Terry O'Shea on the Function, Fashion, and Future of Wearables

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Terry O'Shea is a Fellow in Hewlett-Packard's Printing and Personal Systems Division. He has a PhD in engineering mechanics from the University of Arizona and an MS and BS in engineering physics from the University of Tennessee-Knoxville. He is a pioneer in the field of sensing for healthcare, and his over 20 years of experience include working as a faculty member at the University of Maryland, launching the Intel-funded Technology Research for Independent Living Centre in Dublin, Ireland, and serving on the board of directors for the Oregon Bioscience Association. Before coming to HP, he was a senior principal engineer in Intel's Digital Health Group and their director of rapid prototyping. At HP, he leads a team working on wearable devices—including a smart watch just now entering the market.

Tell us about your past projects with wearable technology.

Back in my student days at the University of Arizona, we were working on implantables. In 1996, we put strain gauges around canine femurs with different hip replacements. We made little wearable battery packs and telemetry systems for the canines, so as they walked on treadmills, we could measure what the impact loading differences were on the leg with the hip replacement compared to the other legs.

After my PhD, I moved to the University of Maryland, where I worked in electronic packaging. I then went to Intel, where I worked on both electronic packaging and reliability, as well as a lot of related telemetry issues. This eventually led me down the path of working on wearables for healthcare.

One of the first projects we had at Intel was modifying the Microsoft SPOT watch to enable it to be a medication reminder/prompting watch. That was the first foray I had into the wearable space. We ended up creating an ecosystem of Bluetooth-enabled devices that we put in 36 homes of elders around the US. One of the devices was a pill box instrumented to detect whether and when participants opened it. The participants were also given a modified SPOT watch with a Bluetooth stack on it. The work was co-funded between Microsoft and Intel. We tracked location in the home, and if the person was next to the medication box and hadn't registered taking his medications, a prompt would appear on the watch asking him if he taken his medication. He could answer yes, no, or that he had taken the medication but the watch hadn't registered it. This project also gave us a lot of experience in location tracking using different RF technologies.

The next big project I did in wearables was the Shimmer design. All the previous telemetry systems I had made—which might now be called the Internet of Things and wearable devices—were based on a single-function board with a radio stack and whatever sensors or actuators were plugged into it, and they were all one-off systems; there was no modularity of design. I sat down with Ben Kuris, who is now CTO of Shimmer Research [shimmersensing.com] but was at Intel at the time. Kuris and I went through how to bifurcate the architecture and wrote the spec sheets for it, and then the wearable sensor platform went off and became a successful product at Shimmer Research. We launched the platform out of Intel in 2008, and it's been going strong ever since. It's been the backbone of a lot of the research in wearables—both academic and commercial. It's a popular platform because the device is reconfigurable, so it can do everything from gait analysis to motion detection as a telemetry device. It can also act as a pyro-electric IR motion detector or sense EKGs, EEGs, EMGs, and EOGs. Its use in fall detection and research around orthopedic movement and rehabilitation has been very rewarding to see.

After working on another somewhat secret wearable program at Intel,

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I came to HP, and we kicked off the wearables program here.

Out of all this work, what were the main lessons learned?

A big one relates to compliance. It's really hard to get people to keep wearing their wearables and keep them charged. Perception is very important—is it stylish enough for their personal tastes, something they believe they need, and critical to their lives? I know we can get great functionality on the device, and we can put great technology on it, but can we as technologists make it desirable? At end of the day, you need to make it so the person wearing it wants to wear it all the time. That's the challenge that has always grabbed me about wearables—how do we make it more desirable and function more easily so that people want to wear it for the rest of the product life instead of just wear it for a little while and then give up on it?

This leads to the ultimate big investigation for me: "not wearables." We can do everything to make great clothing, to implant sensors in clothing, jewelry, watches, and glasses, but we're still relying on people to wear those things. Instead, how do we turn the model around? What can we do while *not* touching you—non-contact sensing—and still collect all those variables—heartbeat, respiration, identification, and what you are seeing or hearing?

That's the long-term goal—to do what we want regardless of what the person is wearing. How do we take information and context and give users back information without their having to interact with the technology? How do you make it that easy? That's the real challenge, and wearables are only a step along that path.

Wearables have been attempted so many times, why haven't they had general success across the population? Is there anything different now that will bring them more success?

