIGHT-BRAIN TO LEFT-BRAIN

"The first thing that strikes you about building these artificial tree branches," says Dave Nesbitt, president and CEO of Matrix Composites, "is how the geometries are so complex." Nesbitt notes that it was, at first, very difficult to conceive how to layup a tree branch in composites and make the result realistic. "The project required us to tap our creative, artistic side."

The company has since designed and manufactured three other similar trees. The most recent, in 2009, was for the Ngong Ping 360 Exhibit on the north coast of Lantau Island in Hong Kong (pictured in the photos, here). The tree is part of the "Walking with Buddha" cultural exhibit, which visitors access via a 5.7-km/3.5-mile cable car ride into the hills above Ngong Ping village.

Matrix Composites' customer on the project was MTR Corp. (Hong Kong, China), which built both the exhibit and the cable car system. The second and third trees, built respectively in 1999 and 2004, were projects for the original theme park customer, but each shipment was delivered to a different location.

The sizes, shapes and complex geometries of each tree, therefore, were unique. Overall tree design and dimensions in each case were specified by the customer's drawings, which were supplied by architects and engineers who specialize in theme park and other artificial foliage construction. The customer also was responsible for hiring contractors to construct the tree's main trunk, which is typically made with more conventional construction materials, such as steel and concrete. Nesbitt's engineering team, then, was responsible for the rest of each tree, from the trunk up and out. Variations in the size and shape of each branch determined the structural loadings, which, in turn, influenced the quantity of structural material used in each branch. However, the basic manufacturing process, as described here, was similar for all the tree projects.

MAKING ART PRACTICAL

Because the number and complexity of unique, individual parts in a given tree proved daunting, the key to practical, cost-effective manufacturing was recognizing and building in some underlying simplicity. For the largest trees, therefore, Matrix Composites was able to develop nine to as few as six unique branch patterns. Engineers were able to recapture the complexity of a natural tree because those branches could be installed at any elevation and at any angle of rotation (360°) in relation to their points of attachment. "Even though we have a limited number of branch patterns, there is a nearly infinite amount of orientations that can occur with those patterns," says Nesbitt, "so if you look at one of the trees, you may never recognize a repeating pattern."

From the master drawings, then, Matrix Composites determined how many different branch patterns or sets it needed to build each tree, the elevation of each branch pattern within the tree and the angle of rotation relative to the main trunk and other branches adjacent to it. Within the specified spatial dimensions and appearance requirements, however, the Matrix team was solely responsible for individual branch design and construction.

Source | Matrix Composites

The tree and "Walking with Buddha" artifacts are part of the Ngong Ping 360 Exhibit, which includes a 5.7-km/3.5-mile cable car system that lifts visitors to other Buddhist sites in the hills above Ngong Ping village.

Initial design of the individual branch components follows an iterative design/build/test process. "The geometries of the branches are so complex, it is somewhat difficult to perform an FEA analysis and be accurate because of the variations," says Nesbitt. Instead, company engineers focused on a layup schedule that would get them close to the loading requirements, then they physically tested the branch structure in the laboratory, using load cells and extensometers to generate load and deflection data. If the prototype branch failed, the layup schedule and construction were modified until laminate load conditions were met, with appropriate safety margins. Then the design for that specific branch type was "locked down" in a CAD solid model and controlled using detailed process documentation.

In some cases, the loading requirements can be extreme, as Nesbitt explains: "A branch can be 4 or 5 ft [1.2 to 1.5m] tall, and if you can imagine placing it in a socket and hanging a 2,000 lb [907 kg] mass from it, that's the kind of loads these parts can see in extreme typhoon conditions with 200-mph [161-kmh] winds."

ARTFUL MANUFACTURING REQUIRED

Each one of the unique branch patterns comprised one or two main branches (distinguished by being thicker than the other branches) and as many as 10 to 12 appendages or secondary branches. Then, there were sets of leaves attached to each of the side branches. The complexity of the geometry precluded the use of CNC machinery to cut patterns for individual branch sets. Instead, branch shapes were created by hand from Chavant clay, using the hand-lofting techniques automobile designers employ when creating a new car model. Master clay models were built for each branch and appendage. A release coat was applied to the masters, and room-temperature vulcanized (RTV) silicone molds were pulled directly from the models.

Next, the elastomeric molds were filled with a grade of Matrix Composites' syntactic foam, and then were placed in a low-pressure compression press. The foam, which reportedly has the consistency of a "low-density playdough," was catalyzed and then cured at room temperature in six to eight hours. The cured part was pulled from the mold, and then functioned as both the composite's core and the mandrel on which technicians layed up the branch's composite skin.

During layup, the syntactic core/mandrel was first overwrapped with a heat-curable film adhesive, then overlaid with multiple layers of glass-fiber braid supplied by A&P Technology (Cincinnati, Ohio). This was followed by unidirectional glass-fiber prepreg and additional film adhesive, both supplied by Ten Cate Advanced Composites (Nijverdal, The Netherlands). This sequence was repeated, as necessary, to build up the laminate to the required structural strength.

The finished layup was overwrapped with heat-activated shrink tape, supplied by Dunstone Co. Inc. (Charlotte, N.C.), then placed in an oven, and cured at 250°F/121°C for four to six hours. During cure, the shrink tape consolidated the laminate while the resin in the repeated layers of prepreg flowed, impregnating the interleaved braid.

After cure, the shrink tape was removed, and the process of attaching the secondary branches began. Although these were generally shorter and thinner than main branches, they also were constructed from a syntactic foam core/mandrel, using a similar layup, comprising TenCate's film adhesive, A&P glass braid and prepreg,

For the Ngong Ping project, more than 30 transoceanic containers of branches (see inset) were shipped from the Port of Miami to the construction site on Lantau Island in Hong Kong. The customer, Hong Kong-based MTR Corp., was responsible for hiring contractors to build the tree's main trunk, using conventional concrete and steel. Matrix Composites designed and manufactured the individual branches and branch sets, based on master drawings supplied by architects who specialize in artificial-foliage design.

Source | Matrix Composites

Source | Matrix Composites

Although the artificial trees look very real, they are, of course, not seasonally renewable like natural trees. Assembled branch-and-leaf sets must be able to withstand typhoon-force winds. Multiple layers of glass braid, glass prepreg and film adhesive are built up around a compression-molded syntactic foam mandrel. After curing, branches are grit-blasted, coated with an epoxy-based texture to impart a bark-like topography and then painted.

Source | Matrix Composites

Depending on the project, there could be six to as many as nine unique branch patterns, like this one. Branches are visually differentiated on the tree by mounting them at different elevations and rotating them in their mounting sockets on the tree. Here, a jig holds the branch in the rotational orientation it will have when installed in the actual exhibit, so technicians can attach its leaves "sun-side up."

and a final overwrap of shrink tape. Then, the secondary branches were attached to the main branch with shrink tape, and the entire assembly was placed in an oven. Held in place by curing fixtures, the assembly is subjected to the same temperature for an additional four to six hours, to cure the laminates of the secondary branches and the joints where they intersected the main branch.

Although the main and secondary branch components were now unified structures, there was still much work to do. Finishing operations commenced with the removal of the shrink tape from the final branch assembly. Then, its entire outside surface was roughened via grit-blasting. After that, TC-4220 from BJB Enterprises (Tustin, Calif.), a thick epoxy texture coat, was applied to the composite with a trowel-like tool, using a variety of artistic techniques to create a continuous, bark-like texture on the branch surface. The coating cured at room temperature in several hours, after which several coats of a so-called "aging paint" called Duranar, from

PPG Industries (Pittsburgh, Pa.), were applied to impart a natural, weathered look to the branch.

Finally, leaves injection molded by a subcontractor, using a fluropolymer resin made by Arkema (King of Prussia, Pa.), were inserted into the branch sockets, where they were both mechanically fastened and adhesively bonded. Here, differentiation of main and secondary branches through rotation created an additional challenge: The surfaces of their leaves had to point upward, toward the sun, as they would on a natural tree. For that reason, the elevation and orientation of each branch was specified in the drawings, and that information also was carried in a barcode and serial number printed on each branch. When an operator at Matrix Composites installed the leaves, he placed the branch in a fixture that positioned it in the same orientation it would have in the field.

ECONOMIES OF SCALE

Given Matrix Composites' high-tech core business, the growth of an off-shoot, specialty molding and fabrication business in outdoor artificial trees has come as a bit of surprise. "There's not a huge demand for large, fake trees in the world," Nesbitt quips, "so after we made our first one in 1997 we said, 'Okay that was fun. Now let's go back to our aerospace business.' And we figured we'd never build another tree." Yet, because Matrix Composites had demonstrated its capability to efficiently manufacture these unique, technically challenging structures, the same customer returned a second and third time, ordering trees larger and more complicated than their predecessors. Although the projects have come sporadically, each required a substantial quantity of individual subcomponents, representing significant business. Nesbitt reports, for example, that the company shipped as many as 60 transoceanic containers, total, in support of the two tree programs destined for installation near Hong Kong. One was for the most recent project, the Ngong Ping 360 Exhibit, and the other was for the theme park customer.

