

# Students Build Smaller, Smarter Heart Pump

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A miniaturized heart pump designed by a team of University of Florida engineering students could become a life-saving alternative for patients waiting in long lines for scarce donor hearts.

The UF team is creating a device with a novel pumping technology that makes it smaller and smarter than currently available ventricular assist devices, which are too large to be implanted in many patients. The pump's small size means also it would be the first such device in the U.S. that could be used in children.

“Current (heart pumps) are really large and complicated, so we’re aiming to build one that’s smaller and allows more types of applications,” said mechanical and aerospace engineering student Ella Kinberg, the project’s team leader.

Ventricular assist devices, or VADs, are connected to a patient’s diseased heart, internally or externally, and help it to pump blood. Although most VADs are used to sustain a patient’s life until a donor heart becomes available, they also can help patients recover from trauma such as open heart surgery, eliminating the need for a transplant. VADs also are being developed to act as long-term replacement hearts, a process known as destination therapy.

The UF student team designed the device as part of the College of Engineering’s yearlong Integrated Process and Product Design, or IPPD, program, a government- and corporate-sponsored research and education program. The team’s goal was to design a smaller, more efficient version of an innovative prototype pump originally conceived by UF biomedical

engineering doctoral student Mattias Stenberg, who acted as a project adviser.

Stenberg designed the original device in 1999 while working with UF mechanical and engineering professor Roger Tran-Son-Tay. Stenberg returned to UF in 2004 to develop and test the prototype with Tran-Son-Tay and UF College of Medicine assistant professor Charles Klodell. Both Tran-Son-Tay and Klodell were faculty advisers on the IPPD project.

“The one thing that (this pump) has that no other pump has is continuous inflow with pulsating outflow,” Klodell said. “It has a continuous pre-filling chamber, something that nobody else has come up with.”

In a human heart, oxygen-rich blood enters the left atrium from the lungs and is pumped out to the body through the left ventricle. The pump prototype was modeled after this system, using a dual-chamber design that enables the pump to fill throughout the pumping cycle. A push-plate valve moves fluid into the main pumping chamber, allowing the filling to transition easily and smoothly.

Standard displacement pumps fill during the diastole phase of the pumping cycle, when the heart is relaxed, but not during the systole phase, when it contracts. Consequently, displacement pumps need to fill the same volume, but in half the time, Stenberg said.

With a continuous inflow, the UF pump is able to reduce the pressure on the blood while injecting it into the pump – an important modification because higher pumping pressure could cause damage to the red blood cells, thereby starving the body for oxygen, he said.

The pulsating outflow allows for greater control over fluid volume passing through the pump. The pump is sensitive to changes in inflow

pressure as well, such as during times of increased activity, so that if the pressure increases, it starts to pump more blood – a self-regulating feature also copied from the way a human heart behaves.

The design “offers the mechanical reliability and the pulse-style flow of traditional displacement pumps with the potential for significant miniaturization,” Klodell said.

The size of the pump is restricted by available space in the abdominal cavity. Most adults can’t receive a currently available VAD, which requires a body surface area of 1.5 square meters, Stenberg said. For pediatric use, that size shrinks to 0.7 square meters.

Once the new pump has been thoroughly tested in the laboratory, the next step will be to implant the pump in a pig for live, in vivo testing. The final step in the testing, human trials, may begin within 18 to 24 months, Klodell said.

There is great need for smaller, more flexible and durable VADs, Stenberg said.

“Currently we do about 2,200 heart transplants per year, but we have about 5,000 people on the donor waiting list,” he said. “If you take a look at how many patients have end-stage heart failure, that figure goes up to 50,000 in the U.S. alone.”

“This device could save their lives,” Kinberg agreed.

Besides Kinberg, the students who worked on the device were Ariane Aniban, Jacob Cazares, Dena Mohnani, Mike Sim and Brian Stankiewicz.

Source: University Of Florida

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