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Decades of College Dreams

3-D printed boats race for innovation

By Katherine Long

SEATTLE — It doesn't look anything like the fantastical, imaginative creations that launch on Green Lake every summer for the Seafair Milk Carton Derby.

In fact, the little boat made by University of Washington mechanical-engineering students looks downright homely – a narrow, beige-colored craft in the shape of a very small canoe.

What's interesting is how the boat was made: with a one-of-a-kind 3-D printer built by university students with re-purposed parts, and designed to melt down shredded plastic milk cartons at more than 600 degrees Fahrenheit.

It's the second year that the University of Washington club – Washington Open Object Fabricators, or WOOF – entered a printed boat in the derby. The entry last year threw judges for a loop, so this year 3-D printed boats had a category all to themselves.

Since they were the only ones expected to bring a 3-D printed boat – indeed, the category was just created for them the day before the competition – the students brought last year's boat and this year's craft, and raced them.

The boat is small. Designated student paddler for the new craft, Matt Johnson, is big. "They give you life jackets, don't they?"

3-D printers use computer-aided design to create three-dimensional objects by laying down thin layers of a material, such as plastic, much like a regular printer lays down ink. Few, if any, printers use recycled plastic because it's so much harder to work with.

The new boat represents a better understanding of how to print with recycled plasticstic, said Dana Henshaw, a student and director of operations for WOOF. The boat required fewer recycled bottles. It was printed over 11 hours instead of 19 hours, by using a different nozzle that extruded a thicker line of plastic.

And a few Rube Goldberg-esque additions to the printer meant just two people, rather than six, were needed to baby-sit the machine as it printed.

"I am very excited about this year's boat," said Mark Ganter, University of Washington professor of mechanical engineering, by email. "The team fabricated a new extruder system this year (which worked much better and was MUCH quieter). They also have a much better understanding of the recycled material systems."

Two days before the race, several students were at work in the room where the club's big printer is housed, examining the work they'd created during a printing blitz that lasted well into the wee hours of the morning. At that point, the boat still had a number of gaping holes, which the students planned to patch with more melted plastic.

Milk jugs are made of a plastic called HDPE that shrinks by 2 percent as it cools. That makes it especially difficult to work with, because as the boat took shape, the cooling layers often warped. Last year, the printer was powered with an industrial-strength drill motor so loud that students had to do all their printing at night, with earplugs. Because hot HDPE plastic doesn't stick well to cool HDPE plastic, the students used a heat gun to warm the lower layer. And they had to keep shaking the hopper filled with shredded plastic so it didn't clump up and stop flowing through the tube.

This year, they swapped out the industrial-strength drill motor for a quieter one that can be run

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during the day. They rigged up an electric heating coil from an old stove to heat the lower layer of plastic, eliminating the need for a heat gun.

They added a vibrating motor to the hopper so the plastic would flow continuously into the extruder. And they also added a more accurate temperature control, so the hot plastic flowed more evenly.

It's all patched together ingeniously, in some places with tape. But it works.

"We fail a lot, but we learn a lot," said student Mark Hanson, who thinks in the future every neighborhood might include a couple of 3-D printing shops stocked with barrels of the raw plastic needed to make almost anything.

Hanson imagines manufacturers one day shipping plastic rather than specific goods, and consumers going to the print shop to order exactly what they wanted made in plastic.

Modifying the printer to work more efficiently, and making the boat, drew on many of the skills the engineering students have learned in class. But this year's crew also insisted on an improvement that required elbow grease instead of brain power: they wanted the boatbuilding process to be odor-free.

That involved "washing out all of those terrible, terrible milk jugs," said student Griffin Nicoll, remembering the dreadful stink from last year's soured milk cartons. "We washed all of the milk jugs."

In the end, though, this year's vessel was a bit less stable than last year's model, and capsized toward the end of the race. To the more spoiled (milk) went the victory.

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