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Directed Fiber Preforms

Hunting Down Styrene

Industry Nice Guy Edgar Morris

COMPOSITES '99

A new millennium made of composites

From top left clockwise: A Polaris rocket; Morris receives JH "Jud" Hall Award from SME; first DOT authorized composite pressure vessel for routine use as a self-contained breathing apparatus for fire fighters; new generation carbon filament-wound composite cylinders for self-contained breathing apparatus; a young Ed Morris winding a rocket motor case in 1960.

This is another article in Composite Fabrication's series to celebrate legends of the industry and the history of their accomplishments.

Edgar Morris:
Nice Guys Finish First!

By Andrew Rusnak
Editor, *Composites Fabrication*

"Now there's a truly nice guy," said CFA's Bob Lacovara, as we trudged out of Luxfer's Riverside plant on a hot, dry day in Southern California.

We made our way across the spongy asphalt to the car and I thought about how Edgar Morris had glided from workstation to workstation in the Composites Cylinder Division that he manages, carefully explaining the details of filament winding, introducing workers on the shop floor as if they were nephews and nieces at a family picnic — cordial first names followed by a measure of respect for how much they've matured.

"This is Manny," he'd say, or, "This is Debbie." And Manny and Debbie would look a little befuddled at the hoopla, but confident they could count on Uncle Edgar when it comes down to listening to their suggestions on untangling snags in the manufacturing process, or plotting strategy to meet a tight production schedule.

Morris had been humble and a little nervous during the interview, more than careful when digressing to off-the-record comments for fear of offending someone, even if the possibility was remote to none. "There are people, and there are people," he'd said.

"Yes, you're absolutely right," I tell Lacovara. "Ed Morris is a nice guy." And a far cry from the quick-turn-around, bottom-line-only, people-are-disposable managers who dominated the advanced composites industry during the 80s and early 90s, I thought. But there's that nagging question, far more complicated than it appears on the surface: Nice guys in manufacturing and their humanistic approach to management, the stuff that looks good in human resources text books, always finish last right?

As we navigated through Riverside toward Interstate 10 and the trip back to Los Angeles, I was hoping for a revelation: Does the people approach work or not? Morris said Luxfer had produced more than 130,000 composite cylinders last year, and they were now the world's largest manufacturer. Easy answer. Morris had been with the company five years. The president hired him to build the composites side of the cylinder business.

But then Morris quickly introduced an array of other variables that led to Luxfer's success like the 1996 approval of carbon fiber for use on cylinders in the U.S., intentionally deflecting Lacovara and I away from what were natural assumptions of his prosperous management practices.

Giving all the credit to 'good timing', however, is too easy. Yes, Edgar Morris — considerate, proactive, like a young boy with a reflective grin — is Mr. Nice Guy. And he's determined to finish first.

It was an 18 year old Ed Morris who hiked to the top of the Bluebird Hills around Glendora, an elevation of approximately 2000 feet in the San Gabriel chain, and scanned the valley below for the flash of rocket motors cutting into the blue, cavernous sky of post-WWII Southern California. Somewhere in the plume of smoke that slowly drifted off, and trips to the California Institute of Technology with his father — a rocket engineer developing JATO assists for aircraft carriers — Edgar's young, fertile imagination ignited and he knew exactly what he wanted to do in life.

"I never had any problem knowing what I was going to do," he says years later in the Luxfer conference room. "By the time I was a junior in high school, I wanted to be a mechanical engineer, and I wanted to work on rockets. We lived in Glendora and the rocket plant was in Azusa, about 20 miles east of Pasadena."

Morris struggles to push aside the anxiety of talking about himself. People's manager or not, like most engineers he'd much rather talk load-bearing designs or

filament wound, helically wrapped and bonded composite rocket cases. So much so, the excitement of shoptalk pits mind against mouth in a race to get the words out. The aerobically fit mind wins as Morris' words sometimes stumble to catch-up. Then, a slow, truly modest thought of, 'Oh'... me again?' thins his voice when a biographical question floats his way. So, before "Where were you bor..." registers as an inquiry, Morris, in his deep, tempered, radio voice, continues his 'know-me-through-my-work' thought. "Actually, some of the earliest winding done in America was for these rockets," he says. "The pipe industry hadn't really developed that much. It was a very new technology."

