



# CREATORS

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**Ed Hepler**

Winner of the Qualcomm  
Tricorder XPRIZE®

May 5, 2017



In April 2017, the winners of the the Qualcomm Tricorder XPRZE® were announced. The goal of the competition was to create a real-world version of the StarTrek® Tricorder – a handheld device that can diagnose at least 13 different health conditions. The competition was intense: parameters were altered to make the challenge even achievable, 40 teams participated at the outset, and the competition ended up taking roughly five years from its announcement in 2012.

In the end, the competition pitted two finalists against each other: Dynamical Biomarkers Group, a Taiwan-based team backed by technology giant HTC and featuring Harvard scientists, and Final Frontier Medical Devices – a bootstrap operation run by ER doctor Basil Harris and featuring ex-InterDigital engineer Ed Hepler as its hardware development lead.

**We caught up with Hepler after his team was announced as the winner in April 2017.**



Take us through your time at InterDigital.  
When did you join the company?

When were you here until, and what  
was your role when you were here?

**Ed Hepler:** I first came in as a consultant – I think it was October 1999, I was brought in to help do the architecture for FDD. I had worked, prior to that, at Commodore, doing Amiga chips, and Commodore went out of business. I started my own consulting firm, and I came in to do the implementation architecture for FDD.

From there, I did consulting with InterDigital for a little over a year. And my manager came to me and said, “Hey, we think that we’d like to bring you on as an employee.” So, I came on as an employee and stayed there until 2012. That entire time – well, up until maybe the last year – I was doing implementation architecture for various modems that InterDigital produced. I decided sort what was in hardware, what was in software. On the hardware architecture, I brought in the concept very early on of doing hardware accelerators, so we were very hardware accelerator-intensive from our architecture, which offloaded the CPU. It allowed us to run at a lower clock frequency, so we had power advantages because of that.

“ InterDigital wanted to start up their own development of FDD.”



## What's your educational background?

**Hepler:** I got my degrees from Drexel University. I got a BS and MS in – they had something at the time called the Honors Program there. Drexel's normally a five-year school because of the co-op experience that they have, but in that five years I did a BS and an MS. I stayed on there – passed all the qualifying exams and did everything for my PhD. But living as a student is difficult from a financial point of view, so I decided to go in absentia, which means I finished everything except my thesis.

And I got an opportunity to work at Bell Labs, so I became a member of the technical staff at Bell Labs at their Indian Hill facility, which is in Naperville, Illinois. So, I went there, worked on their fault-tolerant processor, the processors that run the electronic switching systems and had some pretty incredible requirements or constraints as far as failure or lack thereof.

The specification that we had to design to was we were allowed to have two hours of total downtime in 40 years. That's just a few minutes a year where the processor is allowed to be, effectively, offline. There are various techniques that they use to do that, so I was part of that. This is just before AT&T was broken up, and I worked on some of the processors that they later were trying to make into commercial machines as well.

In Naperville today, on the corner of Naperville and Warrenville roads, there's a huge building. And, in fact, it's bigger now than it was then, but back then, about 5,000 people worked at that building. Where the front building is now, they had temporary trailers, believe it or not, to house some people. And then, if you went down Warrenville Road, there was a building called Indian Hill South and Indian Hill West. Indian Hill West was a building that was dedicated pretty much to processor design. And after about four years in the main building, that second building was done, and I moved over there. My son got married to a girl from Chicago, and we took a half a day and drove down to the Naperville area. And I could hardly find my way around because it had changed so much. And the building that I worked in, I walked into, and it's now being converted into almost like office condominiums. There were a whole bunch of different companies in that one building, but it was sort of sad because I knew the technology and the people that had been in there. It's all gone.



## Let's talk about the XPRIZE®. How did you get involved in the team that won?

**Hepler:** Well, actually, it started - I think it was at the end of 2012. I was at a church gathering, and I was talking with a friend, and we were discussing about how another friend was sick, and they were trying to figure out what was wrong with him. And I said something to the effect...



Gee, wouldn't it be great if we had a tricorder like they had on the "StarTrek®" series, and you could just wave this thing across him and figure out what was going on?





