

DANIEL KRAFT INTERVIEW PART TWO - INTRO

Hello again, Ars Technica listeners. This is the second and final installment of a two-part interview with oncologist and medical futurist Daniel Kraft.

If you haven't yet heard part one, there's a link on the page where this player's embedded, and I strongly suggest that you go back and listen to it before this one.

And with that - back to my conversation with Daniel Kraft.

TRANSITION MUSIC

Rob Reid To me, again, that eye scan study was so profound because it is the first indication that, yeah, we can take this morass of data, put it through very smart machine learning algorithms and start coming up with those predictive points much in the way that we're all very viscerally experiencing the fact that it's done with traffic data. With that context, I think it becomes really interesting to talk about the next things that are going to enter the check engine light equation, some of the things that we aren't quite monitoring yet but are probably on the menu in the coming five years.

Rob Reid: Let's talk about continuous blood pressure monitoring.

Daniel Kraft: We know that high blood pressure, hypertension, about a third of Americans have it. Less than half of these hypertension patients have it well-controlled. When your blood pressure is too high, it gives you significantly higher risks for heart attack and stroke and kidney problems and eye problems.

Rob Reid: Generally, we measure that once a year.

Daniel Kraft: Yeah, with a hundred plus year old squeezing your wrist, which may or may not be accurate, depending on how it's done. Even if you have hypertension and you measure it the same time every day, that's not necessarily accurate. It's going to change through the phases of the day and your stress level and how much coffee you may have had; lots of elements.

What we want is a technology like a patch or something on our watch that will seamlessly track our blood pressure in the background. There's several companies working on approaches, like a little radar, one local one called Blumio and a couple others where it's essentially a radar that looks at your arteries and can pick up systolic and diastolic-

Rob Reid: Really?

Daniel Kraft: ... blood pressure.

Rob Reid: Just from a wristband.

Daniel Kraft: This one's on your upper wrist, but if we can get a handle on that, we can then potentially really tweak your medications and maybe your exercise regimen and really understand that, wow, in the afternoons you're really running high. We need to tweak your medication in the morning.

Rob Reid: Once we get good at parsing the data, which we're not yet, that should be highly predictive of stroke and heart attacks and things like that.

Daniel Kraft: Any of your listeners who may have hypertension or a family member does, go to an Apple Store or online and buy a connective blood pressure cuff. You can connect that to your smartphone. Start catalyzing the future of health care. If you have a health care problem, there's quite a few technologies already out there. Some are FDA approved, some are consumer devices. In fact, in the next month or so, I'm launching a new website called Digital dot Health which will be a place for anyone to find the technologies that exist today and have a digital pharmacopeia, what a clinician could prescribe to a patient.

Rob Reid: One of the things that you've talked about is voice as a biomarker. What might that indicate?

Daniel Kraft: There are several companies. I'm actually an advisor to one called Beyond Verbal. There's an app you can try called Moodies, which is for fun, but listens to voice in real time and gives you a ping on your emotional state. Are you passionate? Are you happy? Are you depressed? Are you maybe trying to hide something? That can give you a touch of point of your emotional state. Imagine your phone is listening to you or your Amazon Alexa or Google Home.

Rob Reid: It's amazing to me how many people are comfortable being listened to 24 hours a day by Google and Amazon. Let's assume that their voice is part of constant monitoring. Would that be something that would be then correlated in ways that we can't even guess with blood pressure and heart and that kind of thing and then become predictive of a bad mental state or depression?

Daniel Kraft: Yeah. Speaking of depression, one of the huge issues in health and medicine today is mental health. We still don't have much data or biomarkers on mental health. It's a huge component of cost from depression to schizophrenia to PTSD. Now with some voice, you can tell whether someone might be going from depressed and talking slowly to being manic or schizophrenic-

Rob Reid: These could be early indicators if somebody's about to go through a depressive era or just flipping bipolarity or ...

Daniel Kraft: ... early indicators, and now we're seeing companies build platforms to integrate your voice, your movement, what your texting is, what your Instagram filters might be to predict who might be getting, let's say depressed. Let's say someone is manic depressive. They may swing between one or the other. You might want to see that early swing and change your medications earlier or call your psychological support team or point them to a chatbot that can give them some support or a tele visit. Part of the future of health care is a lot more of this tele-medicine where you can do virtual visits with a real psychologist or maybe an Avatar version. This company Beyond Verbal and Mayo Clinic studied patients with heart disease and voice changes when you're trying to develop heart disease.

Rob Reid: Really? It could be indicative of incipient heart disease.

Daniel Kraft: Yes.