Morris receives JH "Jud" Hall Award from SME. Left to right: daughter Juliane, wife Vicki, daughter Karin, and son Ted.

Born in Pasadena in 1937, Morris grew up in nearby Glendora where the gravelly rumble of rockets provided an audio backdrop to daily life. Southern California during and immediately following the war was still quite rural. "You could get to the country very easily," Morris laments.

Azusa was home to Aerojet-General Corporation's rocket test facility, and Steele Morris, Edgar's father and a 1924 graduate engineer of the Stevens Institute of Technology in Hoboken, New Jersey, found a home there, leaving the immigrant bustle of New York City after the Depression.

"Theodore Von Karman, a very famous person in rocketry and academics, started a small company called Aerojet during World War II and made rocket motors," Morris recalls. "When I completed my first year at Stanford, I needed a summer job, so my father got me work at Aerojet with the Structural Materials Division doing some of the first filament winding operations. In those days, rocket cases were made from steel, 4130 steel for example, heat treated to a very high level. But steel caused lots of fracture problems. So, Aerojet, here on the West Coast, started filament winding fiberglass, e-glass, in the mid-to-late '50s. My first summer job there we made a filament wound, composites end dome to be bonded on a metal cylinder on the Polaris A3. The cylinder was made from tape-wrapped steel, Swedish steel, very high strength, very thin — helically wrapped and bonded."

Summer and weekend jobs stacking lumber, delivering alfalfa, and extracting honey as a beekeeper molded Morris' work ethic while in high school. And he tagged along with his father whenever Aerojet collaborated with the California Institute of Technology on rocket test projects. Perhaps most of all, however, it was, to use Morris' words, the "possibly perceived threat" of a national emergency during the Cold War that created opportunities in the rocket industry. The little that the West was allowed to see behind the iron curtain served as a threatening, indelible image of propaganda — the expansionist policy of the U.S.S.R represented by scores of goose-stepping proletariats and rockets on carriers rolling in formation past stories high portraits of Lenin decorating the walls of the Kremlin.

Pressure has become an ubiquitous metaphor for fast-paced contemporary life. Morris slides into a comfort zone half-way through the interview, patient, prepared (always prepared!), his finger on the recall trigger. Places and names come easier than dates, but engineering concepts are always as clear as yesterday. It appears the man most responsible for the innovative evolution of pressure vessels over the past several decades is not wrapped anywhere near as tight as his composite cylinders. But there's still an explosive inner drive evidenced by the myriad charts and graphs adorning the Luxfer "war" room. Everywhere are the latest performance measures, continuous improvement indicators, and output reports.

The British-based Luxfer, is more than 100 years old and the inventor of the aluminum cylinder. To walk through the company's Riverside composites facility is to sample the many candy-colored cylinders on display in meeting rooms, offices, and in photos and prints decorating walls. A line of reproductions by Mark Manwaring of firefighters, In the Line of Duty, donning light-weight, composites cylinders dresses up the corridor that leads to Morris' war room. Behind Morris, next to the myriad production charts and graphs, there is a small model of a traditional Japanese Kabuto headpiece, a gift to the Composites Division commemorating the opening of the new plant.

"So, the next summer I went back to the same group, and the summer after that and the one after that until I graduated, then I joined them," Morris continues. "At the time, Admiral Rayburn was running the Polaris program and the steel motor cases were having brittle fracture. Dr. George Irwin and Dr. Joe Keys, from the naval research lab, famous for inventing fracture mechanics, were trying to figure out why the metal was breaking. Rayburn made a decision to change to composite motor cases, and they poured money in. It wasn't just Aerojet, it was Hercules, Allegheny Ballistics Lab and many others. About 1960 is when it got really big, all cost plus, fixed fee contracting. Aerojet was funded to put in a complete factory and hire hundreds of people."

