

## Tube producer uses proprietary equipment, tooling to build a diverse business

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*In 1982, industry veteran Robert Gilreath founded a company to produce small-diameter corrosion-resistant tubular products. Unsatisfied with the equipment available at that time, Gilreath did something few would consider: He developed his own tube mills, tooling, straighteners, and cutoff machines.*



The executive team at G & L Manufacturing includes Mike McGee, materials manager; Mark Conatser, chief financial officer; Brian Huelskamp, operations manager; Tim Saylor, human resources manager; and Bill Henricks, director of sales.

G & L Manufacturing, Cookeville, Tenn., is an unassuming tube producer, working mainly under the radar and doing little to draw attention to itself. The company is conservative in how it uses its marketing budget, relying mainly on advertising directly to current and potential customers. It doesn't have a big presence in industry publications, it has little to do with tradeshow, and its name isn't all over the internet. However, this doesn't mean that the company doesn't warrant some attention. The way it does things, and the results it achieves, provide interesting lessons for manufacturers of all sorts.

The company's story started in the early 1980s. A tube mill engineer, Robert Gilreath, and his business partner had a plan to start a new company to produce small-diameter, thin-wall, corrosion-resistant tube. Making tube is an exacting—some would say vexing—process, but starting a company from scratch to do so is more challenging still by an order of magnitude. However, Gilreath, who had worked on and around tube-making equipment his entire career, was undaunted by the challenges that lay ahead.

The prospect of founding a new company was all the more challenging because Gilreath was dissatisfied with most of the small-diameter mills, tooling, and ancillary equipment on the market at that time. He took the path of greatest resistance when he decided to build his own equipment. Known for meticulous attention to detail and a keen interest in precision engineering, he spent a couple of years developing his own mills. He purchased few components.

“He made the gears, developed the gearboxes, designed the housings, made the tooling—he designed and built nearly everything in the first few mills,” said Executive Manager Rob Adams. It’s almost baffling that a sole engineer would take on such a task without substantial resources—a corporation staffed with an engineering and design team to attend to the myriad details, a fleet of machine tools and experienced operators to make the components, and the deep pockets to buy the raw materials and pay the salaries for such a venture—but on the other hand, this path makes a lot of sense. Gilreath knew what it took to make a high-quality tube, so why not go it alone and develop proprietary equipment and tooling to support his vision?

## DIY Tube Mills

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Gilreath’s approach makes sense: Make good tooling, mount it to high-quality shafts that rotate on the best bearings money can buy, use a proprietary drivetrain, enclose it all in a sturdy housing, and you’re well on your way to developing stable, repeatable processes, which is the key to making quality tube.

A key feature concerns roll tooling adjustment. Gilreath developed a system that uses adjustment knobs. When a mill operator needs to make a slight adjustment in a tool’s position, he can give a knob an eighth of a turn. That *sounds* like a fine adjustment, but at 22.5 degrees of rotation, it’s a coarse adjustment. If an eighth of a turn was too much, no problem. He can back it off by a sixteenth of a turn, and maybe another thirty-second of a turn after that, if necessary, which is 5.625 degrees of rotation. A tube mill with infinitely variable adjustments on the tooling gives new meaning to the phrase *fine tuning*.

The last piece of this formerly mystifying puzzle is Gilreath’s perspective on the tooling itself, specifically tooling quality, which leads to G & L’s view of product quality.

“In Gilreath’s view, the tolerance of any tooling dimension is plus or minus zero,” Adams said. He wasn’t kidding. While no company guarantees that its products meet such an exacting standard, G & L gets close. Its website cites a tolerance of  $\pm 0.002$  inch for many of its products.

**A Tale of Tooling.** Striving to make tooling to an exact size with no tolerance is one of three overlapping factors that illustrates the role that tooling has at G & L. Second is the array of tooling.

“Nearly every set of tooling in the tool crib matches a product’s OD *and* wall thickness,” said Director of Sales Bill Henricks. “This is because, for a given OD, the strip width changes as the wall thickness changes, so the ideal edge guide changes, too.” This isn’t to say that all tube producers need such exacting standards for all products, but it shows G & L’s focus on precision.



**Figure 1**

G & L makes tubing products in many shapes for many applications. Rounds, rectangles, and flat ovals are the most common. The main applications are fluid delivery and heat transfer. As such, the products must resist corrosion from many aggressive chemicals, withstand extreme temperature cycling, and endure severe forming operations.

The third factor is the depth of experience of G & L's tool- and diemakers. The tooling staff's turnover rate is, well, essentially zero (plus or minus zero).