When the next artificial tree order will arrive is unknown, but if and when it does, it will be welcome, says Nesbitt. "It is a nice sidelight business," he observes, "and it gives a bunch of geeky engineer-types a chance to step outside the high-tech world and do something a bit artistic." | CT |

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Mass reduction for mass appeal

FRPs & CMCs in RVs

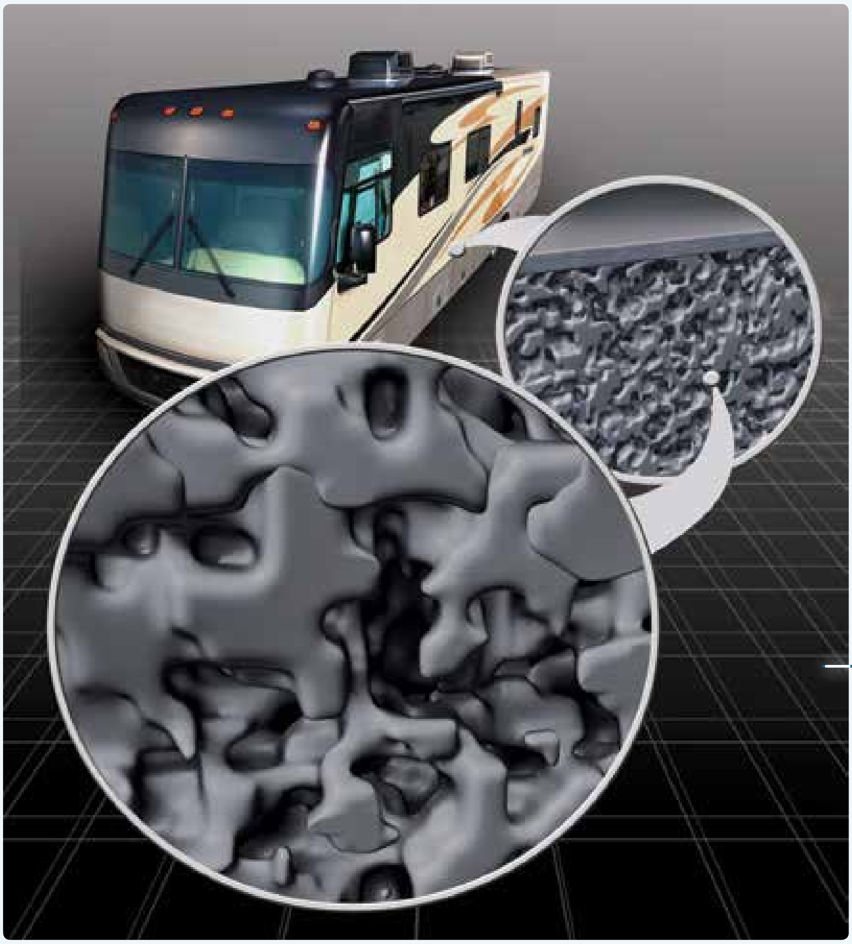
Composites save weight, speed assembly, improve aesthetics, diminish warranty service *and* promote sales.

Whether we're talking about pop-up campers hitched to passenger cars, "fifth wheels" — large trailers towed by pickup trucks — or self-propelled luxury motor homes (affectionately called *mobile apartments*), those who manufacture them are keen to take weight out of recreational vehicles (RVs). But unlike passenger car and commercial truck OEMs, those who build RVs aren't motivated so much by pending fuel economy and/or greenhouse-gas emissions mandates — at least, not in North America, where the regulations don't apply directly to the RVs themselves. Instead, the impetus for lightweighting has two other rationales. First, every pound/kilogram of mass removed is another pound/kilogram of consumer comfort items (e.g., big-screen televisions) that can be added without necessitating that the RV be pulled by a vehicle with greater towing capacity. Second, when the goal is, indeed, an overall lighter RV, the primary aim is to power or pull that RV with a less expensive drive train or tow vehicle that uses less fuel, to minimize the consumer's cost of ownership.

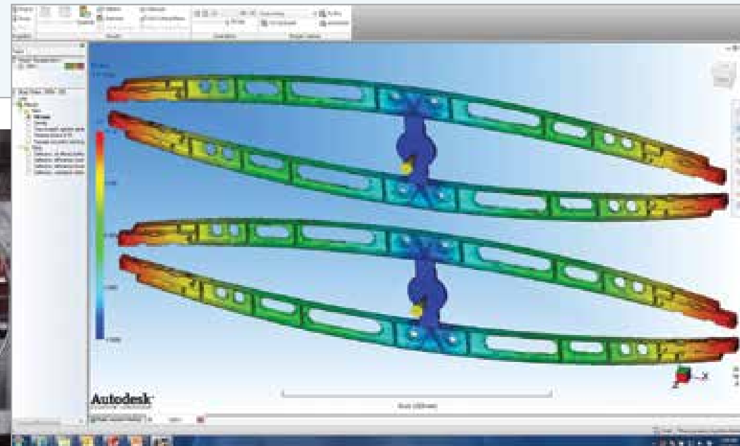
After mass reduction, the hot issue is to reduce RV post-sale maintenance. RVs, especially the larger ones, are rarely garaged. They're parked outside in all types of weather. The issue then, some industry insiders say, is not *if* water damage will occur, but *when*. Some sources report that it can cost an RV manufacturer as much as $10,000 USD to remove and rebuild a wall on a large RV, so as a preventive measure, RV OEMs are eliminating wood products commonly used in sidewalls and floors, which are prone to swelling from moisture intrusion.

Also a hot-button issue is the need to improve curb appeal and weatherability. Although RV industry expectations for exterior aesthetics are not yet as demanding as automotive Class A standards, suppliers report that they've been asked over the past decade to upgrade the weather resistance and UV stability of their "fiberglass"-skinned products — today, a too-limited term for what's available.

Source: TekModo LLC



There's a major push in the RV market toward vehicle weight reduction and elimination of wood, which is prone to water intrusion and rot. Both trends favor incorporation of composites, including this unprecedented use of ceramic-matrix composite (CMC) wallboard shown above, which is replacing complex, heavy, and damage-prone sandwiches of metal, foam and wood.



C-shaped double-arched composite roof bows, from CPI Binani (Winona, Minn.) are replacing aluminum I-beams in tow-behind RVs produced by Keystone RV Co. (Goshen, Ind.). Produced via D-LFT transfer molding, using chopped glass wetout with a recycled polypropylene copolymer blend, the bows feature insert-molded pine wood blocks on both ends, which simplify hand sizing and installation, using screws or nails. Photo at left shows bows during static load testing.

Source | CPI Binani Inc.

This applies not only to sandwich-panel sidewall skins but also to roof membranes (see "Learn More").

Lastly, innovative and automated production processes are reining in the cost of composite components and delivering parts that can be incorporated more efficiently into the largely hand-built RVs.

RAISING THE RAFTERS

A good example of assembly-sensitive design is a composite roof support developed by CPI Binani Inc. Formerly known as Composite Products Inc., this Winona, Minn.-based fabricator has replaced aluminum I-beams with hybrid composite C-beams on roof rafters (roof bows) that support plywood and outer roof membranes on a variety of tow-behind trailer RVs produced by Keystone RV Co. (Goshen, Ind.). Surprisingly, composites displaced metal in this application not because they were lighter or stronger, but primarily because they offer significant improvements in assembly efficiency. The product arrives ready for use at Keystone and saves multiple preparation steps previously required with aluminum beams.

Eric Renteria, CPI Binani's director of business development, product management and marketing, says the company started making the parts after it partnered with a group in the RV industry to ask, *What are the customers' needs?* "The overwhelming response we heard was that roof bows were difficult to use and to assemble, and that there had to be a better way to make them," Renteria notes.

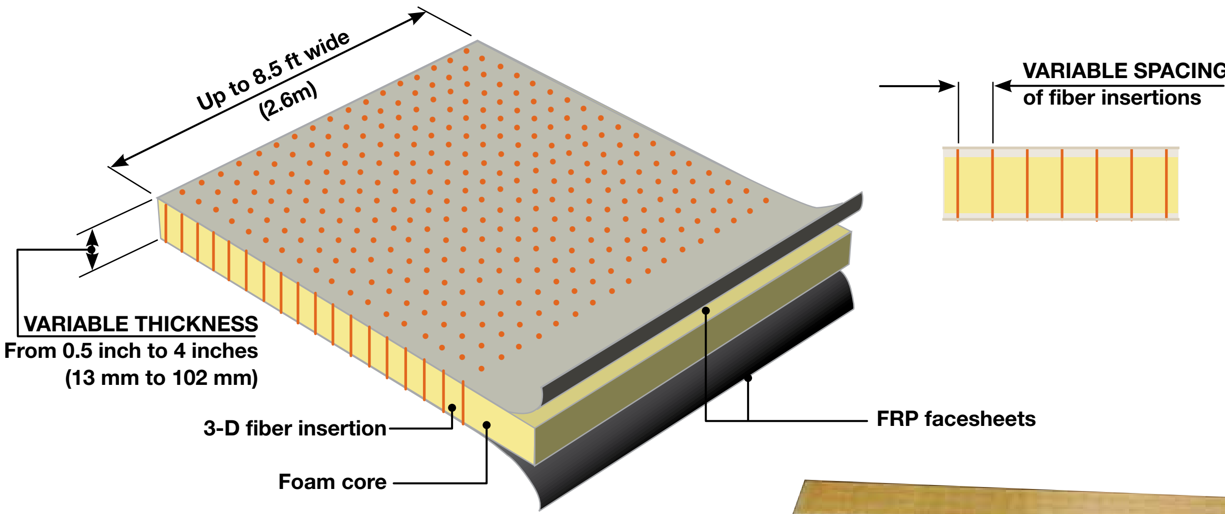
When Keystone showed CPI's engineers the bows it was then using, made of either aluminum or wood, CPI says it engaged in "lots of mold-filling and structural analysis work" to design the company's patent-pending double-arched parts, which are supplied in black and are considered to be hybrid composites because they feature a 1-ft /31-cm section of inexpensive #2 pine (wood) inserts on each end. The inserts are more rigid and are convenient: RV manufacturers use the wood inserts to attach roof bows to vehicle sidewalls, using nails or screws. Further, the length of the molded beam can be adjusted simply by trimming the wood inserts on each end with a saw, so a single design serves a wide range of RV models. But because the pine is variable and typically retains 10 percent moisture, the blocks must be dried before molding to minimize dimensional instability. Toward that end, Renteria says CPI first talked to companies that kiln-dry lumber products to very low moisture content, but found the cycle times too long to meet CPI's production needs. CPI engineers then repurposed a resin desiccant drier unit, and they now dry their own blocks a gaylord at a time.