About the time Southern California found its cultural rhythm, Aerojet executives were fielding complaints from Azusa residents. Windows were being blown out on a regular basis, so the company moved rocket motor and test operations to Sacramento, purchasing large tracts of dredged land the gold industry abandoned in the late 1800s. The Structural Materials Division and filament winding operations remained in Azusa however. Morris worked at Aerojet several years, then returned to Stanford to complete graduate studies. After a year-and-a-half stint at the Lockheed

company's research labs, he returned to Aerojet. But it was now the 60s, and the aerospace industry was beginning a downward trend that lasted until 1971.

"They [Aerojet] eventually tried to sell the division," Morris remembers. "We were in Azusa, but the customer and the main plant was in Sacramento. And business was declining. They tried to sell to the Celanse Chemical Company and the National Lead Co.and others. We continued to develop the Minute Man rocket motor and started on pressure vessels, tried to go commercial. What eventually happened was the division was purchased by three employees, of which I was one."

Employment had dropped from 500 to about 30. But Morris' group acquired all the machinery and equipment, and R&D composites contracts with Wright-Patterson and NASA. A new company was formed — Structural Composites Industries (SCI).

"We started working on boron composites, polyamide resins, carbon, advanced NASA tanks for the space program like Apollo," Morris recalls. "We had a lot of R&D capability, but no commercial product. But, we were in business from the first day. Then we proceeded to do quite a few new and interesting things."

Morris in composites shop at Luxfer's Riverside facility.

Hector Torres, a 26-year veteran firefighter and now Chief of the Baltimore City Fire Department, knows what it's like to hump steel SCBA tanks into burning buildings. Well over 30 lbs., the tanks were cumbersome and limiting.

"It's hard to even think back to steel bottles, but they were rated at 30 minutes," Torres remembers. "What's critical is often times when a firefighter goes into a building, he has to calculate his air so he can get out, especially if he's made significant headway. After 15 minutes with a 30 minute air supply it's time to start thinking about getting out."

When lighter, increased capacity, composites cylinders were introduced, safety margins grew by precious minutes. Torres admits it's very easy to become disoriented when normal reference markers like ceilings and stairwells are engulfed in flames and blanketed by smoke.

"The composites bottle lasts 60 minutes," Torres said. "We're able to double the amount of available air and decrease the amount of weight on our backs. One of the things that every firefighter in Baltimore City, and probably nationally, has is a device called a path alarm. If a firefighter falls or becomes trapped, this device allows other firefighters to make a rescue. Obviously, if someone gets in a situation like that, air supply becomes very important."

It's fairly easy to track Morris' affect on the culture of safety in one of the world's most dangerous jobs. And it's an appropriate destiny for his lifetime of hard work. Round and round in our diffuse, e-world the idea of personal responsibility goes. Doesn't matter mechanical engineer, programmer or cook, offspring of the Great Depression, baby boomer, generation X or next. There are people and there are people.

"We did all kinds of things in the composites industry that really were never done before," Morris continues, reflecting back on the SCI years. As the interview progresses, Morris relaxes even more, modulating the end of many of his responses so they come back sounding like questions, an inflection popular in Southern California patois. He's gone from 'observed on-the-spot uneasy' to observer in the formal way a good professor might judge the implications of a student's question before answering, or the way a project engineer patiently sells an idea to the technically challenged. "We were ahead of our time you might say, always doing something a little too early for commercial success."

A composite railroad hopper car, a 150-ft. windmill blade, and boron polyamide jet engine blades were some of Morris' innovative projects at SCI that proved premature for commercial success.

