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The Upside of Upcycling

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Cody Minderhoud, who rendered the upcycling team's designs in SolidWorks, says it's exciting to think that the fruits of their summer's labor "could really go somewhere."

THE UPSIDE OF UPCYCLING

During a trip to Zambia several years ago, Associate Professor of Biology Dr. Jeff Ploegstra witnessed a different side of waste management.

"I saw people burning trash to get rid of it, because there wasn't an infrastructure for waste removal," he says. "I also saw people repurpose materials; one person used round water bottles to build walls for a building."

He returned from the trip to Zambia with an idea: wouldn't it make more sense to design water bottles that could extend their lifespan and be used as building blocks, rather than as simply a water container, especially if people were already trying to utilize them to build makeshift shelters?

This summer, Ploegstra partnered with Professor of Engineering Dr. Kevin Timmer, Environmental Science Major Mika Kooistra, and Engineering Major Cody Minderhoud to focus on design and waste reduction that would help people around the world.

One of the things they focused on was bringing to life Ploegstra's dream of creating a water bottle design that can be later used as a building block—perhaps to build a house or a retaining wall in areas impacted by natural disaster.

"Many natural disasters happen in coastal areas," says Ploegstra, "and many involve housing loss, massive ground destabilization, and loss of access to fresh water. So how do you address all three of these things at once?"

"If you're shipping water bottles, why not make them useful for shelter?"

says Timmer. "If bottles were potential building blocks, then people might be able to find uses for them, rather than just throwing them away."

The idea of finding alternative uses for a product rather than throwing it away has become known as upcycling. Upcycling is different from recycling, says Kooistra. Recycling reduces production of virgin plastic by reusing waste material, but every time something is recycled, the material degrades. And recycling requires significant amounts of energy, infrastructure for transportation, cleaning, grinding, and reconstituting the material.

"Recycling is a closed loop system—it's about transforming the waste material into new products. With recycling, we're able to reduce the amount of plastic that's produced. However, with upcycling we're trying to create a higher quality, multi-use product at the outset, eliminating the need for recycling," Kooistra explains.

Recycling is important, but it isn't enough, according to Kooistra. The Environmental Protection Agency (EPA) says that 10,090,000 tons of plastic containers and packaging ends up in landfills every year. The highest percentage of total recycled plastics in any one year has only been 8.6 percent. "It's sad that we haven't even achieved a 10 percent recycling rate," says Kooistra. And there isn't even recycling data from before 1980; anything that was recycled prior to 1980 was on such a small scale that it wasn't measured or recorded by the EPA.

"Even if you make a bottle that uses less plastic, you still run into problems. If you ship bottles, you have to put more plastic packaging around it for transportation because it's structurally unsound. Creating plastic packaging for flimsy water bottles also isn't great for the environment," says Ploegstra.

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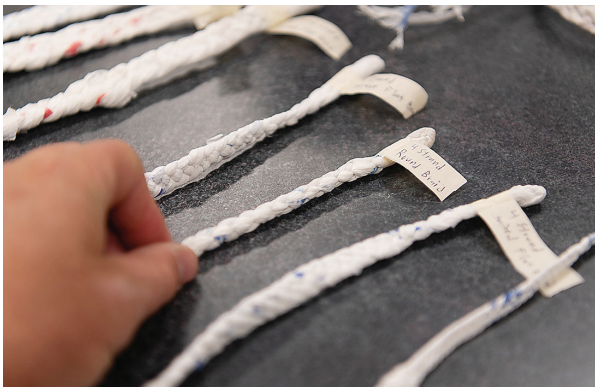
Environmental Science major Mika Kooistra spoke with businesses and industries to get a sense for their needs and openness to adopting upcycling designs.

Every morning throughout the summer, the group gathered to brainstorm new designs, refine design criteria, weigh advantages of different bottle shapes and volumes, and more. Minderhoud was charged with rendering and optimizing the plastic bottle designs using a software design program called SolidWorks. The team came up with many designs, narrowing them down to five that they considered best. They are currently pursuing patents for their best designs.

Ploegstra's favorite design was a bottle designed with retaining walls in mind.

"A lip offsets the cap so that it doesn't interfere with the next bottle and angled sides on each block allow the wall to naturally curve around. You can put a piece of rebar, which is easily accessible around the world, through the holes to anchor the wall," he says.

