

## RATs in the Technology Lab (<https://mindmatters.ai/podcast/ep92>)

Robert J. Marks:

What's the state of the art and the future of virtual reality technology? That's the topic today on Mind Matters News.

Announcer:

Welcome to Mind Matters News, where artificial and natural intelligence meet head on. Here's your host, Robert J. Marks.

Robert J. Marks:

We've been talking with Dr. Tom Furness at the University of Washington. He is a pioneer in virtual reality, has been called the grandfather of virtual reality because of his pioneering work in the field for the Air Force. He is a Professor in the Department of Industrial and Systems Engineering in Seattle, at the University of Washington, and continues to do some fascinating cutting edge work. And we're going to continue to talk with him today. Tom, welcome back.

Thomas Furness:

Thank you. I'm having fun.

Robert J. Marks:

I am too. I'm having a blast. I'm learning a lot. Tell us something about some of your other current projects. One of them is the RATLab, and we were talking offline and it kind of reminds me of the skunkworks and I don't know why engineers use deplorable animals to describe what they're doing. But the RATLab stands for Rocking and Thinking, is that right?

Thomas Furness:

That's correct.

Robert J. Marks:

And it's an incubator. Tell us about that.

Thomas Furness:

Yes. Well, I was enjoying my activity at the university, certainly a wonderful place to do research. But it is a bureaucracy, and I've found that sometimes having worked for the Air Force for the Department of Defense for 23 years, I got used to the bureaucracy. But it sure does slow you down and reduce your flexibility, especially if you want to try out things. And so I decided that what I needed was an outlet to do some pretty far out things that I wouldn't be able to do at the university, because I would be labeled as a flake. Well, I am a flake, but I didn't want to be labeled as a flake. And so in 2005, I was thinking about how can I hire some high school dropouts because these kids are brilliant, but the university would never hire them.

Thomas Furness:

And I had some projects I want to do that I wasn't particularly interested in giving away to the university because those were my own ideas and they were orthogonal the things I was doing at the university. So I was driving home one day and I just happened to glance over the side of the road. There was a house for sale, not too far where my home is. And I started thinking about that, "Hmm, what if I could build a residential business, sort of a lab that would be like a garage shop operation, where I was able to play with technology with a bunch of kids, adults, PhDs, kindergarten, whatever?" And I can hire who I want to hire. I could knock holes in the wall if I wanted to, I could pay them what I wanted to pay them and not have to go through the bureaucracy that would prevent that from happening. Generate IP if necessary, spin off companies. So I talked to my wife about this and she thought I was crazy, but I convinced her that we needed to buy this house.

Robert J. Marks:

Okay.

Thomas Furness:

So we bought this house and turned it into a lab. And I was kicking that around where my wife is and she's the one that actually came up with the name. She said, "Well, experiments, rats and things like that." And I said, "Yeah."

Robert J. Marks:

Oh, okay. I get the connection now for rats. Okay.

Thomas Furness:

Yeah. And so yeah the rats of NIMH, there's a movie about that and rats are pretty smart and really industrious. And so we decided the RATLab would be a good name, but rat doesn't mean what people think it is. It means, we're going to be a rocking group of people.

Robert J. Marks:

Yes.

Thomas Furness:

And thinking people. And I was thinking of sitting in a rocking chair, just sitting there and thinking. But there's a different connotation to rocking as well. So I started the RATLab as a Washington company, an LLC, that would be working on just investigating advanced technology. And I started working with some clients who said, "Could you help me with this problem?" And I said, "Oh, okay." And so I started looking at what they were trying to do. In this case, they were trying to use light to characterize matter. And I'm sort of a photonics guy. So I said, "Well, yeah, we could probably look at that." And so I gathered together some of my rats and we started looking this and we said, "We wouldn't do it the way you're thinking about doing."

Robert J. Marks:

Now by rats, you don't mean literal rats. You mean employees in your lab.