## Are you a StarTrek® fan?

**Hepler:** Yes, I am. And he sort of laughed and said, “Well, maybe someday.” And I said, “You know, I think I saw a news article in the past couple months where the XPRIZE® Foundation had put out a technical challenge to build one of these things.” And so, we sort of laughed and said, “Yeah, we’ll have to look into that.” And so, fast-forward until after New Year’s sometime, and then I was thinking about that and decided to go to the XPRIZE® website.

So, I went the XPRIZE® website, and sure enough, they did have a new technical challenge that had been put out maybe a year or six months or two years before. And they had a map there of the world with dots all over it because – marking where teams had applied to be in this challenge. And there were 300-and-some – like 320 teams or something had submitted applications. And so, I zoomed in on the United States, and I saw dots all over the place and some on the East Coast in the Northeast Corridor. I zoomed in further, and there was one in the Philadelphia area. So, I clicked on that dot and found out that the team was in Paoli, Pennsylvania, which is a suburb of Philly and the next town over from where I live. And so, I thought, “Wow. This is amazing. Here’s this really interesting project going on, and it’s right next door to where I live.” So, I clicked on the team and decided I was going to send them a resume. I told them I had recently retired, and I had some skills that maybe they might need, and, if so, get in touch with me.



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**Hepler continued:** So, fast-forward a little bit further to the InterDigital annual meeting, which at that point was still being held live in Delaware. And I decided to go because that was almost like a little reunion. I could see some people that I knew and whatever. And I saw Bill Merritt, I said hello to him and said, “Hi. I’m Ed Hepler.” And he says, “Oh, I remember who you are,” which sort of shocked me because I didn’t think he knew me from anybody. But, in any case, he stopped and said hello and said, “By the way, someone was asking about you.” I said, “Really? Who would ask you about me?” And it was someone he happened to know and he says, “Yeah, they’re building something from ‘StarTrek®’ like a tricorder – whatever. And he was asking because on your resume it said you had worked at InterDigital.”

And he says, “I told them you were a good guy.” And I sort of laughed and said, “Oh, well, thanks, but I don’t think it worked because I never heard from them.” And I think it was right before I was going to go on vacation in August, I got an e-mail from this guy who said, “I know it’s been long time since you sent me your resume, but we’d like to get together and talk about what we’re doing with the tricorder.”

And so, we went to lunch together, and he told me of his plans and the fact that his brother was a guy who knew Bill and wanted to know if I was wanting to join the team. And they weren’t paying salaries or anything, but he said it would be an interesting experience. And it turned out it very much was. There’s only seven people on the team, and what we did, I think, is pretty incredible considering we had seven people.

The team that came in second was sponsored by HTC – the cell phone guys – and they had all their manufacturing done by HTC. And we built the stuff, basically, ourselves. We did contract out to have the printed circuit boards made – not made, but manufactured. I designed them.

At the ceremony, they showed the two finalists’ stuff, and ours – all the enclosures were done by 3D printers. So, while they looked nice, they’re still just a little rough. 3D printers are good at prototyping and that kind of thing. Theirs were all sort of beautiful, injection-molded devices, but that takes big bucks to do that kind of stuff.



How does it feel to kind of bootstrap something that's done the way you guys did it and beat a really big, well-funded team?

**Hepler:** Well, it feels pretty good. It took a lot of work, but it was a lot of fun. And some of the other teams did some really great stuff as well. I think the fact that Basil, who is the head of our team, is a physician – he's an emergency room physician but also has a PhD in engineering before he went to medical school – really, really helped. So, he sort of looked at things, I think, a little bit differently than many of the other teams. And being an ER doctor, he's a diagnostician, primarily, and so he sort of said, "Okay. Well, how would I go about this from my medical background?" and then applied some of his engineering background. We had, like I said, seven people on the team. And each person sort of had their own specific role.



What was your role?

**Hepler:** My role was to help them figure out how to build the devices. So, they had been a team, probably, for a year-and-a-half or two years before I joined. I was the last person on the team. And they'd come up with sort of an AI engine to do the diagnosis, but they needed ways of getting information into this AI engine. They had some ideas of the kinds of sensors that they needed – the XPRIZE® competition required that you record vital signs and various other things. And they had an idea of how they wanted to do that conceptually, but they didn't really have the engineering background to know how to do that technically.