Rob Reid: What element of the voice changes, the tone or the raggedness or breathlessness or ...

Daniel Kraft: You can hear someone who's got a bad cold, for example, or someone might have heart disease if they get some fluid in their lungs. That's going to change the tonality of their voice, and they've been able to pick up those distinct changes. There's also elements of voice that might predict neurologic disorders like Parkinson's.

Rob Reid: Again, it's the correlation that as you're talking I'm thinking you've got the voice coming in but you have that continuous blood pressure and heart information and it suddenly, all those together going through a machine learning algorithm, like the one we saw with the eye scan, now you start seeing how, yeah, it could point very strongly at heart trouble in nine months, which is a lot better than finding out you had heart trouble nine seconds ago.

Daniel Kraft: Exactly. Another piece that's so important is sleep. Sleep changes ... your quality of sleep impacts your risk for obesity, heart disease, depression. Sleep changes can be detected with a simple mattress sensor or the ring I'm wearing out of Finland.

Rob Reid: Tell us about your ring.

Daniel Kraft: This is a fun device I got in Finland, a company called Oura, basically a quantified self-device on your finger that tracks heart rate, tracks emotion, temperature, steps, but is very good at giving you a very quantified sleep and a sleep score.

Rob Reid: How does a ring know when you're in deep sleep? What does it detect and crunching together?

Daniel Kraft: There are certain patterns in your heart rate; [inaudible 00:39:05], movement. When you're in deep sleep, you're very still. You're almost paralyzed. When you're in REM sleep and your eyes are moving, your heart rate is a little higher, this can pick up and estimate your respiratory rate. It can build you not a perfect map, but it gives you your total time asleep, time in deep, light and beyond.

As we crowd source this, I can now take my Fitbit, for example, go onto the app there, look at my sleep score and my components of sleep and compare that to other people my age and sex and compare it to my history for the last month. I can get a bit of guidance. If I realize, wow, I'm really only sleeping five hours a night, I might want to get to bed earlier. If I notice that I'm waking up 60 times at night and didn't even realize it, I might have sleep apnea. That is something that's very under-diagnosed. You could do a whole sleep lab at home now. Not the full-on hospital version, but 80% of what you would get that can help pick up and hopefully be proactive for a whole set of diseases.

Rob Reid: Again, it's like the correlations that get interesting. It might become determined very quickly that, wow, when people have five hours of sleep, it disrupts their cardio patterns the next day except for this person who's really, really robust. Is there something we should be looking at in this subset of people who don't get disrupted or maybe this person is again hyper-disrupted. They get five hours of sleep as opposed to their normal eight. Their heart rate goes up by 20 beats. What that has correlated to in the past is this third thing that we can't even guess at. It is really the correlation of multiple indicators that we wouldn't even know were necessarily cross related, combining it with looking at hundreds of thousands and millions of people as opposed to the tiny handful in the Framingham Study, that it gets intriguing. Another thing that you've talked about as a potential biomarker is breath.

Daniel Kraft: One of the early Shark Tank success companies, I'm holding one of their prototypes, is Breathometer that will track blood alcohol, but one of their versions will actually track the molecules in your breath. The marketing was you're going to go on a date, you might want to see if you have bad breath or not. We now also know that molecules from your bloodstream are exuded in your breath and can be indicative of early cancer. Someone with lung cancer has a different molecular profile that could be picked up from breath, and not just one breath. You can now breathe into a device and capture five minutes of breath, which is a lot in terms of analysis.

Rob Reid: This is still research phase, correct, or is it-

Daniel Kraft: It's moving to reality across the gate here at NASA Research Park. They have an early Nano Nose. You may recall that some dogs could be trained to sniff out-

Rob Reid: Cancer.

Daniel Kraft: ... cancer. They've now applied that approach to what if the molecules that are the fingerprint of an early cancer. There's a company out of the United Kingdom and Ireland called Alstom Biomedical, are already in clinical trials taking breath and hopefully picking up early lung cancer and maybe even colon cancer or metabolic diseases. A disease like diabetes will show up in your breath with ketones and other molecules.

Breath is a biomarker. Speaking about sweat, there are folks developing sensors and patches that will measure the molecules of sweat. Now, that might be interesting if you're running a marathon and want to optimize your hydration. It might be helpful if you have heart disease or renal failure to pick up your sweat molecules and tweak your potassium regimen, for example.

