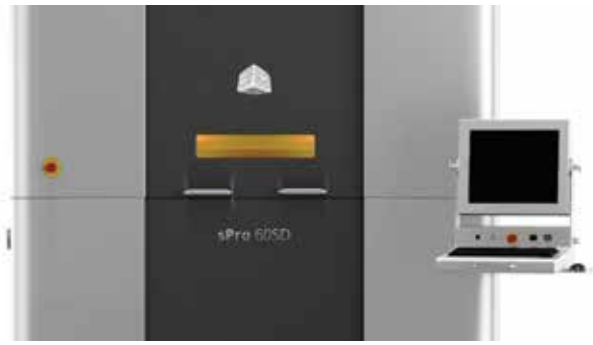

University of Exeter uses SLS® technology and DuraForm® material to help PAPA Pumps explore new design, material, and manufacturing options

- PAPA Pumps benefits from new design, lowered manufacturing costs, and new market opportunities. University of Exeter tries, then buys, an SLS system.
- In revamping both the design and manufacturing strategies for an ingenious water pump, two British organizations make some exciting discoveries — and find new opportunities.
- PAPA Pumps confirms a new pump design that can be manufactured in plastic for 80% to 90% less than its metal counterparts and is less costly to ship. The pump is therefore ripe for promotion to a wider range of global markets.

The University of Exeter discovers why it should bring the benefits of 3D Systems' SLS system in-house

It all started when PAPA pumps, a small company based in Cornwall, UK, was considering ways to improve the design of its main product, a water-powered pump. "We wanted to see if it was possible to make a plastic version that was durable, but easier, faster, and less expensive to produce and ship," says Michael Burton, Managing Director for PAPA Pumps.

These water-powered pumps have been around for nearly two centuries and are typically used in agricultural applications. They need no external power source, produce no pollutants or waste and maintenance is minimal.

The models PAPA Pumps sell are usually machined out of bronze and stainless steel and were created for a market where strength and durability were paramount. Models vary in size from six inches to six feet, depending on the application. The pumps have only one moving part that has a life of up to twelve months. Typical operational life of this pump is 50 years.

With the agricultural market established, PAPA Pumps believed that creating a plastic version would reduce manufacturing costs and retail costs and open new sales opportunities.

Phillip Selwyn, Technical Director for PAPA Pumps, had been working on new design concepts for several months. He finally settled on a design he thought held the most promise and could be produced in plastic. It soon was time to bring in additional experts that would complement PAPA Pumps' internal expertise.

PAPA approaches the University of Exeter Burton and Selwyn contacted the School of Engineering and Computer Science at the University of Exeter in nearby Devon, UK. The University has a program for helping small businesses with design and manufacturing solutions. What's more, this organization is known for its expertise in manufacturing with plastics.

"We're a solutions provider," explains Dr. Lee Bridger, Centre Manager for the School of Engineering and Computer Science at the University of Exeter. "We lead small companies like PAPA Pumps along the way, we bring in additional experts when we need them, and we outsource work to a number of local toolmakers, manufacturers, and other entities as needed."

The new pump

Selwyn's new pump design incorporated several aesthetic, ergonomic, and functional refinements and consisted of several assembled parts and an innovative rubber ring. This ring, also found in the metal pumps, is currently being patented.

According to Selwyn, versatility is the key here. Not only is the design new, it can also be translated easily into several sizes depending on the application. Selwyn's test version was two inches (five cm) in diameter, an ideal size for agricultural and horticultural applications.

The University of Exeter reviewed Selwyn's design and made some additional modifications that would simplify injection molding. Contor Moulding Systems, an injection molding firm in Devon, UK assisted the University with this process.

Exploring ways to prototype the new pump

The next step was creating a testable plastic prototype. Here, two options were considered: 1) conventional machining and 2) 3D Systems' SLS process. Weighing the costs, timing issues, and the practicality of each process, the University chose to prototype most of the pump components using the SLS process.