And so my role was to come in and build the... we have these little things we called patches. For instance, we have what we called a chest patch that attached to your side, and it measured respiration rate and, effectively, did an EKG and body temperature. And we had another patch that fit on your hand that collected other things. So, I basically did all the electrical design, the board design, and all the embedded hardware/software. So, that kept me busy for quite a while.

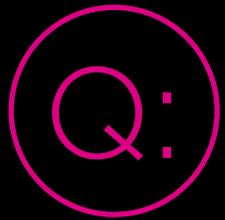


## What was the biggest technical hurdle you had to overcome, or just the biggest hurdle?

**Hepler:** Oh, the biggest hurdle, – well, there were lots of hurdles. We did all our own physical design. We did all of our own software. We did all of our own boards. I mean we, obviously, didn't build the boards. I did the board layout using software that – it's actually free software called KiCad. But then, we sent the boards away and sent the files away and had those boards built. It used to be you could print a circuit board, and when you got them back you could just put everything on and solder them. But now, with surface-mounted devices and whatever, you have to have somebody that knows what they're doing.

But the biggest challenge... I think was just trying to take the ideas that we had and actually get everything to work with such a small team. We had a bunch of different sensors. We had a bunch of software that needed to be written. Everything was connected together via Bluetooth. So, it was just getting everything to work and in a very short timeframe. During that time, there were many days that I was putting in 12- and 14-hour days, and it would come in bursts because we'd get a set of boards back and there would be this mad rush to get everything to work so that we could test them and see if they were doing what we wanted them to do. And we went through a number of iterations of building different things. And all of our enclosures were 3D-printed. And, Basil, being sort of the mechanical guy, did most of that, and I was the electrical guy, so I did all the circuit boards. And the fact that we were a very small team made it good, but it was also bad.

I mean we couldn't hand something to someone and say, "Here, go do this," like you can in a big company. But at the same time, there weren't very many lines of communication that got broken because there were too many people involved. There were only seven of us. And everyone knew their role and did a great job in executing.





There's something to be learned from that, isn't there, if you're starting a company or designing a product?

**Hepler:** I believe so, yeah. I think that there are some companies that get way too many people too fast. There is a sweet spot where you have to have enough people with the correct set of expertise to make everything happen, but at the same time, if you get too many people, it becomes more of a management issue than a problem-solving issue.

If the left hand doesn't know what the right hand is doing, it becomes a problem. In our case, we only had one hand, in many cases, and so there were times when we were designing things and trying to mass-produce these things. All of our enclosures – if you look at the pictures of the devices that we have, we have these little attachments that basically either fit on your hand or fit on your side in the case of what we call a chest patch. Those were all done on 3D printers, and then we, effectively, assembled them ourselves. So, there was a lot of design work to be done, a lot of testing to be done, and you learn things on each iteration.

We only had six or seven people, and everyone had their own little thing to do. And so, I did all the electrical design and all the embedded programming. We had another guy who did all the user interface programming. I'm actually sort of the odd man out because they had all known each other since grade school.

And a number of the team members are related; there are three brothers and a sister and then two other folks that they grew up with. They had actually started working on the XPRIZE® – mostly paper sorts of things, writing proposals to enter the competition itself – prior to my joining the team. And it got to a point where they had sort of decided on certain things that they'd like to do, but none of them sort of had the expertise to bring all of the stuff together. So, they needed someone who had some programming background, some electrical design background and so forth, and so they brought me on.



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You teach at Villanova. If you had kind of a lesson learned to impart to your students from all of this, what would you tell them?

**Hepler:** To keep focused. That's an interesting question – to keep focused and make sure that you don't lose track of where you need to be. Keep focused and make sure that you understand what the end product is, and don't get sidetracked. I think there sometimes is the temptation to do too much too fast and not have a pretty good plan of where you're headed. And make sure that you keep the end product in sight.





Let me ask you kind of a big-think question, and it'll be my last question. I think sometimes people feel like the golden days of an era of certain types of jobs or development are gone. You look at the kind of advances that took place in the '70s and the '80s and '90s in terms of computing and electronics development. And I wonder if people today feel the same level of excitement or if someone with long experience like you feels like that was really the best time, or if now is the best time, or if the best times might be ahead of us?

**Hepler:** It's just big continuum. I'm not sure that there's ever a best time or whatever.



**I think every time  
is a great time.**



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