The artificial heart that could replace transplants

16 Feb 2017

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Photography:
Video:

Daniel Timms spent his childhood learning the mechanics of plumbing from his father. Today he is using that knowledge to create a ground-breaking artificial heart device with the potential to prolong the lives of millions of people with heart failure.

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- Individual
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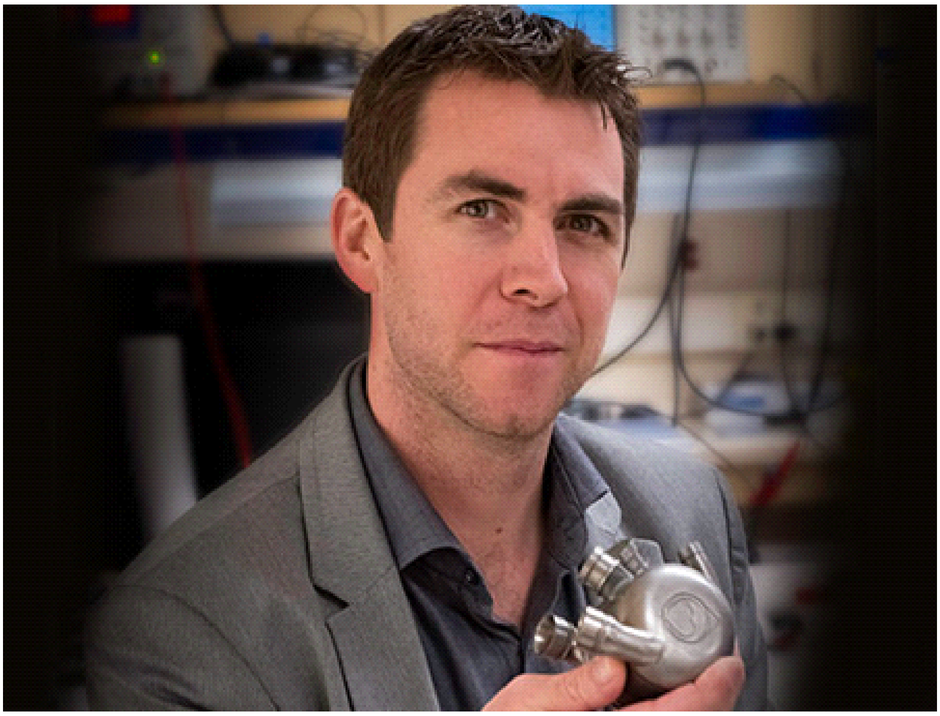


Daniel Timms was 23 years old when he first imagined an artificial heart device in the garage of his parents' Brisbane home while completing a PhD at the Queensland University of Technology. Little did he know his BiVACOR device would go on to lead the field in artificial heart technology.

Small enough to fit inside a child's chest yet powerful enough to support an adult, the device could be the answer for the tens of thousands of people worldwide who desperately need a heart transplant. With only about 4,000 donor hearts available each year, there is a huge gap between what is needed and what is available. Recipients also have to wait for the right-sized heart and the right blood type.

More than 300,000 Australians are affected by heart failure, including Timms' father, who passed away at age 55. There are 11 million sufferers in the United States and Europe. With those figures expected to increase by another 25 per cent by 2030, Timms' device couldn't come sooner.

> "The BiVACOR device could act as an alternative to heart transplant. You could pull it off a shelf and implant it in a patient without having to wait," explains Timms.

The heart with no pulse

The BiVACOR device looks like it belongs inside a machine, rather than a human.

The titanium shell is about half the size of other artificial heart devices. It is small enough to fit in the palm of your hand and weighs about 500 grams, around the same weight as an adult heart.

"If you were to see it on a desk, you couldn't guess what it does," says Timms.

> "And that's because it doesn't work on the basis of a pulse, like a natural heart."

In fact, there is no pulse. Rather than having a heart beat to keep the blood running, the BiVACOR works similarly to a fan – perpetually propelling the blood forward.