"We were a manufacturer with very good design capability," says Morris, who holds several patents, one for integral fittings for rotational hub mountings in composite spar structures. "In those days the large aerospace companies did not have the in-house composite fabrication capabilities they do now. So people came to us with aerospace application ideas. And the government would put up seed money for projects such as the wind energy program. In 1971, the year SCI was formed, NASA put out seed money that resulted directly in what you'll see here today at Luxfer — pressure vessels."

Morris, Lacovara and I agree to tour the composites shop before heading out to lunch. Morris hustles off to check messages and I recall the elaborate write-up on Morris' nomination for the J.H. "Jud" Hall Composites Manufacturing Award (which he won this year) given by the Composites Manufacturing Association of the Society of Manufacturing Engineers (SME). *Edgar E. Morris has worked and contributed to the design and manufacturing of advanced composite fiber-reinforced pressure vessels for 38 years. His efforts are well recognized throughout the composite pressure vessel industry and by most, if not all, of the filament winding manufacturers.* It is here where Morris truly made his mark. From the time his father got him his first summer job, till his tenure now as general manager of Luxfer Gas Cylinders, he has spun a lifelong ambition into a string of technical, economic, and political victories.

Flanked by NASA officials in a meeting room at the Manned Spacecraft Center in Houston, Edgar Morris put his cards on the table. On a hot Texas morning, he had to convince officials from the Department of Transportation to buy into a program that would lead to authorization of the first non-metallic pressure vessel for routine commercial service.

"There was a lot of reluctance to using plastics in those days," Morris says. "No one ever heard of a plastic pressure vessel before...no such thing could exist. Really, the cylinders aren't plastic, only 20 percent by weight. They are composite structures, but people thought they were plastic and that they would degrade in water. They were always worried about water, and thought fiberglass would break the day after Christmas."

In 1971, NASA Lewis in Cleveland was funding filament winding R&D in advanced tanks for the Apollo spacecraft program. But NASA also was under pressure to bring space technology down to earth for spin-off commercial applications. One mandated technology utilization project at the Johnson Spacecraft Center was to make an approved fireman's breathing system.

"They were using heavy steel, low pressure tanks," Morris recounts. "They were terrible. So, I wrote a proposal for the first composite pressure vessel."

Commercial use of pressure vessels was, and still is, heavily regulated. The new lightweight material science of composites suffered institutional discrimination from many "concrete and steel" industries where a 'heavier-is-stronger-is-better' mentality is deeply entrenched in the psyche of decision-makers. And pressure vessels can be very dangerous, packing enormous amounts of stored energy. Morris received NASA seed money and embarked on a three-year mission of fabricating and testing a durable, lighter, composite cylinder that would make the firefighter's job easier.

"Everyone agreed to a higher factor of safety," Morris says. "The metal tanks only had to have a burst safety factor of 2.7. The composites tanks needed a burst safety factor 3.3, so they were thicker and stronger to begin with."

Morris was a little apprehensive at the 1972 meeting with NASA and DOT officials. There was a lot riding on the outcome, much that could shape his future. But, at the time, NASA wielded lots of influence in Federal circles, and they were on his side. And, somewhat surprisingly, while imposing additional test measures, DOT proved very open minded. Morris stepped into the Texas sunshine on his way to the first exemption from the law ever granted by DOT.

"It eventually allowed us to put about

300 breathing apparatuses in the field," he says. "We put 100 in the New York City fire department, a hundred in Houston, and a hundred in LA. It was very successful. All the original designs lasted the entire 15-year life span with no latent defects."

Morris had started a whole new industry, small, but poised to take significant steps with each advance in materials' technology he could sell to DOT. However, he wouldn't always have NASA to help him.