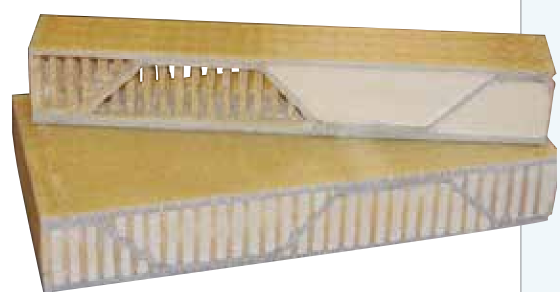
The beams are a polypropylene copolymer blend of 100 percent recycled resin combined with 100 percent virgin chopped glass that has not been twisted into roving. Glass content is 40 percent by weight and starting fiber length (before processing) is 12.5 mm/0.5 inch. The application was so cost-sensitive that recycled resin was the only way to go, but that brought interesting benefits because the resulting matrix — a resin from an undisclosed source with an additives package supplied by Addcomp North America Inc. (Rochester Hills, Mich.), is said to offer the following advantages:

- "Just the right blend" of hardness, for mechanical integrity
- Enough ductility to permit split-free hammering, stapling and/or screwing of hardware into beams
- Bond compatibility with adhesives favored by the RV industry
- A viscosity low enough to minimize glass breakage during molding
- Availability in sufficient quantity to ensure adequate supply

The material is molded in a four-cavity family tool on a 2,000- or 4,000-ton vertical compression press via direct-long-fiber thermoplastic (D-LFT) transfer molding. Cooling the rib bows with the wood inserts in place inside the mold, however, actually takes considerable time because wood, like plastic, is a thermal insulator. As a result, the cycle time is about two minutes, even in a water-chilled tool. Without the wood inserts, cycle time could be significantly reduced, and Renteria says new-generation designs are being validated to find ways to eliminate the need for pine inserts.

Source | Ebert Composites Corp.





Developed by Ebert Composites Corp. (Chula Vista, Calif.) and licensed to Creative Pultrusions Inc. (Alum Bank, Pa.), *Transonite* pultruded sandwich panels feature z-axis reinforcement, yielding a composite with structural fibers that span three orthogonal directions. The through-thickness fibers (precut rovings) are deposited through the top and bottom skins of the panel, tying the skins together through the core. The finished panel offers high strength at very low weight, adds thermal and acoustical insulation, and increases durability. Further, the process can produce very wide and long panels with seamless surfaces — an important feature in RVs, where large panels are the norm and moisture intrusion is a concern at joints.

Reportedly, current bows demold easily and a quick snip separates parts from runners. The wood blocks are then trimmed to OEM-specified length. Finally, one bow surface is prepped for adhesive bonding, which will be performed at the OEM. After that, parts are packaged and shipped.

Although the bows see no outside exposure, they must withstand concentrated loading during tests in which four assembled beams are subjected to sustained 750-lb/340-kg loads for three days at room temperature and must not deflect more than 0.75 inch/19 mm.

A typical 35-ft/11m tow-behind RV typically requires 30 of these beams, which can range from 68 to 96 inches (1,727 to 2,438 mm) in length but with wall sections that are only 3 to 4 mm (0.12 to 0.16 inch) thick. In use, the bow is placed in tension along its bottom edge and compression along its top edge.

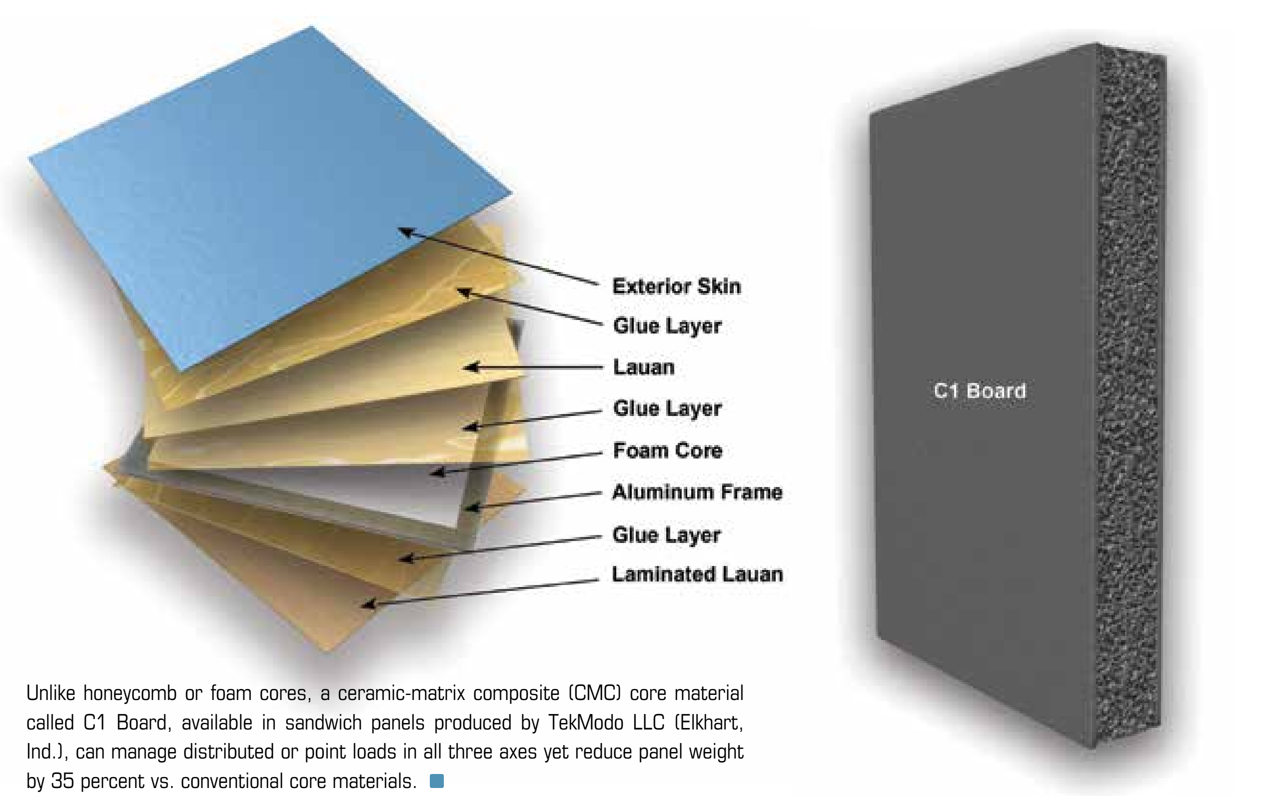
"Although acceptance of composite rafters hasn't spread as fast as we'd hoped," Renteria notes, "our product has been out in the field for several years now and is doing very well there."

BUILDING A BETTER MOUSE TRAP

Alum Bank, Pa.-based Creative Pultrusions Inc. now provides RV OEMs a unique three-dimensional (3-D) pultruded sandwich-panel technology for RV sidewalls and floors, called *Transonite.* Covered by nine U.S. patents, it was developed by Ebert Composites Corp. (Chula Vista, Calif.) under a grant through the U.S. National Institute for Science & Technology (NIST)'s Advanced Technology Program (ATP). "We originally made a NIST proposal to develop an automated process for making 3-D composites by getting fibers into the z-direction," recalls David Johnson, Ebert chairman and CEO. "We felt that if we could do this, we'd create a material that would act more like a metal *and* be machinable, which means originally we were looking at bar stock and billets." Halfway through the program, the Ebert team substituted foam on the inside and switched to pultrusion, and that evolved into the *Transonite* product. Next, they developed the equipment and process needed to deposit the rovings through skins without breaking or tearing them. This provided a pathway for fiber placement, allowing rovings to be pulled through without breakage, leaving straight, regular columns of fiber. All of this occurs *before* resin impregnation, so it necessitated creation of special support tooling to keep the skins and z-axis fibers, in what amounts to a dry preform, from collapsing on themselves.

"This is a very sophisticated piece of equipment," Johnson sums up. "It … has 17 four-axis robotic modules managed by four robotic servomotors each below and above the package just for the fiber insertion." The servos control acceleration and deceleration as fiber bundles are put in place, and also control a cam cutting edge that severs all rovings simultaneously. (Rovings are "clinched" or "riveted," meaning there is no connection between one discrete fiber bundle and another — that is, they are not stitched together). "Essentially, we had developed an 88-axis robotic machine and a 16-step process when we were done," he adds.

Ebert's technology is now in its third generation. The fully automated process and equipment are used to pultrude sandwich panels that feature z-axis reinforcement (i.e., structural fibers that span three orthogonal directions). The through-thickness fibers — pre-



Unlike honeycomb or foam cores, a ceramic-matrix composite (CMC) core material called C1 Board, available in sandwich panels produced by TekModo LLC (Elkhart, Ind.), can manage distributed or point loads in all three axes yet reduce panel weight by 35 percent vs. conventional core materials.

cut rovings — are deposited through top and bottom skins, tying skins together through the core, which is already in place. Glass roving is most common, but carbon, aramid, basalt and other fibers can be used. This increases panel durability by boosting delamination resistance and peel strength one-to-two orders of magnitude and also improves torsional stiffness compared to a similar sandwich panel without the through-thickness fibers.

Although the most common fiber orientation is perpendicular (90°) to the skin surface, the technology's latest generation can add to the core *another* fiber layer (at nearly 45° to the z-axis fiber columns) prior to resin impregnation. The result is an internal "wave" pattern integral to the core that is capable of withstanding deflection and very-high shear forces. Therefore, components can maintain their structural integrity because the fibers hold them together.