"We determined that machining wouldn't give us the level of design we needed," notes Dr. Bridger. "But we did decide to machine the outer casing of the pump. We wanted it made of a clear acrylic material that would allow us to see how the pump was functioning during testing." To date 3D Systems does not offer a clear acrylic LS material.

Selwyn concurs with the University's decision to use the SLS process. "There would have been tremendous costs in creating all the parts via machining," he notes. "And that's the beauty of the SLS system; you can produce three-dimensional, working models in a short period of time." Burton confirms, "The University made the call to use the SLS process, and it made sense to us."

The next challenge was deciding where to have the SLS components created. The University did not own a SLS system at the time. In fact, up until this project, it had never tapped the SLS process as a solution for a client.

The University contacted 3D Systems in Austin, TX, USA. 3D Systems offered to create the LS parts on one of its SLS systems in DuraForm material, one of several LS materials. DuraForm material, a nylon material, is known for its durability and is used by hundreds of SLS system users worldwide to create items ranging from casings for space-bound scientific instruments to road-testable motorcycle fairings.

The parts were shipped back to the University of Exeter for post-processing, which included machining in the screw threads where the pump would be joined to metal pipes. In the meantime, the University was readying a special water tower where functional testing would take place. Four students would spend the next several months testing the pump and documenting the results.

> *"We were very impressed with the speed and results of the SLS process."*
>
> *- Michael Burton, Managing Director, PAPA Pumps*

Testing

Once the pump parts were assembled, testing began. When any problem or irregularity surfaced, design modifications were suggested. Revised parts were created at 3D Systems and shipped back to the University in a matter of days. When the tests were completed, the results were catalogued and presented to PAPA Pumps. The company was pleased to learn that the new pump had performed and had held up under a variety of extreme conditions. These variations included different water input and output ratios as well as ongoing water pressures as high 150 psi or 10 bar.

More reactions to the SLS process

"The new design performed quite well, giving us indications that it was a sound product," notes Selwyn. "The SLS process gave us the security of prototyping the proposed design in a material similar to the production material, all in a matter of days or weeks."

"We easily could have spent months or even years working on this because the old methods take quite a long time —three times as long, on average—because there is a lot of machining involved. Using the SLS process was much more efficient."

- Phillip Selwyn, Technical Director, PAPA Pumps, Cornwall, UK

During the course of this project PAPA Pumps received more good news. It learned that manufacturing the new pump in plastic via injection molding will cost 1/10 to 1/20 that of machining or casting a comparable metal pump.

"We were happy to see this drop in manufacturing costs," says Burton. "Now we can produce thousands of pumps at a time, rather than casting and machining them one by one." A more affordable pump means that it can be marketed to more customers all over the world.

Burton adds that teamwork was a big factor in the success of this project. "Every organization that was involved did what they were supposed to do," he says. "And even though we are a small company, we still had access to a twenty-first century technology at a fairly low cost."

Andrew Sinclair, Sales Manager for PAPA Pumps, adds, "I hope that we can use this process again in the future as we continue to develop and expand our product line.

"Making a lighter weight, lower cost pump opens up many new market possibilities for us." Andrew Sinclair, Sales Manager PAPA Pumps Cornwall, UK

Benefits — and a SLS system for the University of Exeter

While this project helped PAPA Pumps develop a new product that can be manufactured more efficiently and used in a wider range of applications, using the SLS process made an impact on the University of Exeter as well. So much so that it purchased a SLS system shortly thereafter.

"We've since used the SLS process for several other companies to help them prove out their designs," says Dr. Bridger. "We helped one company prototype a case for a new mobile phone. Using the SLS process actually helped this company determine that their initial design didn't work properly, and that they needed to refine their design. They saved thousand of pounds discovering this design problem early."

"This project was an excellent proving ground for us and influenced our decision to bring a 3D Systems' SLS system in-house."

- Dr. Lee Bridger, Centre Manager, School of Engineering and Computer Science, University of Exeter, Devon, UK