"We're an educational institution, we don't work in plastic production, milk processing, or disaster relief—and we're not even bottle designers, really. We want to build interest around creative solutions, broadly speaking, to help address waste management issues—to perhaps inspire others to think beyond the standard bottle design that we've all grown accustomed to," says Ploegstra.



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Upcycling as opposed to recycling not only reduces the waste stream but could help meet the needs of people facing disasters and poverty.

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>
> **— Mika Kooistra, envirnomental science major**

Still, the group wanted the project to go beyond troubleshooting and design. They reached out to Den Hartog Industries in Hospers, Iowa, to get advice about molds and the feasibility of creating bottle structures. Using the 3D printing lab, Minderhoud printed miniature 3D replicas of each bottle design.

Kooistra took on the task of building stakeholder relationships, with the goal of one day finding a way to produce these building block bottles *en masse*.

"We hope to establish partnerships that would allow for global distribution, so that the blocks could be easily produced and disseminated for disaster relief," she says.

Kooistra also reached out to Brommer Sanitation in Sioux Center to learn about Sioux Center's waste stream and to get the company's thoughts on whether the bottle designs might be a good way to reduce waste streams in the United States.

She eventually contacted Hy-Vee and Wells Enterprises about the shape of milk bottles.

"What if milk was sold in gallon-sized Lego shaped jugs? Children could use them to build forts and other structures, which might be exciting for them," says Timmer.

And Kooistra reached out to World Renew, the Federal Emergency Management Agency, and the United Nations Habitat Program about the potential for the brick-like bottles to be used for disaster relief. She found a couple of promising leads, which the team hopes to pursue in future phases of the project. For now, they are solidly in phase one: troubleshooting and building designs.

Another project the team took on was upcycling plastic bags. Like plastic bottles, single-use plastic bags often end up in landfills. The group wondered whether plastic bags could be turned into ropes. Minderhoud and his roommates had saved plastic bags all year long. Once friends and professors heard about the project, they brought in loads of plastic bags as well. Minderhoud cut the plastic bags into strips, learned how to braid, and started experimenting.

"I've braided about 40-50 ropes of varying lengths and weaves using plastic bags," says Minderhoud.

"We also made tarp samples using parchment paper, a heating iron, and ropes. These can work as a great form of short-term shelter from the elements," adds Kooistra.

One interesting challenge of the ropes project was strengths testing.

"When you make ropes with plastic bags, the plastic does tend to stretch quite a bit. We started experimenting with the rope weave and how many bags should go into that weave to find what weight we could max out with stretching," explains Kooistra.

They tested the ropes in the Rec Center using lifting weights. Some of the ropes held to 115 pounds. Minderhoud's most successful weave was the four strand and six strand: "If you want a stronger rope, add bags to it. So technically, there's twice as much material on the cross section of each braid. It's a lot harder to work with, because to braid those I had to have weights at the bottom of each strand to keep tension on it for to achieve a tight braid."

Ropes made from bags may have potential to be monetized—something people in developing countries could create and then sell at markets.

"We've been told by organizations that whatever we create should have a direct and clear use, or it needs to be monetizable," says Ploegstra.

"In many cases, those living in developing countries don't have time to care about the environment or what they are doing with their waste, because their entire day is dedicated to survival," says Kooistra.

Having spent their summer brainstorming and designing, Timmer, Kooistra, Minderhoud, and Ploegstra all agree that upcycling is a wonderful way to live out their faith.

"As Christians, our worldview can be highly influential. We believe that taking care of the environment is important and that we have a role as stewards to help with preserving creation. We see upcycling as a way to be compassionate to our brothers and sisters; upcycling could potentially provide housing or disaster relief supplies for people who may have lost everything or are living in abject poverty already. Upcycling can be a compassionate way to help with sustainable development," says Kooistra.

"God didn't create us to be wasteful," says Timmer. "So, in a sense, our project seeks to enable individuals to be better stewards by giving them an alternative use for plastic bottles and plastic bags, rather than having to throw the products away."

Looking back on the research he conducted this summer, Minderhoud says he feels a sense of accomplishment.

"There is potential that our upcycling project could go somewhere, and it's really exciting to see the fruits of our labor from this summer," he says. "I spent entire days braiding ropes and hours printing 3D models of blocks, which I never thought I'd do. It's great to design your own experiment, gather your own empirical research, and then see how the work could positively impact people and the environment—it's very satisfying work."

SARAH MOSS ('10)

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Faculty and student upcycling team members say their ideas for reducing waste and helping people came from a desire to serve others and protect the world they live in.