The Photon:
Spotlight

On Alumnus Dr. Robert E. Fischell

This month, the department and the university honors its most distinguished alumni in its first-ever Annual Alumni Association Awards Gala. The Distinguished Physics Alumni Awardee for this year is Dr. Robert E. Fischell, inventor of the rechargeable pacemaker, among other things, and president of MedInTec, Inc.

When Dr. Robert E. Fischell graduated from the university with a master's in physics, he had no idea that he had a future in medical device inventions. Even years later as a principal staff physicist working with satellites at the Applied Physics Laboratory at The Johns Hopkins University, it came as a surprise to him. So how did he eventually become a United States "Inventor of the Year" who currently holds over 100 U.S. patents?

"Accidentally," says Dr. Fischell.

While catching up on some academic reading, Dr. Fischell spotted an advertisement publicizing a heart pacer battery that lasted for two years before it needed to be replaced. Dr. Fischell was unimpressed, to say the least. So he got in touch with a cardiologist at the Johns Hopkins Medical School, asked him some questions and then made a life-changing statement. "I said, with my frequently used bravado, I can bring to you in one week a pacemaker that won't wear out in a human being. It's going to be recharged within a nickel cadmium cell inside, it'll be less than half the size and last indefinitely."

The cardiologist was more than skeptical, but Dr. Fischell was confident. He hoped to create a pacemaker that operated on a battery similar to those used in his satellites and was sure that with the help of the physicists working for him at the lab, he could meet the challenge within a week.

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Physics Alumni | UM Physics Research

On Nanotechnology

Nanotechnology 101

An Interview with Dr. Christopher Lobb
Professor, UM Physics

Dr. Christopher Lobb (left) answers questions on nanotechnology posed by Photon *editor Hannah Wong (right).*

The Photon: *In light of all the initiatives coming out on nanotechnology and nanoelectronics, I think the first big question is what is the definition of nanoelectronics, in your own words?*

Lobb: It's a vague definition, unfortunately, but I think it refers to any electronic device that is smaller than one micron. A micron is 10^{-6} meter - that's about 50 times smaller than a human hair. Since the measurement below micro is nano, that's where the word comes from.

P: *Ok. So then, what is nanotechnology? I see the word tossed around a lot, and it seems to be a catch-all phrase.*

L: Well, there is a lot of interest in non-electronic applications, and it gets very vague. They can make human insulin now by changing DNA. That's in some way a nanotechnology. You're taking real tiny objects and making them do what you want. So, yes, it's a big catch-all phrase.

P: *There seems to be this craze that's starting to build up about nanotechnology. Is it just me, or is the general population just starting to hear about it and starting to get real excited about it?*

L: No, I think so. There is a craze building up, and it builds up for the same reason that crazes build up anywhere - people are crazy.

P: *[Laughing]*

L: No, science is fun. The image of people making dispassionate decisions in white lab coats is really not true. When a lot of people decide something is really interesting, they tend to want to get involved with it. So, yeah, it's a craze. And I don't mean that in a bad sense, it really is something that's becoming very exciting.

Part of the reason is the electronics motivation. There's this thing called Moore's Law. What that means is pretty stunning. You even see it for yourself. Basically, depending on what you're looking at, every two to three years, everything is twice as fast, twice as small and half as cheap. And it's just been this remarkable trend in electronics that's been going on since the late '60s, which is why you have personal computers now that are better than supercomputers from 15 years ago.

It doesn't just have to be electronics. It can be machines - it can be little things. People talk about putting little machines in the body to go around and take out cholesterol. That's a long way away, but why not?

P: *What has me stumped is why everything has to be so small. Things in the body, I can understand that, but are we wasting our time trying to make everything to that scale?*

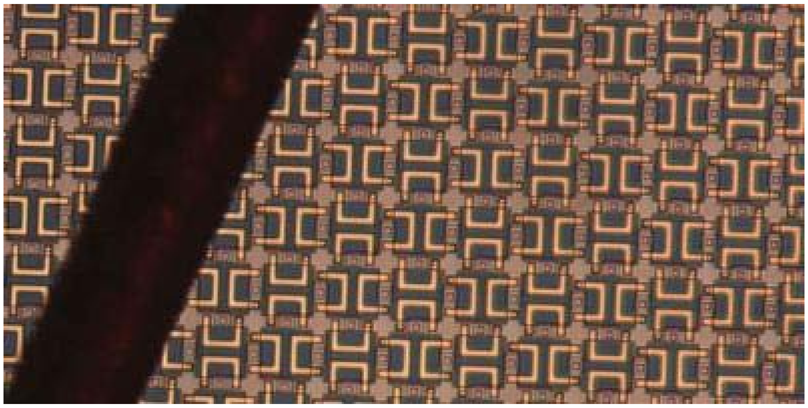
L: Well [laughing] - I don't know whether to give a smart answer to that and say yes, or say no. Look, a lot of things that people are going to try aren't going to work [so in a way] that's a waste of time. [But] you don't know until you try. So I don't think it is.

