Stanford eCorner

The Breakthrough Idea

Gajus Worthington, *Fluidigm*

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Worthington explains that the market climate at the time of the formation of Fluidigm, around 1999, was not favorable towards anything without dotcom in the title, and their funding requests were met with hundreds of no's. However, as the technology continued to develop, it became clear that they were on to something big; a small, simple rubber valve that was like an integrated circuit for biology, he says.

Transcript

That's the way things are done back in the day and this was the new economy. And so we bounced around for over a year, really, trying to get this thing together, trying to get it funded and being told no hundreds of times. But along the way, there were some important things that happened. Steve and his group at Cal Tech worked away and they made breakthrough after breakthrough. And it became clear that at least scientifically and technically, we were really onto something. Or I should say he was really onto something, and I was in the really enviable position of trying to make it into a business. This is the first Science cover here and it shows a close-up of one of the early chips that we made that won some recognition. But this is a reality. That picture on the Science cover is kind of cleaned up. Let me put it that way.

This is what we really had. This was the bleeding edge. We had little rubber chips that were made by hand. They were covered in particles that were really quite simple. What you're looking right at there is just three inlets and they're all connected by channels. Whoop de-doo. What's so interesting about that? Well the interesting thing was that they were all made out of rubber and they had very, very small features some of them that were sub-micron. Nobody had ever micro-fabricated a useful device out of rubber before, although a few years earlier George Whitesides at Harvard had done some interesting work. So that was different nobody had ever done that before but you can see it is pretty ugly. What we had with that was a way to make a valve and this cartoon is what a valve looks like for us, birds eye view and I'll rotate this up on its side so you can kind of see how we exploit the properties of rubber to make a valve.

You have a channel that has fluid going in and out of it and then what we call a control channel, because this is all rubber if I apply pressure here its like stepping on a garden hose the pressure in this channel here will cause the roof of the channel below it to collapse. Because its gasket material you get a complete seal. Because it's a rubber band, if I release the pressure, the valve pops back open. And if you control the geometries properly, you can make very, very small valves that are very simple to actuate. So we were the first people to do that. Lots of people have made little valves before but none of them are really quite this simple and none of them were made out of rubber. So that was interesting. And then we had a realization that perhaps we might be able to do something like something that had never been done before and have a significant impact. So these are computers 50-odd years ago made out of vacuum tubes and cables and alike. And the ENIAC was a major breakthrough in computation, of course, but invoked what came to be known as the tyranny of numbers which is really a practical thing.

In theory, you could assemble a million vacuum tubes and a million cables and get things to twiddle together, but in reality and practice, it's just not possible. There's a finite probability that those solder joints would break or that one of the vacuum tubes fizz out. You just can't assemble that many macro-components without having an army of people to shepherd each one. So that was the tyranny of numbers that was radically blown through by the integrated circuit, as we all know. And really truly and remarkably that the Titanium 2 has more power than 100,000 ENIAC brains and yet it's the size of the proverbial thumbnail. How did this happen? Take a vacuum tube. Make it very small vis-a-vis the transistor. Miniaturization and then integration, figuring how to put lots of those components onto an individual substrate. Two Nobel prizes, actually three awarded for this progression, one for inventing the transistor and then two more for figuring how to put them all in an individual supstrate. That equation, integration plus miniaturization, is what led to the revolution in electronics.

Well, we scratched your heads away. We got to switch. If you think about this, although it doesn't have gain, a valve is fundamentally a fluidic switch. And what's also interesting is that we actuate these valves with an analogous force. It's not voltage but it's pressure. So we thought, "Ha, could we be on to something similar like an integrated circuit for biology?" And then we realized that if we could do that, we could make a fundamental contribution. If you look at the way biology is industrialized by leading pharmaceutical companies and by biotechs, what you'll see are systems that have some resemblance to how ENIAC evolved. But these are not electronic systems, obviously. These are fluidic systems. They're giant robots which fill this room with test tubes and micro-tire plates and capillaries, conveyor belts and alike.

They're very complex fluidic engines. They're very expensive and they are very difficult to run and they impose de facto limitations on the number of experiments that can be done and the type of experiments, et cetera. So if we could put this type of machine onto something very small, say, this big, could we effect a revolution in biology in the way that it is done in the pharmaceutical world and even in the academic world that can significantly reduce the cost and the expense associated with delivering drugs to the market? That was our high insight but note, we did this wrong if you read the text books.