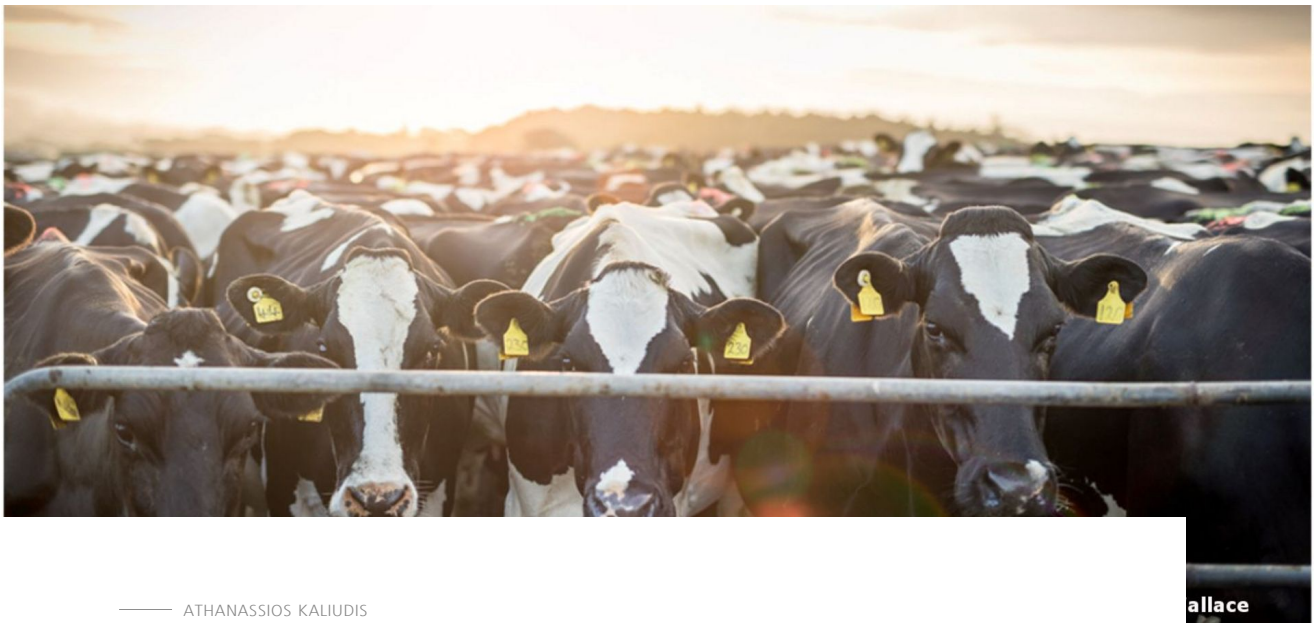


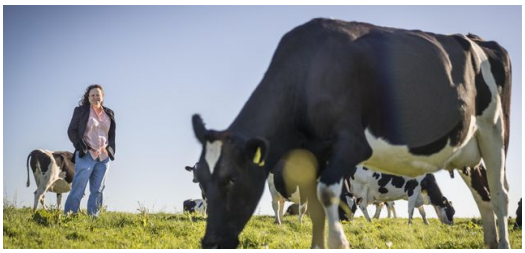
ATHANASSIOS KALIUDIS

“We simply nudge the sperm cells to the side”

Sex is a considerable problem in the dairy industry, because farmers want only female calves. Cather Simpson had a bright idea: use lasers to sort sperm cells. Read on to learn how her idea became a company.

Your plan is to earn money sorting bull sperm cells by sex. Can that work? I certainly hope so! I’m actually a Professor in Physics and the Chemical Sciences at the University of Auckland, and I knew nothing about this topic. But I met a representative from Pacific Channel, a New Zealand venture investment and management firm with a successful track record of commercializing technology for the dairy industry. He came to our university one day, searching for researchers who could solve the five biggest problems in milk production. We talked about them over coffee. Four of the problems were biological or veterinary matters, but the fifth – sorting sperm by sex – was something that I thought might have a physical sciences solution. I was intrigued right away. **And what kind of problem was it?** A very simple one: only female cows that have birthed a calf will produce milk. Of the many calves born on a farm, half will be males and the other half females. But dairy farmers want to control which cows have female calves for breeding reasons. This leads to a question: how can we specify the sex of a calf prior to fertilization? **Can you do that?** Practically all calves in industrialized countries are the outcome of artificial insemination. Farmers use bull sperm sold by wholesalers to impregnate their cows. This means that the sperm cells can be sorted prior to being sent to a farm. Sperm cells that have an X chromosome will lead to female offspring. The DNA content of these sperm cells is three percent larger than the DNA of a sperm cell with only a Y chromosome. We can use a fluorescence method to distinguish between the two; X-bearing cells glow a bit more brightly. If we can sort the sperm cells, then we can artificially inseminate animals with the knowledge that preparation A will produce a female calf and preparation B a male calf. Although there is a method using electric fields for sorting cells by sex, it is complex, slow, expensive and fails too often, so it’s not widely used.