The key component of the device is a small, spinning disc in the centre, which levitates in a magnetic field.

"If you see it, it does seem like magic. You can see it levitating in air – or blood in our case – and wonder...

how can that happen?" says Timms.

"But magnetic levitation technology is used in all sorts of things, for example, the trains in China and Japan."

That levitating, spinning disc inside the BiVACOR has fins on one side, which pump blood around the body, and fins on the other side which pump blood to the lungs.

And because the spinning disc is levitating, it never touches any other part of the device.

"So there's no part of the device that is wearing out," says Timms.

"That's a significant thing to note – the predicted lifetime of the BiVACOR is more than 10 years. There's no reason why the device should stop. Other artificial heart devices may have issues with breaking membranes or other things which have plagued the field so far."

Daniel Timms and the BiVACOR team. Credit: BiVACOR Inc/Texas Heart Institute.

Global Collaboration

Timms says his background knowledge for the BiVACOR device came from his father, when the two would work in the garage and visit hardware stores to develop Timms' vision.

It's taken Timms 15 years to get from the first rough sketch of the artificial heart device to the present. In that time, he completed a mechanical engineering degree at the Queensland University of Technology (QUT), as well as a PhD about the BiVACOR idea.

He did this while working at Brisbane's Prince Charles Hospital, where he was able to seek rare insights from doctors and surgeons to further develop the technology.

A second big break for Timms came when he was approached by Germany's Helmholtz Institute, which is one of the world leaders in engineering parts of artificial heart technology. At the same time, a lifelong cooperation was formed with key Japanese researchers, who helped to refine the magnetic levitation system.

“I’d known about Helmholtz from my studies,” says Timms. “Fortunately they opened the doors for our team to go and work there for almost three years.

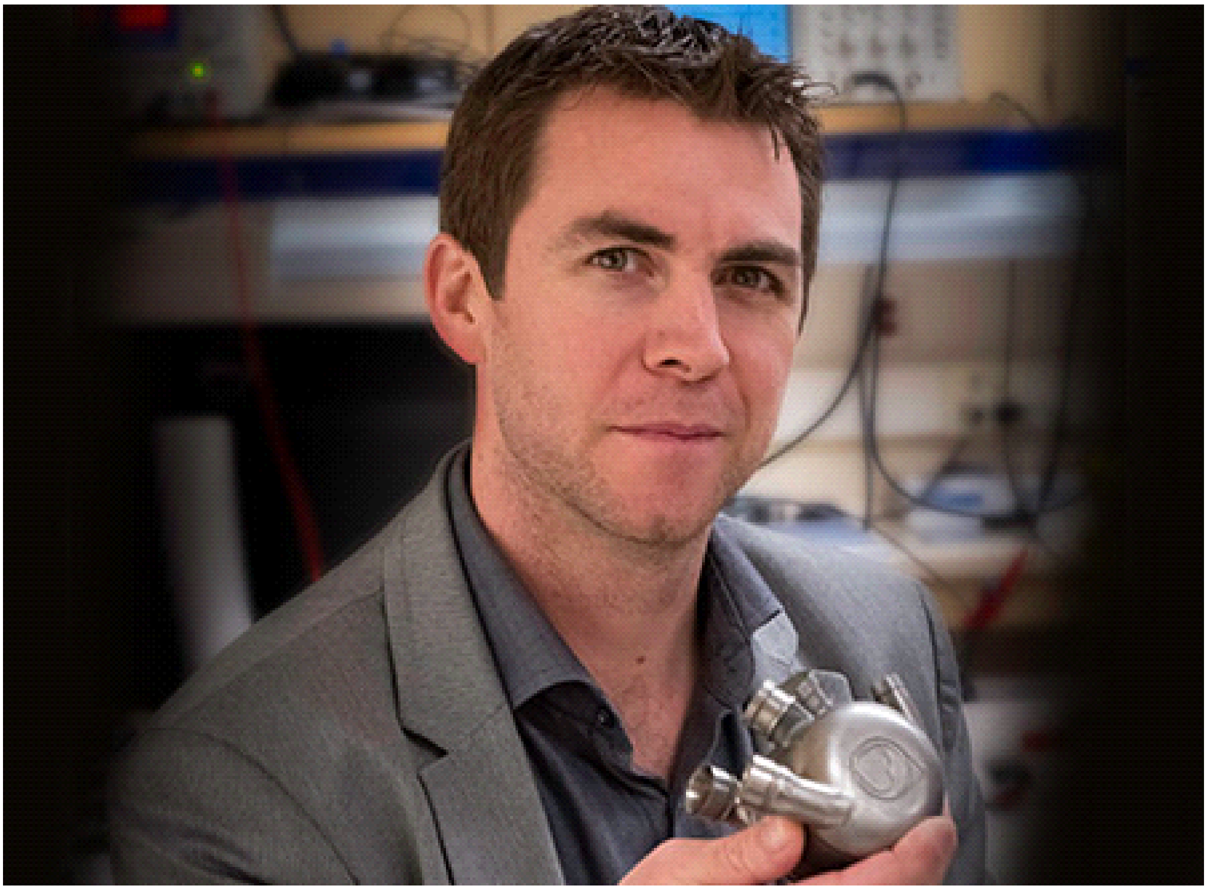
> “Their experience in developing these heart devices, from an engineering perspective in terms of manufacturing, is unique to that institute. So without their assistance, we may have stumbled in particular areas, like specialised engineering techniques.”