In a subsequent step, resin impregnation occurs, then additional skin layers are added (locking rovings into original skins). Finally, the pultruded sandwich is pulled through a heated die, where resin is catalyzed and cured.

Because the cores can be monolithic, foamed resins or balsa wood, and a wide range of z-axis fibers, fabrics and resins can be used, there is great potential for tailoring part properties, weight and cost to the specifics of each application. For example, the current polymer focus at both Creative and Ebert is thermosets, such as unsaturated polyester, vinyl ester and polyurethane. However, Ebert also has tried thermoplastics, with good success. Other variables can be modified, including overall panel thickness (from 0.5 to 4.0 inches/13 to 102 mm), skin thickness (0.05 to 0.40 inches/1.27 to 10.2 mm), the ratio of panel to core, panel width (6 to 102 inches/15 to 259 cm), and the density of the 3-D fibers (0.5/in^2 to 16/in^2 or 0.08/cm^2 to 2.48/cm^2)

The benefits of the panel technology include thermal and acoustical insulation, durability (particularly in terms of delamination, which is said to be virtually eliminated) and corrosion resistance.

Given the degree of tailorability, these panels are targeted not only to the RV and other recreational applications, but also to transportation (i.e., truck trailers and rail cars) and marine markets as well as ballistic panels, air cargo containers, furniture and bridge decks. Further, the automated production process is capable of supporting an auto or truck OEM's higher manufacturing volumes at relatively low cost.

The panels (said to be quasi-isotropic) can be pultruded and cut to nearly any length beyond 1 inch/25 mm, with a maximum width of 102 inches/2,590 mm. "No one else can go that wide," claims Ted Harris, P.E., who joined Creative Pultrusions as market development engineer after many years in the RV industry at several major OEMs. "The most common size panel … in this industry is 4 by 8 ft (1.2 by 2.4m), which means a lot of seams. Many producers have problems doing length, but since we have a continuous process, we can cut our panels to almost any length as they come off the line, and that gives us another big advantage in this market." Specifically, large, clean surfaces without edges or seams are important features for the RV industry, where large panels are the norm and moisture intrusion is always a concern at joints. The resulting sandwich panels are said to offer extremely high strength at very low weight.

Harris is excited about *Transonite* for several reasons. "The fiber inserts are solidly connected to the skins, creating an I-beam effect, so there's virtually no delamination," he contends. Because sandwich-panel walls and floors in the RV system typically are bonded together, Harris notes there are many ways problems can be introduced. "You can get miss-outs [breaks in adhesive/sealant beads] or poor cure of your adhesive," he says, "and eventually that's going to destroy your laminated sandwich. Now, put that panel out in a harsh environment with hot and cold cycling and you're going to start seeing blisters and bubbles. Even with good caulking, if you have wood in your product, it's going to pull in moisture." Harris says that in addition to water-resistance, *Transonite* "has greater shear capacity and shear modulus, it's got localized compression strength and it's got an R value." A 3.5-inch/89-mm thick panel's R-value rating is 11.5. By comparison, the R-value of wood, aluminum and fiberglass panels is almost nil.

Late in April 2014, Creative Pultrusions became Ebert's sole licensee for the technology. It has three *Transonite* production machines and is selling panels into the RV industry. Reportedly willing to be a Tier 2, producing "bare" panels that a Tier 1 supplier could finish, Creative Pultrusions also can produce and supply finished panels directly to OEMs. Although current bare panel technology is white, panels reportedly can be produced in almost any color. Further, a variety of surface treatments for interior/exterior walls and flooring are available, including carpet, antiskid aggregate, wallpaper and polyurea finishes. Wall panels also can be supplied with CNC-routered window and doorway openings and/or channels to reduce installation time and labor on OEM assembly lines.

LIGHTENING UP WITH CMCS

Much more than a lightweighting solution is a new ceramic-matrix composite (CMC) recently rolled out by TekModo LLC (Elkhart, Ind.). Essentially ceramics that can be tailored like other composites, CMCs are known for low density, high hardness, high compressive strength (from 5,000 psi/35 MPa for lower density products to 50,000 psi/345 MPa for fully dense grades) and exceptional thermal and chemical stability. CMCs typically replace metallic superalloys in aerospace parts, such as missile structures, radomes and fighter jet exhaust systems. As one would expect with such high-performance materials, they normally are very expensive, making their use in the RV industry novel. The unnamed producer of Tekmodo's CMC product, however, has developed a new continuous (rather than batch) production process, which drops cost significantly. These new CMCs are described as a silicon carbide-based matrix with ceramic fiber reinforcement in the form of particles, whiskers, fibers or even nanofibers, which improve the ceramic matrix's low fracture toughness and help control crack growth. "Green-stage" material can be injection molded, cast, extruded or pultruded like conventional composites. Both fiber orientation and porosity can be controlled to tailor strength and density to the application. The resulting CMC panels, therefore, are said to be 35 percent lighter but only

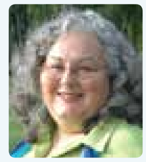
10 percent more costly than the fiberglass-skinned, aluminum and expanded polystyrene (EPS) foam sidewalls they replace. While the latter exhibit poor insulation and structural values, CMC formulations with reduced densities are said to be similar in consistency to closed-cell foams, yet *100 times* stronger *and* provide good thermal insulation (R-value of 40 in 1.5-inch/38-mm thick wall sections). Notably, fully dense versions are capable of stopping .50-caliber bullets in armor plates.

TekModo is the first commercial integrator for the new CMC technology, called C1 Board. Reportedly, the CMC core can be struck with a hammer without crack propagation, despite the fact that ceramics are considered to be brittle. The product's density is typically 12 to 36 pcf/192 to 577 kg/m^3. In use, cores are surrounded by SpectraLite skins of unidirectional fiber-reinforced thermoplastic tapes in colors of red, green, or blue, with newer Intensity grades coming in the near future in what TekModo CEO Marc LaCounte describes as "very vibrant colors with metallic and pearlescent effects — a vivid departure from the RV industry's standard white and brown." Reportedly, coatings are available to produce automotive-quality Class A finishes.

To support the product's launch into the RV and commercial truck trailer markets, TekModo opened a new composites manufacturing campus in Elkhart under the name TekModo Structures LLC. There, it will manufacture finished sidewalls and floors as well as composite-tape-based roof systems, trailer frame/floor combinations and ramp doors. The facility also houses a research cell dedicated to new product development. LaCounte says that a CMC technology called AirFrame already is in the works for trusses.

THE DOWNTURN'S UPSIDE

As this sampling demonstrates, there's a lot happening in the RV market, thanks in part to automotive and advanced materials suppliers that, during the 2009-2012 global downturn, diversified their market focus and worked cooperatively to develop new products for the RV industry — many of which are only now being commercialized. As the RV industry confronts the need to lose weight, improve durability and manage costs, *CT* expects to cover additional innovative technologies in the not-too-distant future. **| CT |**



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Read more about cosmetic and durability concerns for roof membranes on truck trailers | short.compositesworld.com/BigBox.

Applications

HYPERBARIC CHAMBER | Portable, *pliable* FRP handles pressure

Hyperbaric Oxygen Therapy (HBOT) is recognized by Health Canada (Ottawa, Ontario), the U.S. Food and Drug Admin. (FDA, Washington D.C.) and European health agencies as an effective treatment for more than a dozen medical conditions, including carbon monoxide poisoning and decompression sickness. Patients are placed inside a hyperbaric chamber pressurized to greater than 1 bar/14.5 psi, where they breathe 100 percent oxygen through a mask or hood. These rigid, multiplace chambers (they accommodate multiple patients) weigh around 1,500 kg/3,307 lb. Although there is a market for portable, single-place chambers, the "soft" (collapsible) vessels they would require, until recently, could not sustain pressures high enough for HBOT. Groupe Médical Gaumond Inc. (GMG, Terrebonne, Quebec, Canada) has changed that.

GMG's HematoCare hyperbaric chamber comprises three composite parts: a control station, a transport case that doubles as the chamber base, and a unique flexible pressure vessel. The vessel is filament wound with Kevlar aramid fiber (**DuPont Protection Technologies**, Richmond, Va.) impregnated by a specially developed resin that provides flame resistance and strength sufficient to meet pressure loads. It's rated at 3 ATA (absolute atmosphere) or 29.4 psig/2.0 bar, but has a Shore A hardness of only 25 — softer than a gel-type shoe insole. As a result, the vessel can be folded in on itself (see photo immediately below), yet has withstood 9.31 bar/135 psi during burst testing. Assembled, HematoCare is 2.5m/8.2 ft long with a maximum diameter of 1.1m/3.6 ft, but it collapses to 0.7m/2.3 ft long — compact enough for transport via crossover utility vehicle (see bottom photos). Not surprisingly, GMG has patented multiple aspects of the HematoCare, including the innovative fire retardant used in the vessel membrane.

Determining the optimum winding angles and pattern was the key to its pliability and dimensional stability. In fact, the composite's high strength-to-weight ratio helped GMG match the performance of steel and acrylic hard chambers, yet at 125 kg/276 lb, it's roughly *one-eighth* the weight of the lightest HBOT-approved rigid vessels.

A 2014 JEC Innovation Award winner in the medical category, HematoCare is targeted not only to medical care facilities, but diving centers and professional sports team facilities as well.

Source | Groupe Médical Gaumond

Composites enable HematoCare to offer the same performance as rigid hyperbaric chambers weighing 1,500 kg/3,306 lb, but at a fraction of the weight, only 125 kg/276 lb, delivering true portability.

Source | Groupe Médical Gaumond

When assembled, HematoCare is 2.5m/8.2 ft long with a maximum diameter of 1.1 m/3.6 ft, but reduces to a length of only 0.7m/2.3 ft when folded for easy transport in a crossover utility vehicle.