Rob Reid: It might be helpful if you never want to get heart disease or renal failure. I'm going back to your theme about health care versus sick care. Anybody who goes into renal failure or heart disease is probably going to have very, very distinctive sweat, but the interesting question is were there warnings in their sweat that simply couldn't have been picked up because it was 1997, and we weren't doing that kind of thing three years before the problem came on. There's also things that we all have in our homes. You and I both saw a talk at TED not long ago about Wi-Fi, using your home Wi-Fi as a health monitoring device.

Daniel Kraft: Wi-Fi now has been published by MIT, can pick up the vital signs of up to 10 people in the same room and now can even track sleep patterns and movement.

Rob Reid: Vital signs, is it breath or is it also even heart rate?

Daniel Kraft: They're doing heart rate and respiratory rate and emotion.

Rob Reid: Ten people with the standard Wi-Fi router. It may be a little bit of a special Wi-Fi router.

Daniel Kraft: Don't quote me on what exact element they have.

Rob Reid: On the specialness of the Wi-Fi.

Daniel Kraft: We're entering an age when you're just going to walk into your house or any setting; it's going to know it's you or your wife or a friend. It'll start to potentially pull out your respiratory rate, your heart rate, your emotion. We're going to be exuding our digital health exhaust 24/7. There's a dark side to that. What if your insurance company says, "You really haven't been moving much and you haven't been doing your exercise. We're going to raise your premium." That's the big brother element.

Rob Reid: We can, hopefully as a society, have the discussion so it's a little bit less like big brother and maybe a little bit more like small mother. If my insurance company

is doing something that's conceptual creepy but actually adds seven years to the end of my life, not because they love me but because they want to save money, and I get to live an extra seven years, I'm fine with that. Our moms all nudged us to do things that we didn't want to do because they were good for us. There can be ways that even the things that are at least conceptually creepy turn out to be highly beneficial.

It's funny, I saw something, Huggies Diapers, terrible name, TweetPee. Diapers tweet when the kid needs a change. I could see why that would be beneficial, but to get to the last biomarker, our toilets will probably at some point become chemical labs as well. Anything that drops out of our body has got a lot of data that could be radiating out of it, right?

Daniel Kraft: Bingo. Your input, you can measure, there's now little handheld spectrophotometers that can analyze your food and tell whether or not it might have peanuts in it or gluten if you're having an allergy or maybe even count the calories.

Rob Reid: Your food. Interesting, so what's going into your body.

Daniel Kraft: Quantified food. The number one drug, there's a quote from Hypocrites: "Let food be thy medicine." With food, what's interesting there is you know all these fad diets: high fat, low fat, low carb, high protein. It's very confusing. Number one, you can measure your input with some devices. Even your smart AI camera is going to look at your breakfast and know what's in it and then you can measure output. TweetPee is a small example. Even just take something as simple as a camera in your toilet. Not that appetizing to think about unless it sees a change in your bowel habits. Maybe that will give you a clue that maybe you're having early colon cancer or picking up early blood in your urine that might pick up a urinary tract infection or even something more serious like a malignancy in your bladder. Those may come. I've seen several companies and startups start to build out those platforms.

Rob Reid: One other thing I'd like to do a deep dive into is this very interesting thing called the conquering cancer X Prize, which you are running or overseeing. Could you describe what an X Prize is and X Prize generically and why that is a powerful mechanism for marshaling energy, enthusiasm and investment?

Daniel Kraft: Peter Diamandis, in the late '90s, put together the first X Prize. It was the Ansari X Prize to get the first non-NASA rocket up to space and back.

Rob Reid: This is Peter Diamandis who co-founded Singularity University. Peter comes back into your life.

Daniel Kraft: Right. He was doing this crowd source, the Energy of Innovators Around the World to attack space flight. Actually, SpaceShipOne developed by Burt Rutan, a

famous aeronautical engineer, won that prize. Now that company was taken to the next level by-

Rob Reid: Richard Branson.

Daniel Kraft: ... Richard Branson. Probably in a couple years you can pay a lot of money and go fly to the edge of space.

Rob Reid: The idea is that if you have a \$10 million prize, let's say, you can catalyze the investment of far more than \$10 million worth of work by people who are trying to attain it either because they want to get rich or because they're in a university setting, and they can get funded any way, but this is a cool thing that university setting, and they can get funded anyway. This is a cool thing that attracts attention. What's the multiple?

Daniel Kraft: Hundreds of millions dollars are spent on that first, on Ansari XPrize.

Rob Reid: It was a \$10 million prize.

Daniel Kraft: Right, which has now catalyzed the whole consumer space movement. It can unlock these elements that wouldn't have been unlocked. The idea of an XPrize is to put a prize out there that's audacious but achievable and is not going to be something that the market is necessarily going to go after in the same timeframe in the same way.