This was just one of many international collaborations for Timms, who seems to have a knack for developing relationships with scientists around the world.

Taiwan’s National Cheng Kung University invited him over for a month, offering him a lab, access to their artificial heart technology and pre-clinical testing opportunities.

“I walked in essentially with my device in my backpack and said ‘here it is, but I don’t know how to connect it into the circulation system just yet’,” says Timms.

“They went out the back, opened a cupboard and brought out a connection they’d used in the 1980s and then refined it for our device.”



Daniel Timms. Credit: BiVACOR Inc/Texas Heart Institute.

Human trials the next stop

Many of the research papers Timms read from a young age were written by one of the world’s leading cardiac surgeons, Dr Bud Frazier, who has been involved in the development of artificial heart technology for 50 years. Dr Frazier is also Director of Cardiovascular Surgical Research at the Texas Heart Institute, where Timms and the BiVACOR team continue to work in close collaboration.

“Dr Frazier saw our device while I was presenting at a conference in Paris in 2009,” says Timms.

“He predicted it would be something that would lead the artificial heart field in the future – and his contribution to the field is beyond human. To have his endorsement and contributions early on was crucial to us having success in our field, and to open the doors required to get something like this across the line.”

One of the most crucial doors was to his Texas Heart Institute (THI), where Dr Frazier has been pioneering artificial heart development since Dr Denton Cooley implanted the first artificial heart in a human in 1969.

In 2015, a team of 25 medical and engineering specialists from around the world implanted the BiVACOR device into a sheep at QUT’s Medical Engineering Research Facility. Six hours later, the sheep was standing and eating.

Dr Billy Cohn, a pioneering American heart surgeon from the Texas Heart Institute, was part of the team that completed the transplant.

“A sheep without a heart [was] being kept alive by a machine with one moving part,” says Cohn, in an interview with the Australian newspaper. “No pulse at all … the BiVACOR team have come up with a mechanism that makes an artificial heart balance [systemic blood flow] like a native heart, which nobody has ever been able to do.”

The BiVACOR team is now headquartered in the Texas Medical Center, in Houston, Texas, and pre-clinical testing is underway to submit the device to the regulatory bodies for human use evaluation.

As the proud son of a Brisbane plumber, Timms fondly remembers the time he spent with his dad, building pumps and irrigation systems in the backyard. His father did not live to see Timms’ artificial heart come to fruition, but the knowledge he passed on to his son may soon enable millions of people to lead longer, more fulfilling lives.

Find out more about BiVACOR.