Prof. Cather Simpson on a meadow near Auckland. She knows that there are $1.5 billion US annually in the artificial insemination business – for the dairy industry alone. (Picture: Alex Wallace)



For now, we remain a start-up with a good idea and a product that shows promise. We hope Engender Technologies will begin with trading through our artificial insemination partners soon. (Picture: Alex Wallace)

How did you come up with your idea? Right after coffee with the investor, I returned to the Photon Factory, my lab on campus, and challenged four of my students. I told them: "That's the situation. You have 24 hours. I want to hear six ideas – and don't research how other people address this problem." We reconvened the next day. We quickly rejected four of the ideas, but two showed potential. One of the proposals was to simply blow up male sperm cells using femtosecond lasers. However, we felt the drawback to that approach is that a lot of cellular waste would accumulate near the female sperm cells, likely reducing the overall viability of the ejaculate. That's why we opted for the version that maintains the integrity of the male sperm cells – we use a laser to simply move them out of the way. **What does that mean, exactly?** We introduce sperm cells into narrow channels on a microfluidic chip where flow is laminar and shear stresses are low, then identify them using fluorescence. When we identify an X sperm cell, we focus the light pulse from a Yb:YAG laser with a certain wavelength onto the cell. As the cells are transparent at this wavelength, they remain intact. The scattering power of the pulse is great enough, however, to nudge the sperm to another flow stream in the channel. The channel then splits downstream: the X sperm cells flow in one direction, and the Y cells the other.

Awards

Engender Technologies won four start-up awards with its business idea in 2016:

- Winner – Agtech category for Engender Technologies, Silicon Valley Forum World Cup Tech Awards (USA)
- TIN200 Most Promising Early Stage Companies Award (NZ).
- AgFunder top 20 non-US deals (International).
- Named one of 5 Most Innovative International Startups at Series A and Beyond, AgFunder (International)

Prizes

In the same year they also got three national prizes for innovations in industry:

- Primary Industries Champion, Ministry of Primary Industries (NZ).
- BNZ Supreme Winner, Kiwinet Researcher Commercialisation Awards (NZ)
- Baldwins Researcher Entrepreneur Award, Kiwinet Researcher Commercialisation Awards (NZ)

Did you know from the outset that your endeavor would result in a company? Yes, I did. We put our idea in writing and presented it to Pacific Channel and to Auckland UniServices, the university's award-winning tech-transfer non-profit. They provided us with seed capital – and we showed them that our idea works in practice. After founding Engender Technologies, Ltd., we went on to develop the system for bull artificial insemination companies. We're developing disposable chips that are designed to slot into a box about the size of an office printer, and contains everything you need, including laser, pumps and electronics. All the user has to do is plug it in. Our business model has us offering the boxes at a reasonable price, with our profit coming largely from the disposable microfluidic chips, as one chip is needed for each batch of ejaculate. The approach is reminiscent of single-serve coffee makers: inexpensive makers, expensive pods. **Who will your customers**

be? Mostly companies specializing in the artificial insemination of livestock. We are currently working with three of the largest companies in this sector. But the dairy farmers themselves will likely be the end users. And that played a crucial role in development: farmers have no experience whatsoever with lasers. The sperm-sorting box is straightforward and very easy to use; it also works fast.

> **We introduce sperm cells into narrow channels on a microfluidic chip where flow is laminar and shear stresses are low, then identify them using fluorescence.**
>
> Cather Simpson

How great is global demand for your machine? Artificial insemination is big business in the agricultural industry! We were surprised to learn that it amounts to some $1.5 billion U.S. annually for the dairy industry alone. In fact, artificial insemination accounts for all dairy calves in highly industrialized countries, but sex-sorted sperm cells are used only three percent of the time because the prevailing method is so expensive. Conversely, when our technology enters the market, sperm cells that are inexpensive, highly fertile and sorted by sex will suddenly become available. There will then be no reason for dairy farmers not to use this technology. We naturally have our eyes on the Indian and Chinese markets, too. These two countries have the largest markets characterized by traditional dairy farming. So, to come back to your question, we believe that we will sell hundreds of our machines. **When will your company reach that point?** For now, we remain a start-up with a good idea and a product that shows promise. We are working to finalize our R&D and show the advantages of our sorting approach. The next phase involves field testing with our artificial insemination partners. We are also figuring out how to mass-produce the disposable chips. We hope Engender Technologies will begin with trading through our artificial insemination partners soon. **Do you have additional uses in mind for your machine?** Yes. The pork industry faces essentially the same problem. Female pigs are in higher demand because they taste better to consumers. By selecting the offspring sex during the breeding of pigs, we can accelerate genetic gain for the farmer's stock. We also envision a lot of potential applications in medical diagnostics. At the end of the day, our technology allows you to sort anything that is different from something else. Here you can find the Engender Technologies video with Cather Simpson.

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