Rob Reid: It's going to excite a lot of people, get projects-

Daniel Kraft: Right.

Rob Reid: ... together.

Daniel Kraft: There have been other XPrizes. One was for oil clean up, because that hadn't changed in dozens of years. Even the fourth place team had at least doubled the speed of cleaning up oil and making it cheaper. I think the second place team was led by some tattoo artists that used their tattoo knowledge and technology and had a way to better approach oil clean up. Crowd source is new minds.

Rob Reid: How many XPrizes roughly have there been thus far?

Daniel Kraft: There's been the space one, one for cars that could go long distance, electric cars. There are active ones like an artificial intelligence XPrize, and one around carbon sequestration. There's a newly launched one to enable you to put yourself into a robot and do dangerous things. Some of these are quite bold and audacious. What's powerful about it is you get new minds, new thinking to spend a lot of energy and time to solve a problem in a new way. When we're looking at developing a new prize-

Rob Reid: The Cancer XPrize.

Daniel Kraft: The Cancer XPrize. I thought, "Well, lots of people are going after immunotherapy, and new approaches to cures. There's not been a new way to really screen for and detect cancer in dozens of years. We're still stuck with colonoscopies and mammograms, for example." Many patients present late-stage with things like ovarian cancer, and pancreatic, and brain cancer.

Rob Reid: Let's talk about that. What percentage of cancers currently are detected at stage one, stage two versus very, very late? What percentage of cancers are asymptomatic until it's either too late or almost too late?

Daniel Kraft: It really depends on what sub type. Let's say roughly only 10 to 20% are picked up at stage one when you can just cut it out with one surgery and not require advanced chemotherapy or radiation therapy.

Rob Reid: Early detection is a big deal, even with the relatively primitive, blunt instrument tools that we have for fighting cancer right now. What's the difference in survival rate if you catch something at stage one or two versus three or four?

Daniel Kraft: Big picture, about 90% of cancers can be cured if you pick them up in early stage, stage zero, stage one versus only about 10% often have long-cure if you pick them up at late stage, stage three or stage four, which is already metastatic.

Rob Reid: Even with today's cures, which nobody's satisfied with, early detection could literally save nine times as many lives, take 10% of the people from the stage in which 90% can be saved. If you were able to hypothetically detect every cancer early, suddenly you have 100% of the people, the mortality rate from cancer would plummet merely by early detection, and putting merely in quotes. That shows what a big deal it is. We all very intuitively feel like the way to beat cancer is to cure it, and boy would that be amazing. The truth is, early detection solves, it sounds like, almost 90% of the problem.

Daniel Kraft: Right. Many folks here in the US, they never get their screen mammogram or their colonoscopy at age 50. You want to have something that's actionable. Some cancers, like prostate cancer, you don't even want to screen for it in some folks at a certain age because there's not much you should do about it.

Rob Reid: Because it grows so slowly, and if you treat it, the treatment can have terrible side effects.

Daniel Kraft: Right. I've had friends who died very rapidly from pancreatic cancer that when they presented to the hospital was already a huge mass.

Rob Reid: It's usually stage four pancreatic-

Daniel Kraft: Often.

Rob Reid: -that's detected, right?

Daniel Kraft: Exactly, or ovarian cancer, or the brain cancers that only present after a few months of headaches.

Rob Reid: Is there even a diagnostic for pancreatic cancer today?

Daniel Kraft: There's no really good one. You could now take something relatively simple, or now, on the exponential, hand-held ultrasound and artificial intelligence algorithms that will start to read ultrasounds. You could think about a pancreatic screen that could look at your pancreas, your ovaries, your kidneys, that you could do at home as a home screen.

Rob Reid: Let's talk about what you're trying to get done now with the XPrize now that we've established how unbelievably powerful early detection can be if only we can get good at it.

Daniel Kraft: Absolutely. We're designing a new XPrize where the winning teams will develop ways that are rapid, accurate, and affordable, detect cancers early when early detection matters. We envision that being a test that can detect multiple cancers under \$24 under 24 hours from Tennessee to Tanzania. That's very aspirational. It's challenging. Part of what we want to do with this next prize is have a Match.com model. You could join a team that's based in France, because you might be a good coder. You might have an AI expert and a microphotic person at MIT partnering with someone in Singapore.

Rob Reid: A team won't necessarily come to you pre-made. You're going to actually help people assemble teams.

Daniel Kraft: You can come with your team, or you can join a team. Then we're going to roll this prize out hopefully early 2019.

Rob Reid: The teams will start assembling sometime next year?

