Setting the sights: Lasers and high-performance cutting

NASA's Ultra Long Duration Balloon Project has sparked the development of new cutting technology with a wide range of possible applications.

By Carolyn Griffith

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When is a balloon not a balloon? When it's a technical problem, a design challenge, and an inspiration for the development of new and more efficient cutting equipment.

EdgeWISE Tools founder Pat Momany —affectionately called the "flounder" by employees and customers —didn't start out at the high-tech edge of the fabric cutting industry. Problems that need solving get his inventive juices flowing, and his penchant for saying, "Sure, we can do that," before figuring out how, add up to an enterprise that's reinvented itself several times.

Now with that trademark inventiveness and can-do attitude, Seattle-based EdgeWISE is pushing the limits of fabric cutting, in a system custom-designed to cut out the huge scientific balloons NASA plans to send to the very edge of Earth's atmosphere.

From boats to balloons

It started with boats. "My brother and I were in the printing business. In 1985, we met a lady who was putting vinyl names and logos on the sides of boats," Momany relates. "Gerber had released a 15-inch vinyl text cutter, but she was doing graphics and logos in addition to letters. I wondered if we could somehow melt the vinyl to cut it. We started out with a soldering iron attached to an X-Y plotter." After working through many "thermal issues," midway through 1986 Momany, in partnership with another company that later went out of business, introduced a 36-inch thermal cutter to the sign industry.

The following year, "back when 286s were the hot computers," Momany reminisces, he and colleagues at GrafikEdge helped develop sign-cutting software, and came very close to perfecting a swivel knife cutter of the sort that's now widely used in the cutting business. "I didn't trust the software engineers," he recalls this near-hit ruefully.

In the late '80s, Momany began teaching himself about lasers, and in 1990 sold GrafikEdge and started EdgeWISE Tools to develop, sell and service cutting tools and systems. EdgeWISE debuted a roll feed laser (RFL™) system at the International Sign Association show in 1992, and patented it in November of 1993. For a few years EdgeWISE licensed the technology to another company, but when this route failed to produce the desired growth, EdgeWISE began designing and selling its own RFL product line.

According to company literature, RFL technology offers significant advantages over traditional flatbed systems that cut with blades:

- the RFL takes only one-third to one-half the floor space of a flatbed;
- lasers use minimum heat, for less material distortion;
- lasers provide a high degree of accuracy, consistency, control and flexibility;
- the extremely small cut width allows for detailed work and close nesting of components, minimizing waste; and
- lasers decrease the risk of injury, compared to many mechanical cutting methods.

"We started focusing on designing and developing other laser tools, and were invited by Eastman Worldwide, an industrial fabric company, to exhibit in their booth at the 1997 Industrial Fabrics Association show in Nashville. That's where I met Raven Industries' Ron Stevens, who was heading up the manufacturing end of NASA's Ultra Long Duration Balloon Project," relates Momany.

The Ultra Long Duration Balloon Project (ULDB), profiled in our October 1999 issue, is NASA's latest development in near-space scientific exploration. The project aims to develop balloon systems capable of supporting scientific observations above 99 percent of the Earth's atmosphere, for durations of approximately 100 days. Innovations in materials and construction—the current design is 600 feet tall and pumpkin shaped, with lobes that increase its strength, and made of a one mil five-layer Mylar-polyethylene-polyester composite that provides a previously unavailable combination of gas barrier, tear resistance and strength—add up to a balloon that can take near-space extremes of temperature and sun exposure, *and* carry a couple thousand pounds of equipment.

"Ron and I discussed those 600-foot lobes, and I said, 'Sure, we can do that,'" Momany says nonchalantly. "Our

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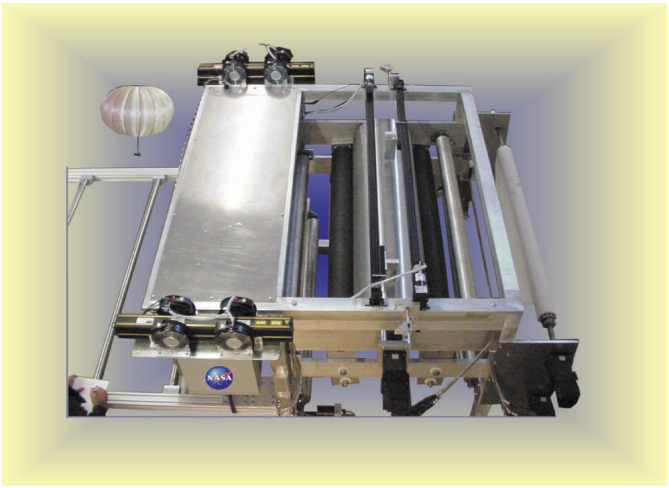

The Single Direction Cutting (SDC) system was designed to provide precise beam delivery, material handling and motion control, developed to compensate for distortions due to material stretching.

thinking has always been not-quite-mainstream, and that's me. I'm a conceptualist; I have engineers to tell me what we *can't* do."