Source | SCIGRIP

SOLAR BOAT | **Bonding the best**

The fifth gathering of the Dong Energy Solar Challenge for boats, held June 28 to July 5, in The Netherlands, was the occasion for a multistage, 250-km/155-mile journey along Dutch canals. Participants competed in customized vessels powered only by energy from the sun, collected by solar panels. The race attracted teams of composite engineers, boatbuilders, designers and technical students from around the world, who responded with many lightweight and sustainable boat designs. Adhesives supplier **SCIGRIP** (Durham, N.C.) sponsored the entry from Poland, dubbed the *SCIGRIP Solar Boat*. SCIGRIP provided technical advice, as well as structural bonding products, both throughout the build process and during the race.

The SCIGRIP Solar Boat Team, from Cree Yacht (Gdynia, Poland), is well-versed in the use of advanced composites and has competed in the Challenge since its inception. Team leader Bartosz Puchowski says its 2014 entry is the team's most lightweight structure thus far. SCIGRIP's two-component, high-viscosity methacrylate (MMA) adhesive, SG 230HV, was used to bond the most demanding joints, including bulkheads, engine column, and floater beam sections. Cure cycle duration is reportedly adjustable from 30 to 120 minutes, which gave the team greater flexibility in working times. A black-pigmented formulation of SCIGRIP's SG3000 was used to bond the deck to the infused hull. SG100 White was used to adhere the structure's catamaran floats to the deck, providing UV protection and preventing discoloration as well.

Before the competition began, SCIGRIP also issued specially packaged "Repair Packs" to its own team *and* the other 42 participating teams. The pack included a broad selection of SCGRIP fast-curing and waterproof adhesives formulated to bond easily with composite substrates as well as wood, aluminum and steel.

Poland took 2nd place in 2008 and came in 3rd — but received the Innovation Award for the lightest boat in the competition — in 2012. In 2014, however, Poland's team and the *SCIGRIP Solar Boat* finally placed 1st, finishing the five-stage, week-long competition four minutes and 18 seconds ahead of the closest rival.

EVENT PAVILION | SMC panels ensure architectural authenticity

To expand its services, the High Bullen golf and spa hotel, located on a former country estate in Devonshire, U.K., converted a little-used tennis facility into a flexible space for weddings and meetings. Strict local authorities, however, required that new construction or renovation be consistent with traditional architectural styles. "To reproduce the original building's appearance with *natural* stone would have been very costly and taken a very long time," says Michael Frieh, executive director of **Acell Industries Ltd.** (Dublin, Ireland). That's why the hotel's owner contacted Acell for a cost-effective solution that could duplicate the look of High Bullen's 19th-Century "Devon stone."

Acell's patented molding technology was up to the task: It combines sheet molding compound (SMC) faceskins with a core of frangible yet fire-resistant "mineral foam" in a low-pressure compression molding press. A master model of fiberglass can be layed up directly on any natural material, making it possible to replicate virtually any planar architectural texture, ranging from, as in this case, classical stone and brick to very contemporary designs, in cast aluminum mold surfaces says Frieh. Color is duplicated with inmold coatings, natural sand or even printed fabrics. Realizing shape and color in a single step eliminates secondary finishing, keeping cost and production time to a minimum. Frieh credits such process efficiency with a big role in sealing the hotel contract: "The speed of installation and the panel price were very attractive."

For the pavilion façade, Frieh says, "we photographed buildings in surrounding villages to get the feel of the local architecture and the variance in the Devon stone material." Acell also chemically analyzed a Devon stone sample, and incorporated powdered iron oxide and sand grains during the inmold coating process, so the panels look and *feel* like authentic stone.

Stone samples and a facsimile of slate roofing tiles, also reproduced by Acell, have been accepted by the owner, builder and permitting authority. Frieh expects to get the "go ahead" imminently and, when the pavilion makeover is done, will follow up with a model guest bungalow that will net a contract for *100* planned units.

Calendar

AUG

August 4-7, 2014 ***CMH-17* PMC Coordination Meeting**
Miami, Fla. | www.cmh17.org

SEPT

Sept. 9-11, 2014 **SPE's Automotive Composites Conference and Exhibition (ACCE)**
Novi, Mich. | http://speautomotive.com/comp.htm

Sept. 10-11, 2014 **CW TRAM – Trends in Advanced Machining, Materials and Manufacturing at IMTS 2014**
Chicago, Ill. | www.tram-conference.com

Sept. 11-12, 2014 **FRP Bridges 2014**
London, U.K. | www.netcomposites.com/calendar/frp-bridges-2014/1335

Sept. 16-19, 2014 **SAMPE Asia 2014 and Korea Composite Show**
Goyang, South Korea | www.sampe.org/node1

Sept. 23-25, 2014 **SAE 2014 Aerospace Manufacturing and Automated Fastening (AMAF) Conference and Exhibition**
Salt Lake City, Utah | www.sae.org/events/amaf

Sept. 23 -26, 2014 **HUSUM WindEnergy 2014**
Husum, Germany | www.husumwindenergy.com/content/en/start/start.php

Sept. 30-Oct. 2, 2014 **IBEX 2014**
Tampa, Fla. | www.ibexshow.com/tampa2014.php

OCT

Oct. 6-7, 2014 **International AVK Conference on Reinforced Plastics/Composites**
Düsseldorf, Germany | www.avk-tv.de/congress.php

Oct. 7-9, 2014 **Composites Europe**
Düsseldorf, Germany | www.composites-europe.com

Oct. 13-16, 2014 **CAMX – The Composites and Advanced Materials Expo**
Orlando, Fla. | www.thecamx.org

Oct. 27-29, 2014 **SAMPE China 2014**
Beijing, China | www.sampe.org.cn

Oct. 28-29, 2014 **JEC Americas Boston**
Boston, Mass. | www.jeccomposites.com/events/jec-americas-2014-boston

NOV

Nov. 11-12, 2014 **Advanced Engineering UK 2014**
Birmingham, U.K. | www.advancedengineeringuk.com/hub

Nov. 11-13, 2014 **Feiplar Composites + Feipur 2014**
Sao Paulo, Brazil | www.feiplar.com.br/ingles/index.html

Nov. 17-19, 2014 **JEC Asia 2014**
Singapore | www.jeccomposites.com/events/jec-asia-2014

DEC

Dec. 1-3, 2014 **5th Wind Turbine Blade Manufacture Conference**
Düsseldorf, Germany | http://10times.com/wind-turbine-blade

Dec. 9-11, 2014 **CW Carbon Fiber 2014**
La Jolla, Calif. | www.compositesworld.com/conferences/compositesworld-2014-carbon-fiber-conference

Dec. 10-12, 2014 **India Composites Show 2014**
Mumbai, India | www.indiacompositesshow.com

TRAM AEROSPACE CONFERENCE

TRENDS IN ADVANCED

SEPTEMBER 10-11, 2014
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AT IMTS 2014

Modern Machine Shop

Wednesday, September 10

8:00-9:00am - Registration and Coffee

9:00-9:15am
Welcome Address
Adrian Allen, Commercial Director, The AMRC

9:15-10:05am
Keynote: Important Trends in Manufacturing Technology - Dr. Greg Hyslop D.Sc., Vice President and General Manager of Research & Technology, The Boeing Company

10:05-10:30am
New Uses for High Speed Electro Erosion (HSEE)
Scott Walker, President, Mitsui Seiki

10:30-10:45am - Coffee Break

10:45-11:10am
Harnessing New Technology and Opportunities
Bill Smith, Director of Technology Development, Spirit AeroSystems

11:10-11:35am
Super Plastic Forming for Aerospace
Andries Buitenhuis, Chief Engineer, Fokker Aerostructures

11:35-12:00pm
The Impact of New Trends in Machining Technology and the Effect on the Manufacturing of Aerospace Components - Michael Standridge, Aerospace Industry Specialist, Sandvik Coromant

12:00-1:30pm
Lunch and Keynote Address
Ricardo Traven, Chief Test Pilot - F/A-18 Programs Super Hornet Demonstration Pilot, Boeing Test and Evaluation

1:30-1:55pm
Measurement Systems to Optimize Automation Processes - Lester Glover, Vice President of Business Development, Hexagon Metrology Inc.

1:55-2:20pm
Future of Aerospace Technology - Breaking the Code
Colin Sirett, Head of Research & Technology, Airbus in UK

2:20-2:45pm
Connecting the Dots - Jim Kosmala, Vice President of Engineering and Technology, Okuma

2:45-3:00pm - Coffee Break

3:00-3:25pm
The Identification and Management of Residual Stress
Dr. James Hughes, AMRC

3:25-3:50pm
Advances in Metrology Assisted Manufacturing
Tarquin Adams, Group Communications Manager, Renishaw

3:50-4:10pm
The Billion Dollar Solution
Nadia Alberti, Alberti Umberto

4:10-4:20pm - Coffee Break

4:15-4:40pm
Business Innovation: From Bushveld to Aerospace
Rich Ward, President, WARDJet, Inc.