It's so true that wearables have been attempted many times and yet haven't caught on broadly. Another aspect of this might be that we've been taking a step backward with our usage model. Take a look at the SPOT watch versus the Mirasol-based Qualcomm Toq, or Samsung's smart watches. These are all a step backward from the Microsoft SPOT watch in one sense, because that older device was more independent. Now we have made these devices all dependent accessories to clients like phones and tablets. What would be good is if we can make that next leap back to independence so there's no longer a reliance on an interim hopper and its radio stack.

The Shimmer design: (a) the wearable sensor platform and (b) its reconfigurable elements. (Source: Shimmer; www.shimmersensing.com.)

But again, a big part of the problem is that we've been producing cool technology designed by technologists. This can take us back to the HP 1—that was a great watch, and it's now very desirable on the used market, but why didn't it catch on more then? The engineers and technologists are doing the best they can in their frame of reference, but this may not be what people want to wear. If you look at the beautiful pieces of art that have come out of technology, they're not usually designed by engineers. I think we're just starting to see this improve in wearables—we know we have to make it look attractive and beautiful and not geeky. In wearables today, we're starting to see a transition in to fashion.

How about things like Google Glass, which some people think is cool and others think is geeky. Will we continue to see a spread of opinions?

Exactly, and that has been the case for a long time. If you look back at some of the classic cars, like the Edsel, some people thought that was a really cool innovative-looking car, and some people thought it was ugly.

Looking at Google Glass, the newer version is much better and has a nice aesthetic to it. Over time, will people adopt to it? Quite probably—we're only just now really getting into the Glass paradigm. Ten years ago, most of the glass was relegated to watching movies on portable devices, looking at a display inside the glass—the same thing with prisms and other optic systems. But as time progresses and the technology improves and the optics get better, it can take off. But you still have the big challenges of charging the device and making sure you have the right stuff displayed at the right time.

You're starting to see it used in the high-end sports venues like the America's Cup. There were a lot of optical wearable telemetry systems used by the sailors there to provide information directly to their eyes at the right time. That's where the technologies start, and then you see them trickling down from the people on the bleeding edge—but

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it takes another five or 10 years before the technology really penetrates the mass market.

Even if you design a piece of clothing with wide appeal, people like to change the look of clothes day to day, and over time their tastes change. Is this an issue for the adoption of wearables?

Absolutely. Going back to the medication reminder, I wanted to make sure we got the design solid and adoptable for users. Our target audience consisted of geriatrics at the time, so we did a lot of focus group work to make sure we got the style right—something they would enjoy wearing. Even so, in the end, a lot of them didn't wear the device because they didn't think it was fashionable. The focus group we had just didn't pick up the demographic or pick up the needs of most of the elders we were targeting. And the same demographic can have diverse tastes. So it's a really hard problem to get the fashion and style right, especially as things change. Some things are classic in style, and if we can grab ahold of those attributes in our designs, we'll be much more successful.

What are the biggest technological problems currently facing wearables?

The battery issue is important—making the device very low power is a huge win. If we look at the breakdown of where the energy goes, there are three big areas. The first is sensing—whether the heart rate or something else. Displays are the next big power draw. Then it's getting the signals to and from the wearable device and out to the cloud or aggregator infrastructure—that transceiver is the third thing.

Very little of the problem seems to be in the processing of information, because a lot of that is done off the wearable itself. However, some of the recent GPS watches are marvelous in that they do all the GPS timing calculations on the watch itself but still have a better battery lifetime than what it was. This can help promote a more independent role for the wearable.

The other thing I'd really like to see true, high-quality circular displays. Not all fashion is square with rounded corners, and yet some of the circular-seeming displays out there are not really circular.

What makes something a wearable?

A wearable is a device that has its own retention mechanism, whether it's retained by a clasp or something like a Band-Aid or a clip over the ear, or a band like a watch or a belt clip. All those things make it a wearable. In contrast, there is a class of IoT devices that aren't environmental monitors but are called pocketables. This is a whole new class of devices, like the Bluetooth blood alcohol Breathalyzer sensors. France mandated that every car have a Breathalyzer sensor, so there has been a huge take off of these Bluetooth alcohol sensors.

There's also a company that puts out a pocket weather sensor and pocket indoor pollution sensor. These devices are smaller than your phone, but you can drop one in your pocket and take up sensing later. AT&T has its own—a pocket playlist—a little pocket juke box hard drive with a server on it, and you can connect several devices to it, and it's battery powered. But these pocketables do not have their own retention devices to keep them fixed to the body. It's a wearable as long as it can retain itself to your clothing or body. If you do a somersault and it falls off, it's probably not a wearable.

Besides more independent functionality, how do you see wearables fitting into the infrastructure and the rest of the ecosystem in the future?