Daniel Kraft: There will be a process where you can put the teams together, apply in various stages of this. We envision this to be \$100 million or more XPrize where there may be sub components, like an AI component. What if we had all the digital data from mammograms and we crowdsource and have a sub prize? How could you take the existing data and better analyze digital mammograms to make better diagnostics and therapeutic support?

Rob Reid: Oh, interesting. We do have this massive base of scans that have already been taken that have in fact been mapped to actual outcomes, like god knows how many mammograms are on file somewhere. All of the older ones, we know whether that person developed cancer or not.

Daniel Kraft: Might we get insurance companies to share some of their data? Because maybe you pick up signals from consumer behavior that might indicate early cancers, lots of new ways to think about it. There are some really amazing blood biopsy companies starting to look at this approach as well.

Rob Reid: Liquid biopsy.

Daniel Kraft: Liquid biopsy.

Rob Reid: Would you care to define what liquid biopsy is?

Daniel Kraft: This is an area that's moving quickly. Let's say a pregnant mother wants to look at the health of the fetus. It used to be you have to put a needle into the placenta and pull out some cells and analyze them.

Rob Reid: When you say used to be, we're talking eight or nine years ago.

Daniel Kraft: Actually, it's still commonly done, amniocentesis. It has some risks.

Rob Reid: It was the only choice until quite recently.

Daniel Kraft: Right, yeah. In the last 10 years now, where pioneered at Stanford and elsewhere, can look at circulating DNA of the fetus and detect that in the blood of the mother. Now we have the ability to do deep sequencing to detect those genes and determine whether that child might have something like trisomy that would give them Down's, or other genetic diseases. It's a much less invasive but very powerful way to do pre-natal screening.

Rob Reid: A simple blood draw instead of a needle going into a place that's very, very sensitive.

Daniel Kraft: Exactly. That's now evolved to the point where if you have a tumor, let's say a pancreatic tumor, some of those cells are dying, and the DNA is circulating around the body of the patient. Now you can take some blood from that patient, find some of the DNA associated with pancreatic tumor, and detect that. It's pretty easy to determine that in a person with advanced disease, but could that go all the way to the point where we could take a drop of blood and pick up molecules that are representative of an early cancer?

Rob Reid: That's what's often called liquid biopsy. This could be one of your early detection vector, getting a blood draw that could pick up a cancer that might be almost anywhere in the body, I imagine, on this side of the blood-brain barrier.

Daniel Kraft: That's one promising approach. There's companies like [Gray Ellen Gardent 00:52:54] and Freenom looking at that sort of approach. I still think, from my understanding, talking, they're still several thousand dollars and not something that's going to be available or super rapid and cheap. Maybe this prize can help

those companies tweak their formula, or combine with others, or a company that's doing breath, or folks developing AI sensors in ultrasound. I imagine that the winning teams won't just have any one blood test or one sensor. It may be some combination of a platform where you can literally walk into a booth. They may take some urine, some blood, some breath, put on a hat to look at your brain, and five or ten minutes give you a nice scan and call you all clear or indicate that there's a next step to go to work something up. I think by catalyzing new thinking, even if we change the pathway of early detection by a year or two, that's going to save tens of thousands of lives.

Rob Reid: Oh, tens of millions even, right?

Daniel Kraft: Hopefully bring this to many parts of the world with no access to screening. Then hopefully if you are in Tanzania and you pick up early breast cancer or ovarian, we can now bring some technologies that were only available in the West and democratize that. We want this to be the all-in prize. You could support this with a crowdsource dollar, and your organization could put in millions.

Rob Reid: You already have a first sponsor, correct?

Daniel Kraft: We have support from the American Cancer Society as an anchor. Lloyd's been very involved in designing the prize. If you just go to [XPrize.org/cancer](https://www.xprize.org/cancer), you can sign up and get more information as this rolls out.

Rob Reid: What is the time term of the-

Daniel Kraft: I anticipate this will be probably about a five-year prize, but with some micro prizes in between, some sub prizes like the AI elements, maybe prizes for pulling together a way of giving a risk score.

Rob Reid: As an oncologist who has this exceptional insight into what's happening on many fronts, where do you think we'll be in five to ten years if for every hundred people who die of cancer today, how many would you imagine will die of cancer in 2028?

Daniel Kraft: I think it would be reasonable to have a 40-50% decrement there, part of that again driven by earlier detection, part of that driven by this new approach of powerful, targeted therapies from immunotherapies and molecular approaches. Just like HIV was a death sentence 20 years ago, now it's a chronic disease for many because they have a combination of cocktails that keeps it at bay. Some forms of cancer may not be fully cured, but will become very chronic and manageable.