4:40-5:05pm
The Reality and Challenge of Machining Complex Monolithic Aerostructure
Mark Wilson, Head of Manufacturing Research and Development, BAE Systems

5:05-5:30pm
Friction Stir Welding - A Perspective on the State-of-the-Art and Technology Challenges
Tracy W. Nelson, PhD, Mechanical Engineering, Brigham Young University

6:00-8:00pm - Networking Reception at the House of Blues

MACHINING, MANUFACTURING AND MATERIALS

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Thursday, September 11

8:00-9:00am - Registration and Coffee

9:00-9:15am
Welcome and Conference Details
Don Kline, Vice President, Gardner Business Media

9:15-10:05am
Keynote: Driving Success through Intellectual Property Collaboration
Peter Hoffman, Vice President, Intellectual Property Management, The Boeing Company

10:05-10:20am - Coffee Break

10:20-10:45am
Advancements in Materials
Tim Armstrong, Vice President of Research and Product Commercialization, Carpenter Technology Corporation

10:45-11:10am
Innovative Technologies for the Aerospace Industries
Michael Kirbach, Director of the Aerospace Excellence Center, DMG MORI

11:10-11:35am
Engine Performance Driving Manufacturing Excellence - Bob Fagan, Chief Technology Officer, Commonwealth Center for Advanced Manufacturing

11:35-12:00pm
Cost Effective Machining of Titanium
Mark Larson, Manager of Titanium Process Development, Makino

12:00-1:30pm
Keynote Lunch: What's Driving us Forward? Landing Gear - Past, Present and Future
Chris Wilson, Managing Director and Vice President Production, Messier-Dowty Limited

1:30-1:55pm
Combining Additive and Subtractive Technologies for Practical Production of Complex Components Including Robotic Cells
Brett Hopkins, North America Professional Service Business Development Manager, Delcam

1:55-2:20pm
Shaping the Future: Additive Manufacturing at GE Aviation
Greg Morris, Additive Technologies Leader, NPI Value Stream, GE Aviation

2:20-2:45pm
Advanced Aerospace Manufacturing Today
Rick Schultz, Aerospace Program Manager, FANUC America - CNC; Chris Blanchette, National Account Manager for Distribution Sales, FANUC America - Robotics

2:45-3:00pm - Coffee Break

3:00-3:25pm
Hole Generation in Airframe Structure
Rich Garrick, President, Precorp, Inc.

3:25-3:50pm
Identifying and Managing Chatter
Dr. Gareth Morgan, Advanced Manufacturing Limited; Jerry Halley, EVP - Chief Engineer, Tech Manufacturing, LLC

3:50-4:15pm
Environmental Impact of Manufacturing Processes
Dr. Sergio Durante, Executive Vice President of DIAD Group; Dr Nicola Ridgway, Research Manager, TEKS

4:00-5:30pm - Questions and Cocktails with Industry Experts

For session abstracts and speaker bios, visit tram-conference.com

NEW Products

Inductively heated molding process for mass production

Inductive mold-heating specialist **RocTool** (Charlotte, N.C., and Le Bourget du Lac, France), announced at CompositesWorld's Thermoplastics Composites Conference for Automotive (June 11-12, Novi, Mich.) the launch of a new tooling system and molding process that the company says is

well-suited for high-volume manufacturing applications. Called Light Induction Tooling (LIT), the system incorporates a closed mold — a steel female tool with a silicone male tool. A unidirectional or woven fiber reinforcement (carbon, glass, natural or aramid), either dry or prepreg, is placed in the female mold. If the reinforcement is dry, resin is added in powder or film form. The resin matrix can be thermoplastic or thermoset. The silicone male core is then closed and clamped to the female base. Pressure up to 30 bar/420 psi is provided by air injected into the mold as RocTool's inductive heating system reportedly ramps up mold temperature to 280°C/536°F in 45 to 90 seconds, depending on the part and material. The same system quickly cools the mold and part via water in another 60 to 120 seconds. Total cycle time is said to range from 105 to 310 seconds. RocTool says the system requires no preheating or resin injection, provides a resin-rich surface, enables thin-walled parts and offers good temperature control. On display were three suitcase shells (wall thickness of 1 mm/0.04 inch) that were molded with LIT using carbon, glass and natural fiber infused with PET and PP resin. **www.roctool.com**

3-D draping software for complex laminates

Nuclear Strategy Inc.'s (Bristol, U.K.) Advanced Drape Software (ADS) for composite structures that are produced by automated fiber placement (AFP) and automated tape laying (ATL) provides a 3-D mathematical modeling solution to the 3-D problem of optimizing layups on tool surfaces with complex curvature. According to principal developer Yoldas Askan, even slight fiber path deviations can introduce internal stresses to placed fibers, which then act as crack propagation sites, like impurities in metals. Instead of relying on steering to compensate for such errors in conformity, ADS enables more accurate modeling of carbon strip behavior in order to minimize gaps and overlaps in adjacent fibers and enable the actual engineering of fiber orientations and minimized gaps into the final composite structure. Manufacturers reportedly can save money, reduce cycle time and improve structural performance by using ADS in place of integrated laser projection, adaptive molds and other strategems, and can perform more virtual layup studies on the mold, enabling the calculation of optimum carbon ribbon width and thickness for a specific structure and minimized manufacturing time. **http://nuclearstrategy.co.uk**

Digital vacuum gauge

Airtech Advanced Materials Group (Huntington Beach, Calif.) has introduced the Vac-Gauge 40D, a digital vacuum gauge used for leak detection and vacuum determinations under a vacuum bag during infusion molding processes. The gauge offers vacuum readings in four selectable units: mBar, mmHg, inHg and KPa. A heavy-duty, ridged plastic jacket protects the gauge from damage during normal shop use. The Vac-Gauge 40D connection stem is a 1/4-inch/18-NPT thread fitting that fits into Airtech's Airlock 450TF, 550TF and AQD quick disconnects. The gauge has a time-selectable auto-off function and can be calibrated. **www.airtechonline.com**

Epoxy composite tooling materials

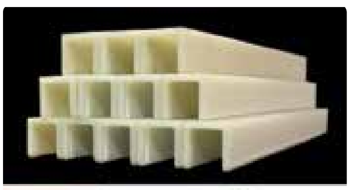
Sika Deutschland GmbH (Bad Urach, Germany) has introduced Biresin CR132 ST and Biresin CR136, two epoxy tooling resin systems for composite molds. Biresin CR132 ST, a paste-like epoxy resin system, is used to couple a gel coat to the first laminate layer, with what is said to be minimal print-through of the first fabric layer. Biresin CR136 is a filled epoxy system that reportedly helps conduct and distribute heat across the mold area, when the tool(s) is(are) heated by steam, oil or other fluids, ensuring that all areas of the tool cavity are equally heated. All the resins offered by Sika in the Biresin range are fully compatible, offering what is said to be a high-performance, easy-to-use tooling system with a T_g of 130°C/266°F, allowing usage up to 120°C/248°F. **http://toolingandcomposites.sika.com**

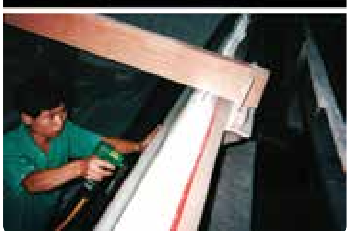
Flame-resistant PVDF

Arkema Inc. (King of Prussia, Pa.) has announced that Kynar 705 polyvinylidene fluoride (PVDF) has been developed to address the growing need for high-performance flame-resistant fibers. This polymer is said to be suitable for ASTM E84, "Standard Test Method for Surface Burning Characteristics of Building Materials." The new homopolymer grade of Kynar 705 resin has a limiting oxygen index of 70, which means it will not support combustion below 70 percent oxygen concentration. Arkema says the resin was developed for low-denier fiber applications and can be manufactured into spunbond nonwovens and multifilaments, which then can be converted into staple fiber nonwovens or into woven products. **www.arkema.com**

Sandable, planeable composite staples

Utility Composites Inc. (Round Rock, Texas), manufacturer of RAPTOR composite staples and nails, has introduced the latest addition to the RAPTOR product line, the SH/04-40 composite staple. This 11-mm/0.43-inch, 16-gauge staple is said to be sturdy enough to perform well in wind turbine blade manufacturing and composite boatbuilding and is compatible with resin transfer molding (RTM), vacuum-assisted RTM (VARTM), prepreg, fiberglass mat, carbon fiber mat or SCRIMP layup. Utility Composites claims that it is not necessary to remove RAPTOR staples because they will not promote delamination. Further, they are not susceptible to corrosion, and interfacial bonding with thermoset resins is reportedly excellent. Because RAPTOR staples can remain in the material, there are no holes to fill from fastener removal and no outgassing from holes. The company notes that the SH/04-40 staple performs optimally in the OMER 83P pneumatic stapler and is compatible with BEA P8/16-428 and Kowa S-8 tools. **www.raptornails.com**





Glass-filled polymers for additive manufacturing

Polyamide specialist **Solvay Engineering Plastics** (Lyon, France) has introduced a new 40 percent glass-filled grade of its range of Sinterline polyamide 6 powders, designed for use in selective laser sintering (SLS) of automotive under-the-hood components as well as electrical and consumer goods. Based on the same resin chemistry as Solvay's established Technyl polyamides, Sinterline reportedly delivers prototype parts with functional properties, bridging the gap between visual prototyping and injection molded PA6 or PA 6/6 components. Solvay says this material creates time and cost savings for OEMs and Tier 1 suppliers (particularly in the automotive industry) because it can provide more predictable results during functional prototype testing, minimize the need for preproduction tooling, and speed the transition from design to market. Sinterline powder grade offers a tensile modulus of 6,300 MPa at 23°C/73°F, combined with a porosity of 1.8 percent. **www.solvayspecialtypolymers.com**

Large-format FRP sheets

Röchling Engineering Plastics KG (Haren, Germany) is now offering its Durastone fiber-reinforced plastic sheets, produced via press molding in lengths of up to 12m and widths of up to 0.95m (39.4-ft by 3.1 ft). Durostone sheets comprise a resin matrix of polyester, vinyl ester or epoxy and glass reinforcement (mat or fabric). Large-format sheets are available for customer machining, or Röchling can custom-machine them to customer specification prior to delivery. Target applications include generator and transformer construction, control panels and vehicle and traffic engineering structures. In the electrical industry in particular, the larger sheets enable the application of one-part peelable slot liners made of Durostone EPC SL 38 in generators that are 10m/32.8 ft long and longer. **www.roechling.com**

