An Unfolding Story: Behind the Birth of the World’s First Origami Kayak

Where polypropylene meets the ancient Japanese art of paper folding

By Robert Grace

Years ago, designer/architect and outdoor enthusiast Anton Willis lamented that he couldn’t fit a kayak into his small San Francisco apartment. Then, in 2007, he came across a 4,500-word New Yorker magazine profile of American physicist Robert J. Lang, who also happened to be an ardent practitioner of origami, the ancient Japanese art of shaping sheets of paper into figures, using no cutting and no glue.

Lang—who earned a master’s degree in electrical engineering at Stanford and a Ph.D. in applied physics at the California Institute of Technology—was using origami not only to make incredibly intricate artwork, but was applying these same concepts to create practical applications ranging from implantable and expandable mesh heart supports, to giant folding telescopes used in outer space. (Read the full New Yorker profile of Robert Lang here: bit.ly/TheOrigamiLab).

Something clicked in Willis. He wondered why this technique couldn’t be used to make something like a kayak. He continued to pursue this concept, even while serving...
from 2007 to 2012 as chief executive officer of Civil Twilight, a San Francisco-based, cross-disciplinary design collective that he co-founded. Developing a folding kayak began as a design project within Civil Twilight, "and eventually subsumed it," Willis says, resulting in his 2012 launch of Oru Kayak Inc., also in San Francisco.

Back when Willis first had the idea of folding up a kayak like a piece of paper, he immediately thought of the lightweight corrugated polypropylene that is used in yard signs and packaging. He'd used that material for making architectural models, although at the time he knew nothing about its specifications or chemistry.

Over time, Oru formulated a custom resin that combines excellent weather resistance, chemical resistance, durability, flexibility and lightweight strength. "We are happy with the blend," he told Plastics Engineering in a recent email interview, "but we keep evolving towards better materials. We are exploring honeycomb sandwich technologies, for example, as they combines the excellent mechanical properties." At present, each of its kayak models uses about 11 pounds of polypropylene.

In that same exchange, Willis and Oru’s manufacturing and design team shared some insights into what goes into producing the firm’s growing range of kayaks.

Willis, Oru’s chief design officer, prototyped the kayak folds on paper models. "While computer-aided design programs were used to lay out the 2D fold patterns, all of the 3D folding volumes were designed (and continue to be designed) through physical models rather than 3D software," he explains.

"The first corrugated plastic prototypes were made using a modified gasketing hand tool, to compress living hinges along the fold lines," says product engineer Stefania Cargnello. "Through our current contract manufacturer,
we now prototype kayak skins on a CNC machine, which automatically cuts and folds the material. For production, we use very large steel rule dies to both cut and crease the material."

Oru makes each of its kayaks from one seamless sheet of material; there are no joints below the waterline. Structural connections primarily use screws and rivets, since polypropylene is hard to glue, and difficult to heat weld cleanly. The firm takes care to ensure all its designs minimize the use of screws and rivets below the waterline, where they could cause leaks.

"Currently," Willis explains, "we use a rotary die-cutting process. The machine is fed one flat plastic sheet at a time that sits on a customized die. In the same process, the edges are cut, and all the creases compressed. After this, an operator manually folds the kayak once, on all crease lines. Various other parts—trim, straps, connectors, etc.—are fastened to the kayak by hand."

Oru continues to explore alternative processes that involve heated blades, he says; these include vertical presses, CNC machines, and fully automated robots.

Whereas Oru’s earlier designs joined panels with buckles, the firm now uses nifty extrusion “zipper channels” it designed (as shown in this nine-second video: bit.ly/OruZipperChannels).

And, while most materials on the Oru’s kayaks can be recycled, the company says that to fully embrace the circular design model and the reuse of materials, they need to make the kayaks easier to disassemble at disposal. "We are working towards that, with better edge trim attachment technologies, fasteners solutions, and redesign of parts," Oru says.
The company currently produces 4,000 kayaks per year—all at its factory in Pomona, Calif.—and is quickly expanding its reach to Canada, Oceania, Europe and Asia. On its website, its tagline declares: “Designed in San Francisco. Manufactured in Los Angeles.”