Rob Reid: Now another thing that you just gave a talk about at Cedar Sinai was VR and AR in a medical setting. It'd be great to talk about that briefly.

Daniel Kraft: Let's start with augmented reality. There are now platforms where I can now pull up the patient data, maybe your lab information, and it might coach me to ask you certain questions. It now is enabling me to scribe and someone can be recording the data from this so I'm not spending so much time taking notes. Now I can potentially layer data through things like the Microsoft Hololens, where I can virtually see data about you overlaid on your body. Let's take an example of a spine surgery. I have a CT scan, I have MRI data of your spine. You're laying on the table. Now I can literally overlap the anatomical data, where your spine is, where I want to operate, have guidance between the procedure steps.

Rob Reid: This is pre incision? You can basically see the X marks the spot-

Daniel Kraft: Right.

Rob Reid: ... superimposed exactly where X wants to be on that particular patient.

Daniel Kraft: That's active guiding procedure. We can now dial that back all the way to the virtual reality side, so full-on VR, where before even walking into the operating room I'm going to be in the virtual operating room. I'm going to see your actual spine and CT scan data, and I can practice that entire procedure with virtual instruments. That's a powerful way to simulate the entire procedure ahead of time.

Rob Reid: This is ten years out?

Daniel Kraft: No, there are companies already blending this. There's a company out of Stanford called OSO RX for orthopedic surgeons, for example, that train. There's a company out of Israel called Augmedics, which is layering augmented reality data overlapping when you see the patient on the table.

Rob Reid: Also in terms of training, you were part of this very interesting procedure that happened in London, right?

Daniel Kraft: The training idea here is that there's not enough surgeons in many parts of the world and many of the specialists may not be in a remote area. I was in the operating room with a good friend of mine named [Shaffi Ahmed 00:56:38]. He's a surgeon in London. He's often called the virtual surgeon. He's a cancer GI specialist in terms of surgery, but he pioneered the approach to actually record a surgery in VR. You can go on YouTube now-

Rob Reid: He has something like a GoPro on his head when he's operating?

Daniel Kraft: No, you put a VR camera above the patient. Literally you can go back later and watch that whole surgery. You can look around the room in your VR headset.

Rob Reid: You're not seeing it from his perspective, you're in the room and you can walk around and watch from different directions?

Daniel Kraft: Exactly. It's like you're right where the anesthesiologist is looking over. Two years ago I was in the operating room with him where they did the first livestream surgery. They had the camera there, and they were streaming in VR to about 5,000 individuals around the world using their Google Cardboard. Put your smart phone in a VR case-

Rob Reid: There were 5,000 attendees?

Daniel Kraft: In real time watching this surgery and being educated in how to do this particular case.

Rob Reid: Of course, there's no reason why it would have to be in real time. It would be just as educational for somebody to press play and experience this after the fact, right?

Daniel Kraft: That's one option. Number two, let's say you're a relatively inexperienced surgeon in Antarctica, let's say, and you have a case you've never seen before. Now you can bring in a virtual mentor watching with you in real time. There's another start-up called Proximy, which is pioneering even using an iPad or things like Hololens and Google Ask to mentor and have someone over your shoulder virtually coaching you, sort of social VR meets mentoring, meets training.

Rob Reid: Tele-mentoring I think was the term you used.

Daniel Kraft: Tele-mentoring, or again, recorded surgeries and other procedures that can be done in asynchronous ways. Then the final part of it that's getting super interesting in virtual and augmented reality is therapy. I think most people know the game Pokemon Go. It's an augmented reality game on your smart phone. You can collect badges and points. That got a lot of people out and moving. People walked billions of more steps than they would have otherwise collectively. It actually had a lot of health applications. That's a kind of augmented reality. Some people do versions of that when they're running on a treadmill and they're racing people virtually. We're now seeing virtual reality move to actual therapeutics. Someone with a bad pain situation, let's say they've had a burn and they're in the burn unit getting painful debridements, they could-

Rob Reid: Is this a hypothetical or is this-

Daniel Kraft: This is today.

Rob Reid: What's the company behind it and where is it happening?

Daniel Kraft: Academic groups out of Stanford, out of Cedar Sinai, out of Seattle. I think it's called Snow World, where you put on the VR headset and you're in Antarctica.

Rob Reid: The patient is?

Daniel Kraft: The patient is.

Rob Reid: The patient who's suffering from burns.

Daniel Kraft: They're seeing a bunch of penguins, and snow falling, and they're throwing snowballs at the penguins, and they actually feel virtually cold. It turns out those patients need less than half the amount of opiates than they would normally.