What you're going to see in the next generation is a transition away from the single contact devices, where the device is next to a cell phone or tablet. I think you'll start to see the device acting as a hub and connecting to your phone, your home, instruments on your bike, and to other wearables. It's a transition moving away from the wearable being a device that connects to an access point to being a device that's a hub itself in a star network.

Are wearables primarily intended for responding to or augmenting today's applications and use cases, or will they open up new use cases?

I don't see an end to new use cases any time in the future. That's what is cool and exciting about this area right now. You see use cases taking off that nobody thought of that are useful and changing people's lives—and that people have fun with too.

Even going back to earlier work, we originally intended the Bluetooth-enabled SPOT watch to be a location-tracking, meds-prompting device. But the guys at Microsoft added Pong features to it—game controller features—and connected it to the screen projector in one of their offices to play Pong. They would stand against each other on either side of the screen and play, which wasn't at all part of the original vision. These things happen quickly. Today, look at the number of apps in the Pebble ecosystem—it's astounding the new ideas people come up with. Pebble is a wonderful and elegant design, and some of the great things people do with it and the usage models are really taking off. This will keep happening as wearables become more prolific throughout society.

Does this suggest it's good to open up the development platform to others, even if what they do doesn't fit in with the original vision?

It's always great to do this on the research side, to try new ideas and experiments. And there are business models, such as the Apple iOS and Google models, that that have opened this up to other developers and have really proven this can be successful. But there are issues of regulatory and compliance with local government rules that may require you to do the opposite. It all depends on the business cases and environments.

Do you foresee a wearable device replacing our mobile phones? If so, would this be good to aim for, or less interesting?

Yes, no, maybe. Let me start by saying that with the large number of looks that different people go for, it would be really difficult to find a one-size-fits-all thing, such as a watch, that we could also use as a phone. Of course, where there are challenges, there are also opportunities, but I think this is a hard one to solve.

A person taking calls from a watch has been interesting ever since Dick Tracy days. There have been several of these on the market, so it's not really innovation, but the more interesting thing is can we make the technology so small that it becomes natural and something people want to do? If you look at how technology has progressed just in the phone area, people would always hold the phone up to their head because they thought they needed to. Now you see more people holding it away from themselves with the speaker phone on, even in public. This is because they don't want to hold this device up to their face or ear. Will be people okay talking to their wrist, putting more of their calls on speaker phone, or requiring speakers near their ears? Social acceptance of new behaviors with technology changes over time.

There are so many places to wear a wearable. Are some places better than others?

They're all good for something; we just haven't figured out what that something is yet! I've seen some really smart headsets come out that can do heart rate monitoring just as well as a chest strap or watch. Some watch displays show all kinds of content and information—more than you can get from looking inside Glass. But I've also now seen my son get addicted to tennis on Google Glass, playing until he sprains his neck. Every one of those usage models you could have done with a wearable on another part of your body. It all depends, and we're still trying to figure that part out.

Micro-projection is one research area O'Shea highlights for future wearable devices.

An article in this issue, "The Multiple Dispositions of On-Body and Wearable Devices," describes the need to design wearables knowing that they might be worn in ways different from the intended use. Have you seen something like this in the design process?

Yes. In fact, in testing the accuracy of fitness bands, some groups strap the band around the handle of a baby stroller, because a lot of the exercising moms think the band interferes with their movement but they still want to use it. Or they put it in a backpack. And some fitness bands were as accurate in the backpack as on the wrist. Having that kind of continuity and accuracy in different places is incredibly important, and designers of wearable technology need to keep in mind that people don't always wear things where and how you expect. This is something we need to play around with and understand.

Some argue that wearables should focus on just one thing; others argue that the real estate on the human body is too precious for the wearable to do only one thing.

This depends on the usage model. There's a really good glass-mounted display out there using technology from Recon Instruments that is just for sailing. When sail boat racing, if you look through the glasses, it will tell you the bearing and angle of a boat. If it did a lot more than that, it would be too much information for the helmsman to consider. We saw these used during the America's Cup. Google Glass has that same functionality, but you don't want to be fumbling around in the middle of the race to get back to the original screen. So there is a lot of room for both single-function and generic devices.

What device would you personally like to see become available?

Micro-projection is going to be the next coolest thing. The ability to hold your hand out to project onto the table the contents of a large display that could come from your watch would be phenomenal. A device with micro-mini-nano projection—that would be the bee's knees. I'd rush to buy one of those!

So I encourage everyone to keep working on wearables—it's a big area, and it's growing. We're at the tip of the iceberg, and I'm excited to see what everybody has to offer going forward. P

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