We climb into Morris' new Dodge Durango and head to Mario's Place in Riverside for ravioli in light cream sauce. Morris steadies the wheel with his forearms as he employs his large, lumberjack hands to emphasize an explanation on the mechanics of filament winding. There are two propane tanks behind the back seat under a folded, space-foil, heat deflector used for the front windshield. Morris and his wife Vicki, a chemical engineer and expert on cryogenic applications of composites structures, use the Durango to reach their waterfront getaway on Lake Arrowhead. Hiking is the couple's passion and release. They met while working at Aerojet in the early '60s. Vicki designed the solid propellant destined to fill the lightweight, rocket motor cases Ed was winding. Married in 1962 after a short courtship, Morris is quick to admit Vicki's energy and patience is the main ingredient of his success formula.

Heaven in a Bottle

Upon returning from Mario's, we complete the tour of Luxfer's Riverside Aluminum Cylinder Facility. Morris spent the second half of the morning in blissful abandon, guiding us through the composites shop like a forest ranger conducting a nature tour. Immediately energized, he steps into the shop environment proud, suppressing his titillation. As he explains, "five spindle" and "resin pick-up by weight is about 30 percent" can barely be made out above the din of activity. We're on the highest mountain in the park and the teenage boy is still looking for flashes of light on the horizon. He loves it here — beyond the paper reaches of performance measures — making complicated and useful strides for material science. This place where the product is boss; this place that granted him his greatest victories and biggest disappointments.

After Morris and NASA successfully lobbied DOT for regulatory changes that allowed fiberglass to be used in the manufacture of fire service self-contained breathing apparatus (SCBA), SCI attempted to penetrate the commercial market.

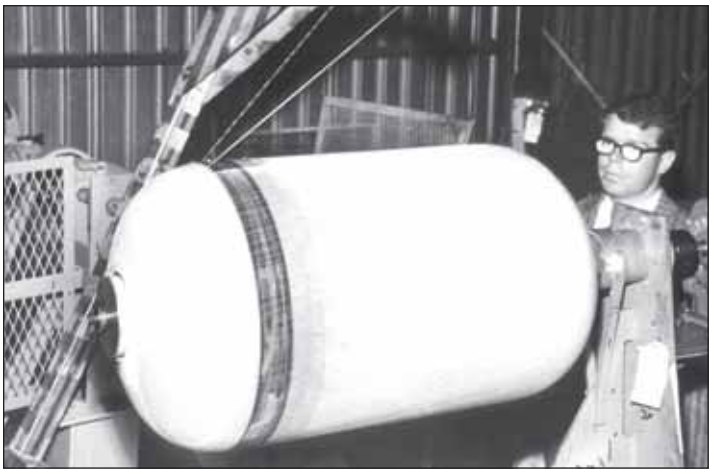
"The funding kept coming for aerospace," Morris says. "We made some rocket motor cases, and during the Trident program, made Apogree kick motors. But the first year the fiberglass cylinders were approved, in 1976, MSA [Mine Safety Appliances] bought a thousand. The second year they bought 5,000, and the following year 10,000."

Also in '76, Boeing was desperate to shave every ounce of excess weight from its 747 SP Aircraft. Because it was somewhat lighter than fiberglass, aerospace engineers wanted to use Kevlar® to fabricate cylinders used in emergencies to inflate passenger evacuation chutes. They were looking for an exemption from the DOT standard as well as a manufacturer and approached Morris and SCI. Morris became program manager, got DOT approval for Kevlar®, and started making cylinders. (It was some five years, however, before the cost of Kevlar® could be reduced enough for it to enter the fire service market.)

"By this time at SCI, we still did tubes, drive shafts and advanced pressure vessels for military aircraft," said Morris. "But our main business became high-rate production of high-pressure cylinders. We received larger and larger orders and kept growing and growing."

Morris was the first to fully develop fiber-reinforced composite pressure vessels using load-sharing metal liners, a patented

Morris in front of Luxfer's Riverside facility.


A young Ed Morris winding a rocket motor case in 1960.

technical advancement that made the growth of SCI possible and has led to big accolades for Morris in the composites industry. But the unfortunately unusual phenomenon of concurrent political and technical success that marked the transition of fiberglass and Kevlar® into the pressure vessel business faded during the 80s and early 90s, just when another crucial hurdle needed to be jumped.