The enormity of the ultra long duration balloon poses huge manufacturing challenges. "The biggest problem was that NASA wanted the lobes to be cut to 600 feet plus or minus *a quarter inch*," Momany marvels. "These scientists are amazing. You get them in a room together and they have all these ideas, but they're sometimes not very realistic about manufacturing reality. We got them to agree to plus or minus three inches; that's a .5 percent margin of error."

Momany knew immediately that their RFL system, which moves material backward and forward under stationary cutting heads, wouldn't do the trick; moving the film that Connecticut-based Dimension Polyant had developed for NASA forward 600 feet and then back to cut one gore would inevitably distort the fabric beyond the required accuracy level. The obvious solution was to develop a system that would move the material in only one direction. Momany is quick to credit engineer Bill Stuart with figuring out how to devise the software controls for EdgeWISE's Single Direction Cutting (SDC) system, which combines state-of-the-art laser beam delivery, material handling and motion control to calculate required material length and digitally compensate for the stretching that occurs during handling.

Most cutting systems, Momany says, are driven by Hewlett Packard Graphical Language (HPGL), whose limitations render it unable to handle ULDB-sized projects. "With HPGL, you lose accuracy over long lengths of material…you run out of math; you run out of decimal points," he elaborates. EdgeWISE engineers have developed a new data processing technology that can achieve accuracy out to 16 or more decimal places.

"And with HPGL, at 3,000 inches, the system would just stop, and you'd have to re-send the images—but it wouldn't have any way of knowing where it had left off," Momany says, noting that 3,000 inches, or 250 feet, is less than one-half the length of a ULDB gore. "Our system can just keep on going."

As Momany explains the SDC's advantages for the NASA application, he keeps bumping into his company's own "cutting edge" issues: proprietary technologies, which he doesn't dare explain in excessive detail. EdgeWISE is currently patenting the SDC system, with between 15 and 20 individual processes listed as claims on the application; this is one of four patent applications the company has going, and Momany expects to initiate another two sometime this year. (The tiny company, by the way, employs three full-time and two part-time workers, and uses five to seven contractors.)

As it turned out, EdgeWISE's SDC system was able to come darn close to the original tolerance requirement, at +/- .3 inches; but, as NASA, Dimension Polyant and Raven Industries continue to tinker with the composition of the balloon fabric, new hurdles emerge. Simply cutting one lobe down the middle of the run of fabric results in 40 percent waste, so EdgeWISE designed the system to cut half lobes down each straight edge, to be sewn together afterward, cutting waste down to only 14 percent. This means the system must be able to detect the fabric edge, which was no problem with the earlier translucent material. The most recent version of fabric, however, is transparent, so edge detection becomes a bigger problem.

Performance and perforation

Momany suggests that the SDC system would be suitable for a variety of applications with simple cutting patterns requiring high volume throughput, such as automotive air bags. The RFL system is faster than a flatbed, and the SDC is faster yet, able to handle 350 or more linear feet of material per minute.

In addition to the advantage of taking up much less floor space than flatbed systems, the roll-feed SDC allows for faster throughput without increasing safety compliance issues or the need for training. "We try to make every machine using a Class One laser beam—as safe as your laser printer," Momany notes. By definition, Class One beams are totally enclosed. If, for example, the ULDB gores were to be cut with a laser moving over a flatbed, "to move 600 feet, it would have to be a Class Four beam—and everyone in the room would have to be laser-trained and wearing goggles," he explains.

Now, EdgeWISE is working on adapting laser cutting technology to perforation applications. "We can take 60-inch-wide material and perforate it with a quarter inch separating the holes in a row, and a quarter inch separating the rows, at 85 feet per minute—that's a half-million holes a minute," Momany says, noting that one client, an aerospace company, uses the resulting perforated material to filter resin evenly onto parts that must be glued together.

"The limitation on most perforation operations is mechanical; it's like they're using a rotary pincushion, and the needles break all the time," Momany says. It's not uncommon for needle breakage to occur several times a week, or even daily, resulting in four to eight hours of downtime each time. "The laser perforation could be used in manufacturing disposable diapers, bandaids, all kinds of geotextiles."

While in Momany's view it's EdgeWISE's small size and flexibility that enables it to take on these kinds of problem-solving challenges, he also admits that the aerospace client was originally nervous about the reliability of such a tiny supplier. The ULDB Project provided a needed dose of credibility. "When you say you're working with NASA, that tends to get people's attention," he concludes. R