Wide-format, flatbed cutting system

AZCO Corp. (Fairfield, N.J.) has introduced a shear-cut traveling knife assembly designed to cut material up to 1,400 mm/55 inches wide and 3 mm to 55 mm (0.1 to 2.2 inches) thick. This cut-to-length unit is built to feed the material all the way through the knife assembly. A precision-ground urethane drive top roller supplies a force that provides positive traction between the material and the drive system. A brushless servomotor is said to ensure high accuracy with low maintenance. Its programmable logic controller (PLC) controls and monitors servomotor drive operation and the entire cutting process. System set-up and control is managed by the operator from a color touch screen interface. To ensure safe operation, the unit will operate only if material is present to be cut. **www.azcocorp.com**

Textbook explores mechanics of adhesives

DEStech Publications Inc. (Lancaster, Pa.) has released *The Mechanics of Adhesives in Composite and Metal Joints: Finite Element Analysis with ANSYS* (192 pages, hardcover, $129.50 USD), by Magd Abdel Wahab, Ph.D, professor and chair of Applied Mechanics, Ghent University, Belgium. The text investigates the mechanics of adhesively bonded composite and metallic joints, using finite element analysis (FEA) and, more specifically, ANSYS FEA software (Ansys Inc., Canonsburg, Pa.). The book is intended to provide engineers and scientists with the technical know-how to simulate a variety of adhesively bonded joints using ANSYS, the basics of which are presented. It explains how to model stress, fracture, fatigue crack propagation, and thermal, diffusion and coupled field analysis of the following: single-lap, double-lap, lapstrap/cracked-lap-shear, butt and cantilevered-beam joints. Readers receive free digital access to a variety of input and program data, which can be downloaded as macrofiles for modeling with ANSYS. Book highlights: Scientific background and practical methods for modeling adhered joints; tools for analyzing stress, fracture, fatigue crack propagation, thermal, diffusion and coupled thermal-stress/diffusion-stress as well as life prediction of joints; and access to downloadable macrofiles for ANSYS. **www.destechpub.com; www.ansys.com**

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Sitting pretty

CAR SEAT CONCEPT SCORES A FIRST

Automotive supplier's reinforced thermoplastic back frame curtails weight and simplifies molding/styling tasks.

With few exceptions, composites in high-volume commercial passenger vehicles were limited, early on, to high-temperature intake manifolds, oil pans and other powertrain parts. More recently, they've seen use in doors and other interior components. Johnson Controls, Automotive Seating (Plymouth, Mich.), however, is angling for an industry first by extending them to passenger car seating systems.

The company's new "smart seating" concept, the Gen 3 Synergy Seat, made its debut in a big way in 2013, appearing first at the North American International Auto Show (Jan. 19-27, in Detroit, Mich.), then the Shanghai International Automobile Industry Exhibition (SHIAS), April 20-29, and the Internationale Automobil-Ausstellung show (Sept. 12-22, 2013) in Frankfurt-am-Main, Germany. Targeted to the upper end of the passenger car market, the seat features a fiber-reinforced plastic back frame in place of the conventional stamped-steel frame.

This back view of Johnson Controls' (Plymouth, Mich.) Gen 3 Synergy Seat shows its external, contoured fiber-reinforced thermoplastic seat back frame. In commercial production, seat frames will be molded from Bond-Laminate's OrganoSheet, a laminate comprising E-glass twill fabric and polyamide 6 resin. Replacement of a conventional steel seat frame with a composite frame enables designers to integrate parts used for secondary attachments and use the frame as an aesthetic element.

Source / Johnson Controls

The Gen 3's back frame is about 20 percent lighter than a typical steel back frame. That's significant because back frames are an ideal target for weight savings. "In the interior, you look at what's driving weight, and seats are at the top of the list," says Tom Gould, design director, Johnson Controls, noting that a primary reason for this is that there are many parts and standalone structures within the seat.

BEYOND WEIGHT SAVINGS

Gould, however, sees composites in seating systems as a real game changer because they give engineers an opportunity to make revolutionary design changes. In a conventional seat, the steel seat back is buried under layers of fabric and foam. Its function is strictly structural. But the Gen 3 Synergy Seat's composite seat back is a visible, aesthetic component. Its function is both structural *and* stylistic.

"This is where the composite seat story becomes very interesting, because you can do things with composites you can't do with other materials," Gould contends. An exterior back frame offers fresh opportunities to improve seat packaging efficiency by reducing the number of parts and different materials used and, thus, streamline the manufacturing process.

Nick Petouhoff, Johnson Controls' director of engineering, says the visible seat back also presents opportunities for "offsets," that is, features that help to nominally balance the higher cost of the composite. Mindful that offsets would be crucial to customer acceptance, the seat's design team strove to incorporate as many as possible.

In a seat with a metal back frame, a number of secondary attachments affix the head restraint, lumber support, a motor for adjusting the seat and trim wires that attach foam or trim coverings, says Petouhoff. "With the Gen 3 seat, we are able to incorporate many of these parts and features in the tool used to mold the seat back."

As an added benefit, fewer parts and less material permit a slimmer contour, providing passengers with greater interior space and legroom. As a stylistic element, the composite can be decorated in a variety of colors and textures, using either thin films, paint or fabric. The seat back frames for the demonstrator seats were in-mold decorated with a white thin film.

HOLISTIC DESIGN APPROACH

Johnson Controls' interest in composites and innovative seat design preceded the Gen 3 Seat program. An international team of engineers at the company took a blank-slate approach to automotive seating several years ago in a project called "the redefinition seat." Its goal was design solutions that redefine ways occupant movement

JOHNSON CONTROLS' GEN 3 SYNERGY SEAT

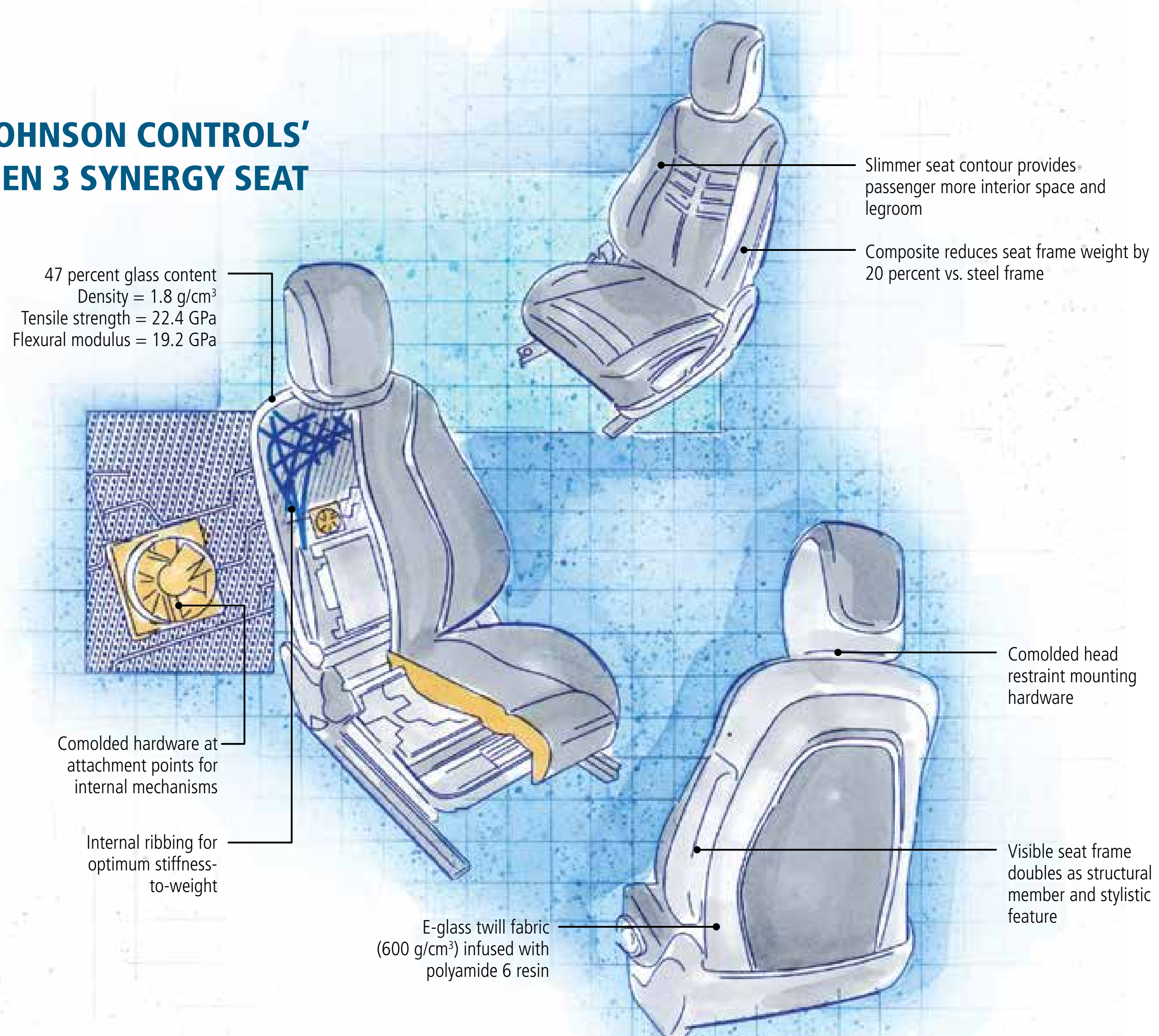


Illustration | Karl Reque

ENGINEERING CHALLENGE:

Eliminate weight in automotive seating back frame without compromising structural and safety performance, passenger comfort and visual appeal.