But the thing that the integrated circuit people realized, [and] the electronics industry realized was that smaller was cheaper. If you can put the entire processor on one chip - which is now so old people don't even think about it - it's a lot cheaper to build a computer that way then it is by having separate chips that you have to wire together.

So I think that's the motivation - small is cheap. Especially when you think about what you're getting for it. Every time something gets faster and smaller, it gets better; you can do more with it. I think there are many people who would say the reason we have such a big economic boom is the rise in productivity that's come about because of the electronics industry. If I knew a lot about economics I'd be rich.

P: *[Laughter]*

L: But I think it's probably true.



Example of a structure at the nanoelectronic scale. A small section of a Josephson Junction array is shown in the figure. The array consists of a square lattice of superconducting crosses which overlap at their edges. (The superconducting crosses are the dull red areas.) At the overlap of each cross is a small square which is partly surrounded by a gold loop. This overlap is a Josephson junction. The dark region on the left is a human hair, for size comparison.

P: *When it gets really minuscule like we're talking with nanotechnology, isn't it just too difficult to manufacture it that way? I mean, ok, so it's a few atoms bigger as far as materials go, that's not gonna kill you.*

L: Think about that digital camera, how many pictures can you put into the memory?

P: *An enormous amount.*

L: It's an enormous amount, but imagine if you could put every movie you'd ever want to see on one of the memory cards, or whatever you put in there. Maybe you don't want to do that, but why not?

Even since I was a student, an undergraduate, the world has changed in ways you don't think about. Thermostats on the walls. They used to be these little mechanical contraptions that were really beautiful and they had these bimetallic strips and all kinds of little contacts and things, and they were bulky and awkward and everything like that. Now if someone had said in 1965 that you should do that with electronics, you would have laughed at them because it would have been very hard to do. And now every thermostat is a little microprocessor because it's cheaper. So you can use them for things you wouldn't, because they're dirt cheap. Cars have lots and lots of microprocessors in them to just do ordinary things like turn the fan on and off, because it's cheap. So, it's got a ways to go before it runs out, is my guess.

P: *From what you're saying it sounds like nanotechnology has the potential to spin off into all these various things which is why the word nanotechnology is so misunderstood - so many scientists are using it in all these different fields. Is this like opening a whole new can of worms?*

L: Well, I think in a way. It's something maybe comparable in scope or even greater in scope than the industrial revolution. The 19th century was defined by machines. This one is defined by electronics. I know I'm not going into all the other things, but the electronic revolution has been absolutely stunning.

And the idea that you can extend that kind of thing to other fields, to biology, etc. - if only some of the things people are playing with work out, it's going to have a tremendous impact.

P: *When do you think, nanotechnology going to start affecting our lives? It seems a little far off. I just hear about it as theories, etc., but when will the common person start saying, "Oh my gosh, nanotechnology. Look at how it's impacting us?"*

L: Well, I think it depends on what you define as nanotechnology. The smallest features in the fastest integrated circuits are already in the hundred-nanometer range in size.

P: *So people are dealing with nanotechnology and don't even know it.*

L: But, I think these things sound crazy and visionary - well, let's take the quantum computer thing. Whether that will ever work or not, I don't know. A lot of people are working on various aspects of it. There are at least seven physics faculty at Maryland working on quantum computing, for example.

A lot of very exciting things are going on, but in the end if someone builds one, it will get announced that there is a computer, and it's a new computer, and it's faster for certain problems than ever before by a lot. And it lets people break codes better, or whatever it's good for, and there will be a little article in *The [NY] Times* and people will say, "Ah, it's just another computer," and they'll be right.

P: *Miracles happen, and you don't even notice.*

L: Yes, and we live in an age of miracles. It's great.

P: *That's interesting. Now, there was one thing I was trying to visualize - I can't picture how a computer or any of the various microprocessors can become so small. How can an atom be put together in a way that it can be a computer? It seems pretty rudimentary to ask...*

L: No, it's not rudimentary at all, and there are people who think that you can't make things that small, and that's certainly a viable belief. But just speaking very broadly, because I'm sort of toward the camp that they can't be, you learn in chemistry that the atoms have orbitals, quantum states. They draw the solar system model, and electrons are allowed to have certain orbits but not anything in between.