Via external labs, Oru says it has extensively tested and certified the strength and durability of its products, to include ASTM Tests such as C365-11, D7249-16, C273-16, D4157-10, and the Fold/Bend Cyclic. The firm’s kayaks are confirmed to withstand at least 20,000 folding cycles.

One of the biggest challenges to overcome in the project involved finding a contract manufacturer that could comprehend and execute the plan.

“We were trying to use a material and manufacturing technique developed for boxes, and adapt it to kayaks,” the company says. “There was a lot of collaboration to figure out the best way to solve a lot of challenges, and reach a level of quality assurance appropriate for a consumer product.”

Now, Oru is aiming to further improve its products, to include making them more modular and customizable, so customers can use them for different activities—whether it’s camping, fishing, or just hanging out.

The company launched its first model, the 12-foot-long,
25-pound Oru Kayak, in 2012. It followed up in 2015 with a pair of 16-foot expedition models—the 34-pound Oru Coast+ and 32-pound Oru Coast—for serious sea kayakers who wish to travel longer distances. The boats’ greater length makes them considerably faster and more efficient to paddle, the company states, while also enhancing stability and providing enough space inside to accommodate gear to last for days.

In January 2016, Oru rolled out its 12-foot Beach LT model, designed for casual paddlers. The firm says that at 28 inches wide, the Beach is stable enough for easy cruising, while its extra-large, 20- x 62-inch cockpit makes it comfortable and easy to enter, “while offering enough room for kids and dogs as well as paddlers.” And, it claims, the Beach can be assembled in just five minutes—half the time of the original Bay model, and a third of the time needed to assemble the larger Coast version.

It launched the updated Coast XT model in March, featuring a new closure and fold pattern. Today, Oru prices its products as follows—the Beach LT ($1,299 retail price), the Bay ST ($1,599), and the Coast XT ($2,499).

In a November 2014 interview with Canoe & Kayak mag-
azine, Willis recounts: “I’d never designed a boat before I started working on the Oru Kayak. I’m an architect by trade. As a designer I have always been drawn to boats. Boats are one of the things whose shape is most dictated by function but also one of the most beautiful things designed by man.”

Asked to comment on the most innovative aspects of his foldable kayaks, he says: "I combined a very old object and a very old design element and made something very futuristic that’s still rooted in the past. It’s one of the simplest construction phases of any boat. Once the guys in the factory are trained they can make a boat in five to 10 minutes.”

Since Oru Kayak’s launch six years ago, others have jumped on the floating origami bandwagon. A Knoxville, Tenn.-based company, for instance, has developed MyCanoe, a 52-pound, 14.5-foot-long canoe that folds down into a case measuring a case 37 x 8 x 25 inches. Started by Jay Lee, founder of fitness apparel company Coovy Sports, and Paul Jin, a long-distance swimmer, the firm (www.oricanoe) says it makes its products “from a custom polypropylene with a 15-year UV treatment that is rated 20,000 folds.” The canoe is said to take 10 minutes to assemble and is priced at $1,390.

It’s clear that Willis—inspired by physicist Lang (who now collaborates with Oru Kayak)—started a significant boating trend with foldable PP boats. Oru Kayak today says it sees “great potential for using our materials and manufacturing techniques for other items. We’re currently still focusing on kayaks, but we’re always sketching and noting new ideas for the future.”

Perhaps Cargnello captured the spirit and essence of her firm best in a blog post: “For me,” she wrote, “Oru Kayak is more than a product. It is the reminder of unfolding possibilities. It is the clever and magical transformation of a flat sheet into a vessel. It is simple but precise. It melds the patient geometric lines of origami with the fluid forms of the boat. It opens up dreams and opportunities. It merges different technologies, materials, perspectives, and ways of creating in the world. Our team strives to make something so special that people want to be surrounded by it, even outside of the water.”