DESIGN SOLUTION:

Consolidate parts and reduce postmold processing by replacing an internal stamped-metal seat back with a lightweight, visible composite back frame comolded with attachment hardware for head restraint, trim wires, etc.

can be constrained during a crash yet also reduce mass. "Rather than just saying, 'let's substitute one material for another,' we took a more aggressive approach and looked at the very design principles of seating to see how we might start over," says Kurt Siebold, senior manager, new technologies.

The project's prototype seat cushion pan and seat back frame (carbon fiber composites) had new features that could enhance safety and reduce part count and mass. For example, the tube-like front edge of the cushion pan, during a crash, acts as a passenger restraint, distributing the load of thighs and posterior as they thrust forward. "If you can find ways to mitigate moments of force in the design, you can create lighter seat mechanisms and structure," says Siebold.

Design protocols for the Gen 3 seat were similarly established, using a holistic approach and an interdisciplinary project team that began by gathering information on the latest trends in consumer research, market data, customer feedback and benchmarking. It then defined the requirements of the seat's three stakeholders — consumers, society and OEMs — emphasizing within the design the objectives of safety, comfort and functional ergonomics. Drawing on inhouse seat-design expertise, alternative metals, mechanisms, foam, trim, fabrics and composites were evaluated. The overall goal was a seat design that reduced mass and complexity.

Jeff Lindberg, Johnson Controls' chief engineer, automotive seating, says that the Gen 3 seat is beyond the prototype phase and that the first demonstrator seats were built on production tooling to show customers that the design principles would work in a complete auto interior/seating context. Lindberg declined to reveal the exact thickness and other dimensions of the composite seat back ►

Source | CT / Photo | Michael LeGault

Johnson Controls recently installed a crash test sled at its engineering and design facility in Plymouth, Mich. The sled will enable engineers to conduct and coordinate various dynamic load tests on the Gen 3 Synergy Seat that are required by the U.S. government and auto OEMs prior to commercial production.

Source | Johnson Controls

Cut-away views of the Gen 3 seat show the inner portion of the composite seat back frame and illustrate other features incorporated into the seat, including its Vibratec double-layer foam seat cushion and breathable fabrics.

for the demonstrator seats, noting that these parameters ultimately will be vehicle-specific. "Dimensions and thicknesses … are dependent on the vehicle/seat packaging dimensions and requirements, as well as how much content will be packaged into the seat," Lindberg explains. "The degree to which the seat back frame could be made smaller, thinner or lighter will depend on the actual application." Lindberg reports that taking into account the potential for greater shape complexity and part integration, a 15 to 20 percent weight reduction for the composite back frame is expected.

TOUGH CARBON FIBER/THERMOPLASTIC

The seat backs for the demonstrators were made from polyamide-infused carbon fiber, to enhance durability during transport, handling and display in trade-show settings. In production, Johnson Controls plans to mold back frames from Bond-Laminate GmbH's (Brilon, Germany) OrganoSheet, comprising that company's trademarked TEPEX dynalite 102-RG600 E-glass roving twill fabric, with an areal weight of 600 g/m^2 and a polyamide 6 (PA 6) matrix.

In production, the glass roving is heated and preformed in a mold at a temperature in the range between 240°F and 260°F (115°C and 127°C). The preferred heating method is mid-wavelength infrared (IR), but contact heating in the mold may be used with a release film. Next, the formed sheet is placed in the production mold — tools can be either aluminum or steel — mounted in an injection/compression machine at JCI's facility in Burscheid, Germany, and infused with PA 6. Tool temperature is maintained between 195°F and 230°F (90°C to 110°C). The consolidated laminate is approximately 47 percent glass, with a density of 1.8 g/cm^3, a longitudinal tensile strength of 22.4 GPa and a flexural modulus of 19.2 GPa.

The seat back must meet government-mandated structural and dynamic loading thresholds, which correlate in the lab, respectively, to a high-strength static test and a high-energy impact test. The company recently installed a test crash sled at its R&D facility in Plymouth to conduct trials (see photo above).

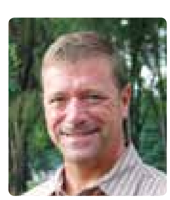
Petouhoff reports that the strengths of the composite and steel seat backs are comparable, but he points out that one challenge of working with composites is that the performance properties of a given laminate can vary with the operational temperature in an auto interior, which can range from -22°F to 176°F (-30°C to 80°C). The properties of steel, on the other hand, are relatively constant in this range. Rigorous field testing of Gen 3 seat systems will be necessary to validate the composite's performance under this wide range of environmental conditions, he says.

SAFETY PLUS CONSUMER APPEAL

The frame's exterior position and open contour enabled designers to draw a pleasing contrast between the light-colored frame and darker interior zones of the seat. Further, there is a deliberate play on the contrast between convex and concave surfaces that has the effect of visibly reducing volume, making the seat appear lighter. Beyond composites, the Gen 3 seat system also incorporates other innovations. The seat's breathable Dri-FIT fabrics, for example, wick moisture away from the passenger's body. And its VariTec foam seating system's dual horizontal foam layers, with varying levels of hardness, ensure comfort on long drives.

THE ROAD AHEAD

Johnson Controls is now carrying out codevelopment work on the Gen 3 Synergy seat with a number of automotive OEMs toward the goal of full commercialization. "There's definitely excitement about the use of composites in seats and automotive interiors," says Gould. "The industry just needs to understand how they will impact mass of the vehicle and, at the end of the day, the cost." | CT |



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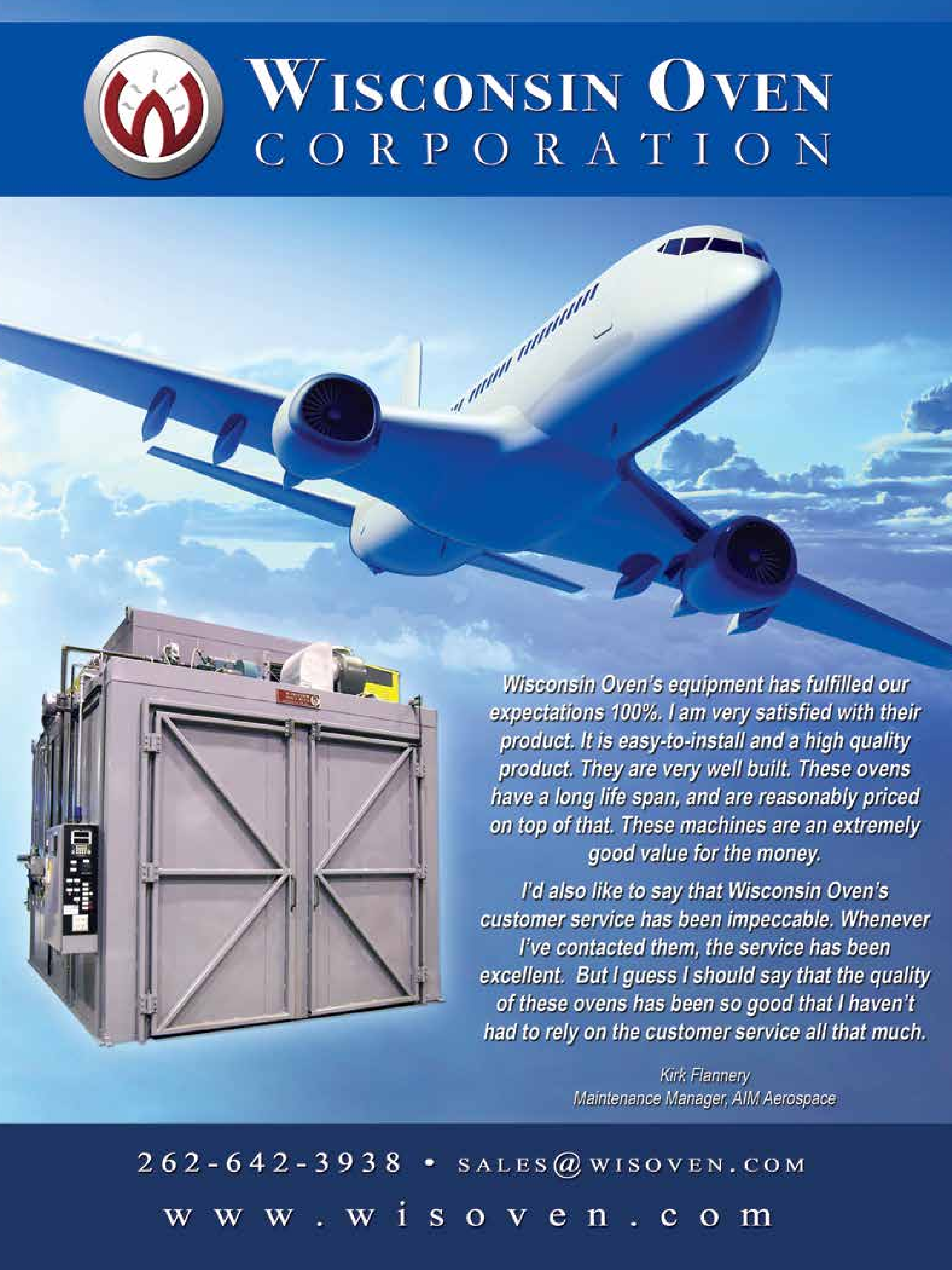
WISCONSIN OVEN
CORPORATION
Wisconsin Oven's equipment has fulfilled our expectations 100%. I am very satisfied with their product. It is easy-to-install and a high quality product. They are very well built. These ovens have a long life span, and are reasonably priced on top of that. These machines are an extremely good value for the money.
I'd also like to say that Wisconsin Oven's customer service has been impeccable. Whenever I've contacted them, the service has been excellent. But I guess I should say that the quality of these ovens has been so good that I haven't had to rely on the customer service all that much.
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