"Two have more than 30 years of experience," Adams said. "The manager is a degreed engineer from Tennessee Tech," so the tooling department staff is fortified by both experience and education. It would be almost impossible to hire a qualified tool-and diemaker, so the company relies on in-house training.

**Steel and Beyond.** A key attribute at G & L is a thorough understanding of metallurgy. While Gilreath had a deep understanding of steels of all sorts, his knowledge of metals wasn't limited to steels. Around the time that Gilreath was thinking about establishing G & L, titanium was transitioning from a niche metal to the mainstream.

Titanium's combination of high strength, light weight, and excellent corrosion resistance makes it ideal for aeronautical and space applications and contributed to many of the advancements in aeronautics in the 1960s and 1970s—and it still has a primary role in aircraft and spacecraft. For decades it was so expensive that few industries outside of aerospace used it, but by the late 1970s its price had dropped enough to make it a viable material for more applications. Gilreath saw the potential in titanium early on.

“Titanium is available in more than sixteen grades,” Henricks said. “The majority of titanium tubing used in aerospace application is seamless,” he said, but welded titanium tube has many applications outside that industry, including power generation and heat transfer.

“Titanium’s springback is worse than that of stainless steel, which is bad enough, so forming it and welding it at a typical mill line speed is tough,” Henricks said. Gilreath interpreted its characteristics as challenging, not problematic, and worked titanium into the company’s area of expertise.

A swimming pool heat pump illustrates the many benefits of titanium. In a conventional pool heating system, the refrigerant flows through coiled copper tube. A twisted or spiraled titanium tube provides more surface area, so heat transfer is more efficient. Copper erodes away because of the constant flow, whereas titanium resists erosion. Also, titanium resists scale buildup. A heat pump with copper coils usually has a 3- to 5-year warranty, Adams said. A titanium heat exchanger has a lifetime warranty.

This doesn’t mean that titanium is a primary or dominant alloy at G & L. In fact, it would be hard to pin down any one alloy that takes a lead role. The company has decades of experience in making products from austenitic stainless steels (SAE 304 and 304L, 316 and 316L, and 321), ferritic stainless steels (SAE 409, 436, and 439), superferritic (E-BRITE<sup>®</sup>), duplex alloys (SAE 2205, 2209, 2507, and 2102), high-nickel alloys (SAE 600, 625, and 825), and INCOLOY<sup>®</sup> and MONEL<sup>®</sup> alloys (SAE 323 800, 840, and 400). The products are as diverse as the alloys (see **Figure 1**).

**Welded Tube Made Well.** Tube and pipe producers can use up to four modes for testing the products they make: inline nondestructive, offline nondestructive, offline destructive, and metallurgical analysis. G & L uses all four.

As the tube is running through the mill, it is evaluated with eddy current. Offline ultrasonic testing is used on some products. These comprise the first line of defense against defects.

Next is a thorough visual evaluation. When he was a student at Tennessee Tech, Gilreath learned about metallurgical inspection, and he brought this capability to G & L. The company has a metallurgical lab that examines welds, heat-affected zones, and parent materials, making micrographs up to 100 times magnification to measure grain size and evaluate weld profiles, thereby validating mill setups. And, although the company doesn’t do any fabrication, it knows that many of its products go through severe forming operations, so it puts its products through a variety of destructive tests to evaluate minimum yield strength, ultimate tensile strength, and percentage of elongation. Specific destructive tests include flaring, flanging, flattening, reverse flattening, reverse bending, and hardness testing. It also does corrosion-resistance testing.

Finally, for lengths of tube intended to carry fluids, an air-under-water leak test pinpoints any pinholes that slipped past the other tests.

**Little Room for Error.** It’s no secret that seamless pipe products are usually considered to be superior to welded pipe products, especially regarding pressure applications and any use that requires severe forming. In as-welded products, the weld seam is less ductile than the parent material and therefore is a weak point—the area most likely to fail when the tube is subjected to substantial internal pressure or mechanical forces.

In-line annealing evens the score, and G & L verifies the robustness of its annealed products by performing destructive tests on lengths chosen at random. It doesn't test them once per day, once per shift, or even once per hour, but about every 45 minutes.

Depending on who you ask, seamless tube and pipe tend to have a better measure of roundness than welded products. Regarding welded tube, the key is to purchase material with consistent characteristics, using quality tooling, and a thorough understanding of tooling setup.

Last is wall thickness consistency. Extrusion mills and draw benches set a high bar, but indeed some welded products exceed the bar, according to Adams.

"Our tube has replaced seamless in some cases," Adams said. "Because the internal mandrel drifts, the wall thickness can change along the tube's length," he said. "Making welded tube is a different game altogether. The strip's thickness is extremely consistent," he said.