And it wasn't just because approval by the federal government of even lighter carbon fiber for SCBAs for firefighters got stuck in what became a bureaucratic morass at DOT. Gone were the "there are people" Morris worked with before.

In 1994, two years after Morris and SCI applied to DOT for carbon approval, Morris left the company for reasons he'll only disclose off the record. SCI had been without competition in the business of fully wrapped composite cylinders for five years, and sponsored the industry's most monumental technical advancements. Morris immediately went to work for Luxfer with its well-established tradition in aluminum and 'hoop wrapped' cylinders, and continued his pursuit of getting carbon authorized. Acclimating to a new position, chartered to build Luxfer's filament wound composite cylinder business, and rebuilding diplomatic ties with DOT proved to be Morris' biggest challenges.

That same year, 1994, something happened to illuminate the United States' fumbling approval process. Carbon was authorized for construction of high-pressure, lightweight, commercial cylinders... in the United Kingdom. Along with fiberglass, carbon vessels were manufactured by Luxfer in Southern California and sold in the UK. Nineteen European countries followed suit, then Japan, Korea, Hong Kong, China, and Singapore. South American countries became the latest to grant approval until, finally, in 1997, the U.S. gave its nod, followed by Canada.

"The primary advantage is significant weight savings," Morris says. "With fiberglass and Kevlar® we cut the weight of metal cylinders in half. Metal cylinders with one hour of air, weighs 48 pounds. How can you fight a fire for an hour wearing one of these? Then there's the valve, coat, helmet, tools. A fiberglass cylinder with an hour of air weighs 18 pounds, and carbon is like 12 pounds. The weight savings are incredible."

Boyish enthusiasm returns to Morris as he relishes technical implications. It seems to be where he always ends-up, on a strong note of optimism. He laments the biggest breakthrough in cylinder technology — approval of carbon fiber — took 23 years. But he's confident future advances will be treated expeditiously, especially if the U.S. wants to be world leader in material science.

"They [DOT] are improving quite a bit," Morris reflects. "The new people in the department are very proactive in doing their jobs. In Europe, the philosophy is to have performance specifications. You meet performance [with a product], and the government doesn't tell you how to get there. In the United States, for good reasons or bad, often specifications are not only performance related, but deal with materials, processes, and design. They sort of tell you how it's supposed to be done. But there are reasons for that. I can't take a position on whether it's good or bad. It has to do with public safety and that's the most important thing. These cylinders are very dangerous."

The waiter addresses the table of three at Mario's and I notice Ed Morris glance at his guests to measure their approval. Not that they're picky, but he took no chances. Mario's is 'neighborhood upscale.'

Ed Morris, Mr. Nice Guy.

It's refreshing to see a successful manufacturing manager/engineer apply a winning formula more associated with social workers and (I hesitate) priests, than Marine drill sergeants and wild animal trainers. It's a measure of Morris' humanism. At Stanford he supported his mechanical engineering major with liberal arts studies in western civilization and Russian history.

Morris' edge in business, what's reasonable and successful, and what comes natural to him, emerges from his life experiences. "I'm a California boy," he says, celebrating only the novelty. And one who grew up in a resilient generation that inherited the need to keep life directly in front of them at all times, complaining little. Morris' affect on people is not just that of admiration for a man who's made great strides in a niche market, or of a manager with an ear, or a boss who may come off more like a go-to Uncle at a picnic. If you let him, he can spin a balmy, pleasant atmosphere, technically seductive, one worth nurturing. With an engineering professor's repertoire, his student curiosity for new challenges perpetuates triumph.

Lacovara orders off the menu and Morris and I request the special. The restaurant is busy with the late-in-the-week, Riverside lunch crowd. After the meal, a short but polite debate ensues and I watch Lacovara calmly insist to Ed Morris that he will pick up the tab. ***–CFA***

Andrew Rusnak is Editor of Composites Fabrication