Rob Reid: Literally? Just being in this VR environment, yeah.

Daniel Kraft: In this virtual cold environment. That's one of the early approaches for managing opiates or pain needs to help rewire your brain. It's being used with folks with PTSD to put them back in potentially scary environments, maybe even blending that with other drugs like psilocybin and MDMA.

Rob Reid: We heard about it in a very recent episode, yes.

Daniel Kraft: Exactly. Blending of modalities. I just got my Oculus Go the other day. \$200 device. I can now fly on an airplane and be in a virtual environment.

Rob Reid: If your Twitter feed is to be believed, you actually did that.

Daniel Kraft: Felt a bit nerdy-

Rob Reid: You couldn't see anybody judging you for being nerdy. You could just hit the mute judgment button, and all those people staring at you for being nerdy, you can't see them. What do you care?

Daniel Kraft: See no evil, speak no evil. Another study that was done at Stanford, let's say there's an eight-year-old kid, has to go into the hospital for a pretty scary procedure. You can now take that child at home before they ever go to the hospital, put them in the VR, and they can see the pre-op room, they can see the OR, their post-op. They can understand the surgery. It definitely would reduce stress and anxiety in kids. That's being done in adults in hospital settings. They're stuck in the hospital, let's say they're having a ... They might be in there for a month or two. They can have virtually be almost anywhere in the world, visit their friends, the classroom, have social VR. This has even been used in hospice care for folks in their last days. They can put on the Oculus or other VR-type headset, visit places from their past, interact with friends and family. It's going to be a very powerful modality. It's getting cheap and available, and we're just starting to see the applications for therapy, training, and beyond.

Rob Reid: The augmented reality as well. I would imagine having access to a patient's vital signs while you're operating on them without having to look up, having the equivalent of what a mechanic would see when they're looking at a complex environment inside, like a Boeing jet engine. The human body is pretty darn complex as well. To have those kinds of heads-up elements available through AR as well is just something that could be very powerful.

Daniel Kraft: Here's an example. You know laparoscopic surgery, you're trying to take out the gall bladder?

Rob Reid: Laparoscopic, for those who don't know-

Daniel Kraft: This little belly button surgery. You're putting a little camera and some instruments through small incisions in the belly. Instead of opening up the patient and cutting out the gall bladder the old-fashioned way, you do it in a very minimally invasive way.

Rob Reid: You need the access to the visuals that are coming out of the system that's gone inside.

Daniel Kraft: Today it's basic visuals. The next layer, the AI and machine learning, can look at that picture and say, "Well, this is the gall bladder. Here's the blood vessel. Here's the hidden nerve. Here's the tumor behind that, which you can't see." We're going to start to learn in real time to mentor that surgeon through that case. Here's the dangerous part. By the way, the anatomy is a little different in this patient. We're going to blend AR and AI and coaching and big data and crowdsourcing of maybe millions of videos of a laparoscopic surgery to dramatically improve outcomes and deskill that so that all these healthcare technologies can eventually bring healthcare to folks who don't have access today. Can take a nurse in a rural village, in a remote mountain region where there's almost no medical care, and up-skill them to be as good as an experienced cardiologist or maybe proceduralist, bring in the care when they need it through tele-health and mentoring, or a drone that can drop off the drugs or blood products.

It's this combination of things, AR, VR. It's a great example of convergence. Also, by the way, can be used to leverage behavior change. You may know all your steps in your sleep at night, but unless you can change behavior ... We're seeing now augmented reality give you an AR coach, psychologist. There's a platform out of USC that basically built an avatar of a psychologist that can watch the patient talking, their [inaudible 01:02:15], their voice, and respond appropriately. They're blending that with actual care to, let's say, help former military folks deal with PTSD in a very effective way that's showing it's promise.

Rob Reid: You don't seem very excited about this for some reason. I'm joking. When I first saw your Ted Talk on the main stage, it was 2011.

Daniel Kraft: 2011, yeah.

Rob Reid: How time flies. Your enthusiasm about it is both infectious and also reassuring, because I assume you know a thing or ten about healthcare. The fact that you're optimistic and enthused like this is an incredibly positive thing.

Daniel Kraft: I want to be careful not to over-hype things. Part of what I like to do is to help catalyze innovators, patients, doctors, nurses, systems, to see the potential of what's already here and what's coming and catalyze its use in smarter ways to solve healthcare pain points. Something we catalyzed at Exponential Medicine, we had the head of innovation from the National Health Service in England come first as a participant, then as faculty. He got inspired to ... National Health System has some amazing doctors there, but they're getting burnt out. He went and started a new program, Health Entrepreneurship, for clinicians there. There are now like 300 young medics, as they call them, entrepreneurs, now leveraging NHS data and platforms that is going to catalyze a whole new set of tools.