Well, computers are about storing and manipulating zeros and ones, and if you could take an atom and say that the electron in the smallest orbit is zero, and if it's in the next biggest one, it's a one. You can make that the basis for a bit. So, that's what people are thinking, but they're thinking it in a very broad way, because they don't know how to do it yet. You didn't lack either imagination or background, no one knows how to do it. That's the point.

P: *So, what advice would you give to students, the visionaries of the future* *who see the potential of nanotechnology and are interested in getting involved?*

L: Well, I guess I'd suggest some things which are what universities are good for. First, is that people need a broad education. It would be very easy to say they should just study physics or engineering, and they'd be all set. But, unfortunately, it's not like that.

It wasn't long ago that high schools were telling people who didn't want to go to college to become draftsmen and that was very bad advice, in hindsight. There aren't many people left doing that and the people who are doing it are the ones who were flexible enough to learn about computers. But the same things might happen with medicine, you never know. Everyone's saying this is going to be the biological century, but I think it's going to be the century where the boundaries are much more blurred, and if all you do is study straight biology or straight physics, you're not going to be prepared for the things that might happen.

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Dr. Fischell with a real-life stent and a close-up picture of the device. The actual stent is barely visible on the top-right corner of the paper.

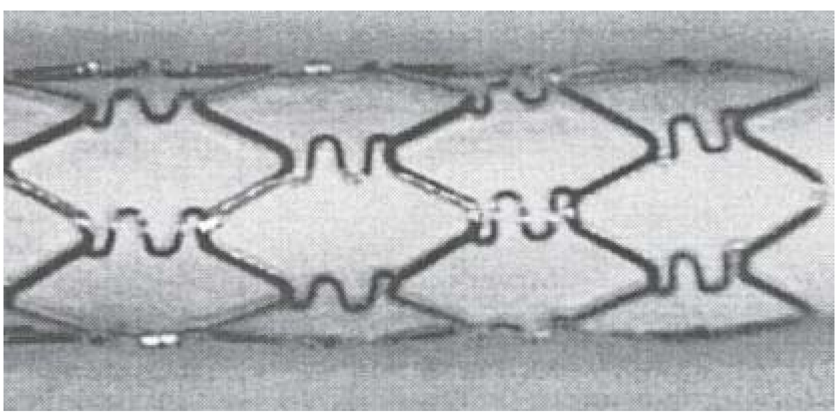
He created a prototype in three days.

It was then that Dr. Fischell had found a new calling and began his work as a medical device inventor.

Eventually, Dr. Fischell left Johns Hopkins to pursue his inventing interests privately, heading up companies such as MedInTec, Inc., Cathco, Inc., IsoStent, Inc. and NeuroPace, Inc. which allow him the freedom to both invent and market his patented work.

Working privately has even given him the chance to work with his three sons and his wife, creating what Dr. Fischell calls, "a little family business." His three sons, one with a Ph.D. in physics, another with an M.D in cardiology, and the other with an M.B.A. in marketing and finance, work with him as either consultants or fellow inventors, while his wife works the financial side of the business.

Among numerous other medical devices, Dr. Fischell has worked with his sons to invent new and improved patterns for stents, which are small, stainless steel tubes placed over balloon catheters and inserted into obstructed arteries. After the balloon is deflated, the stent is left in the artery, allowing blood flow and combating Coronary Artery Disease. (Please see figure below.)



Close-up view of a stent on a balloon.

Dr. Fischell says that inspiration for his inventions come quickly. "Normally, if I get an invention, it occurs to me within a minute. When I see that there's a problem, and if I can't get an answer in sixty seconds - the general idea, the whole approach - then I usually give up... It either occurs to you or it doesn't occur."

According to Dr. Fischell, all his productivity allows him to file a new patent about every six weeks, though his work is not without challenges. "I don't know how many times we fail. We frequently fail before we get to the end. Frequently. But in the end we often succeed, and we change people's lives and that makes you feel really good about yourself."

Dr. Robert Fischell and Marian Fischell at their home office.

So does he ever plan to slow his pace and retire? "I can't imagine what retirement would be. I mean, what do you do when you get up?"

Dr. Fischell notes that at this point in his life, it is his desire to change lives that motivates him. "If I have the chance to benefit some people, there's some responsibility to give it a try. When at the end of this year, there are three thousand people everyday who have their life improved because we made a stent that's better, that's doing things that others couldn't do, that can prevent the need of bypass surgery, my sons and I are very proud of that. That's what we work for. It's not that much a matter of money anymore. It's a matter of what can you do."

• See Dr. Fischell's profile

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