When Adams lists a few of the applications for G & L's products, it sounds like the applications themselves also have little room for error. Many of the company's customers make safety-critical and mission-critical equipment, so no one wants to skimp on quality.

"Nuclear power plants, aircraft de-icers, railroad switchgear, submarines, and medical equipment are some of the more high-profile applications for our products," Adams said.

## A Story of Growth

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In 2005, Gilreath sold the company to a small group of private investors. At the time, it was running seven days a week, three shifts per day, and the company was by all measures a manufacturing success story. Its customer base and its revenue had grown handsomely over the decades without the benefit of an outside sales force, and the investors sensed that the company was destined for further growth.

Since then, G & L has grown from 25 employees running three tube mills to more than 150 employees operating 28 tube mills. The company has grown through diversification into new markets with new products—residential water heaters, power generation, oil and gas, military, food service, transportation, medical, and semiconductors. In HVAC markets, its products go into boilers, ultrapure water filtration, and systems for swimming pools and large aquariums.

It also has grown through acquisition.

In 2010 G & L acquired a tubing business in Elgin, Ill., and in 2016 it acquired another in Englewood, Colo. Well-versed in making products similar to those made at G & L, employees at these companies complemented the G & L staff in skills and culture, according to CEO Phillip Jones (although zero tolerance in tooling dimensions may have been a new concept to some).

**A Firm Foundation and Fuel for Future Growth.** When Gilreath retired, responsibility for the technical philosophy went to Mike Adams, the company's technical director, who at that point was a 20-year G & L veteran. Responsibility for financial decisions went to the executive team, who continued to run G & L extremely lean, keeping inventory to a minimum. This is a good business practice in any manufacturing company, but especially in one that deals with expensive metals

plagued by price volatility. Metal traders barely raise an eyebrow when nickel exceeds \$15,000 per ton, and it's not uncommon for the price to double or halve in less than 12 months, which sends shock waves through industries that use a lot of stainless steel alloys.

Another point concerns finances directly. Beyond salaries, the owners haven't taken a dime from G & L since they purchased it in 2005, according to Jones. Profits remain in the company coffers to fund acquisitions and a new concept at G & L: equipment purchases. The company has been making significant investments to keep up with recent growth—investments in technology, people, training, and facilities, with a focus on lean manufacturing and the associated certifications.

Meanwhile, the management team provides incentives for the equipment operators to expand their skill sets, another important ingredient in moving the company forward.

"On each shift, about 20 to 30 percent of the personnel can do all the jobs on the shop floor," Adams said. It's a lot to learn considering that it takes four to five years to master the 300 or so variables that go into making tube, by G & L's count. The 70 to 80 percent of the staff members who don't perform all the jobs have an incentive to learn all they can and do all they can. Pay is based on skill set, and the pay differential between the least-skilled new hire and the most-skilled veteran is "significant," Adams said.

Growing with Industries, Customers. The company's extensive experience with corrosion-resistant products is a strategic asset as industries change. Few manufacturers have much protection from competition these days, so most are compelled to make better, longer-lasting products. One example is a typical automotive exhaust system. Once made from galvanized steel, they used to last just a few years. That changed in the 1990s as automakers changed to stainless steels for this application, and these days automobile exhaust components last decades. A recent drive in the automotive industry to achieve a 15-year service life on fuel filler necks likewise has led to the use of more durable alloys for these components. This doesn't mean that every carbon steel product will eventually be replaced by a corrosion-resistant steel, but it does mean that some will, to the benefit of G & L and others in this arena.

Of course, G & L doesn't do business with industries; it does business with companies. It has many long-term customers, and like many manufacturers, G & L sees itself as a strategic partner in many of these business relationships.

"Many of G & L's customers are major companies and leaders in their markets, but fundamentally it's all about strong relationships," said Jones.

While nearly every company says it, G & L can back it up: Its first customer continues to be a customer to this day. To attract and keep customers, G & L strives to do what its customers want it to do—for example, providing products in the formats its customers need, straight lengths and loose-wound coils—and it's also careful to avoid anything that its customers don't want it to do, specifically fabrication work. Some producers do a little fabrication, but this can turn into a trap if the producer encroaches into its customers' areas of expertise. G & L has no interest in trapping itself.

A plaque in G & L's lobby stands as a testament to the company's ability to attract and retain customers. It was awarded by a longtime customer, a water heater manufacturer. Mounted to the plaque is a faulty tube. This sounds like it's some sort of mild insult or a bad joke, but it's not. According to the customer who awarded the plaque to G & L, it's not just a faulty tube, but the first faulty tube it ever received from G & L.

Not bad considering that the customer had purchased about 10 million feet of G & L products before it received one bad tube.

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