Rob Reid: NHS, which is, for those who don't know, that's the National Health Service in the United Kingdom. They have amazing data. Kaiser has amazing data, because they have so many patients. They have some really, really good research docs. Occasionally, you hear one of them being interviewed on NPR. They just have this super power of insight because of the number of patients that have been in the Kaiser Health System throughout the United States. NHS, obviously, the entire United Kingdom. That data access has led to very, very powerful insights.

Again, using the analogy of the Framingham study, comparing that to what might be achieved with the All of Us survey, comparing to that what could be achieved with just the exhaust coming from all these different devices, it's kind of amazing what could result from this, and particularly because we do have the machine learning tools, as evidenced by that amazing retina work that we talked about earlier. That's just the tip of the iceberg of what can be done. Really truly amazing things can arise from all this. Well, thank you very much for putting me in such a fabulous mood, and hopefully many of our listeners as well.

Daniel Kraft: Thanks so much for having me. It was fun. Thanks.

Rob Reid: I always love talking to Daniel because I come away from our conversations so optimistic. This was a particularly special one, because it came with a built-in field trip. After the conversation, we spent a bunch of time crawling inside, under, and around those World War II vintage planes that we were talking about. These are amazing contraptions, almost like flying factories. They were so industrial, and had such large crews doing such mechanical work. There was a B-17, a B-24, a P-51 and more. At least, that's what Daniel told me, and I do believe him, because the man does know his World War II era war birds. Apparently, this particular fleet of planes comes to Moffitt Field every year, Moffitt Field being the airstrip that's contained within that vast NASA facility

where we conducted our interview. I have to say, Daniel was, just as advertised, quite a bit like a fully-grown kid around all that gear.

On the other end of the age spectrum, we met a 100-year-old airmen that day who had been part of a B-17 crew during World War II. The guy's name was even Orville, which when you think about it, is kind of the perfect name for an aviator of his generation. We met him just as he was about to go up in a B-17 again for the first time in 70 years. I put a few pictures of all that fun up on my website at Afterdashon.com for those of you who are interested. Next, I have something really intriguing for the Patreons backing the show at the five bucks a month level or more. It pertains to the amazing contrast between the Framingham study that Daniel and I discussed, which truly revolutionized medicine in the 20th century, and the massive, broad population genomic studies which are just getting underway right now.

I can't think of a better person to comment on this phenomenon than Robert Green, who was my guest on episode 16 back in November. Robert, as many of you will remember, is an expert in personal genomics at the Broad Institute, which is affiliated with both Harvard and MIT. As someone who is a practicing clinician for decades before he became an academic researcher, he has a truly front-line understanding for how the Framingham study shaped the science and practice of medicine over the past decades. In my Patreon feed today, you hear a conversation between Robert and I about Framingham and its massive successor, which just started getting underway in the last few weeks. It's called the All of Us study.

All of Us will study a million Americans intensively for years. Unlike Framingham, which didn't collect as much as a single letter of DNA for any of its initial, original participants, all of us will ultimately collect full genomes for almost every participant. Rather than being paired with just a few raw numbers from biannual physical exams, this data will connect up to millions and millions of data points, many collected from the sorts of devices that Daniel and I just discussed. Please tap into my Patreon feed if you would like to hear Robert and I discuss this fascinating and timely subject. It's almost a 40-minute conversation, much less formal than the one you just heard, much less edited and prepared, but nonetheless quite intriguing. Coming up soon on this show, I have a truly intriguing interview with one of the great architects and influencers of 1960s American culture, who has been no less influential in shaping the digital culture that we're also immersed in today. He has also teamed up with George Church, another recent guest, to resurrect some extinct species, including the woolly mammoth. That's coming up in just a couple weeks, so stay tuned in June.

END INTERVIEW ELEMENT OF PART TWO

So Ars Technica listeners - here we conclude the second and final installment of my interview with Daniel Kraft. I do hope you enjoyed it .

If you enjoy my work, I hope you'll consider visiting my site, at after-on.com. Or, just type the words after-on into your favorite podcast player, and scroll to through the episodes. You'll find lots of stuff about life sciences - above all, genomics and synthetic biology. Conversations about robotics, privacy and government hacking, cryptocurrency, astrophysics, drones, and a whole lot more.

Or, you could just join me next week, here on Ars.

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