Thomas Furness:

That's right. The kids and the employees that worked at the RATLab are called rats, including me, I'm the king rat. And so we started looking at this and lo and behold, we came up with two or three patents and the company said, "wow, that's great, and could you develop a slew of prototypes?" And we said, "Well, sure." And what I did was I chalked this house full of all kinds of technology. And we make our own electronic fabrication, printers and milling machines and things like that. And so we started making stuff and they said, "Wow, this is pretty good. How would you like to take it over all of our R&D?" And I said, "Really? I want to play with stuff." And they said, "Well, you can do that too." And I said, "Well, it's going to cost you." And they said, "Well, how much?" And I said, "A million bucks." I didn't know. I just threw it all throughout that. And they said, "Okay."

Robert J. Marks:

You know of course you didn't ask for enough.

Thomas Furness:

At that time, I said, "Good grief. I should have asked for two or three."

Robert J. Marks:

Absolutely.

Thomas Furness:

So anyhow, we got some money and we started playing around with technology and we ended up with 20, I think it was 20, patents or something like that in this particular area. And then we got approached by a few other companies, one who wanted to work on what was called HeartRate Games. How do you use games as a means of helping people get to healthy and with exercise machines. So what we did was figure out a way to take a bicycle, just your regular bicycle, plug it into this machine, and you'd be peddling away on this bicycle. And you put on a headset, virtual reality headset, and you become a dragon and you breathe fire. And you start flying around in three dimensional space while you're pedaling. And your peddling charges up your flame thrower, and you have to keep an energy level up on that flame thrower.

Thomas Furness:

And then you're flying around and you have these dragons that are trying to attack you and you're zapping them with your flame thrower and things like that. It's back to the pain thing we talked about before. You get completely distracted that you're exercising. And by the time 30 minutes is up, the game's over and they say, "Really? We have to quit now." When in fact you look at the profile of what you've done, and we came up a way with doing adaptively. So we wanted to keep you in the zone of where you were sufficiently challenged, but it wasn't too much, so that you would stay on this curve of exercising and eventually over a period of time, you get to the point where you didn't have to have the game anymore. You felt really good exercising.

Thomas Furness:

And then it became a social thing. You wanted to compete with other people and getting people over that hump of where exercising is unpleasant, to where it is pleasant, because you're fit, you're more fit, that was our objective. And we worked on that for a while. So with a company called HeartRate Games. And then we spun off a few companies along the way. One of the projects I started working on was with the XPRIZE. I don't know if you've heard of the XPRIZE Foundation.

Robert J. Marks:

No. Let me back up. HeartRate Games. If I wanted to buy one of these, is it commercially available now?

Thomas Furness:

Nope. It's not. As it turns out, HeartRate Games went under.

Robert J. Marks:

Oh no. This such a great idea, Tom, and I need exercise.

Thomas Furness:

Yeah. Well, it would work and we knew it worked, but the problem is the industry is dominated by a few manufacturers. And we started talking to those manufacturers and they just were not interested. They thought, "Nah, it's going to be too big a deal, too expensive, and we have a direct line to all of these fitness centers and we're trying to convince them that this is a way to go. And so, as it turns out, that we couldn't get through that particular roadblock.

Robert J. Marks:

I would think the home market would be really good.

Thomas Furness:

Yeah, and it could transform this whole situation where it makes people uncomfortable to exercise. No pain, no gain kind of thing. But we can make the pain go away and make it fun. Make exercising fun, so you get to a point where you're fairly fit.

Robert J. Marks:

Well, keep me up on that because I want one.

Thomas Furness:

You want one. Okay.

Robert J. Marks:

Yeah. I want one, okay?

Thomas Furness:

So that was one of the projects we worked on. And then another project we started working with the XPRIZE Foundation. And XPRIZE, I don't know if you know about the XPRIZE foundation.

Robert J. Marks:

No, no I don't.

Thomas Furness:

But they award these big prizes for accomplishing something, pressing the technology limit, and SpaceX won the XPRIZE for one stage to orbit. And there's an XPRIZE for mining on the moon and for acid in the oceans and things like that. And anyhow, this XPRIZE was a Tricorder XPRIZE, the medical tricorder, like

in Star Trek, where the doctor scans the patient, noninvasively, and tells what's wrong with him. So I was asked by the medical director of the XPRIZE, Tricorder XPRIZE, if I would like to be a judge of this. Now it turns out this guy used to work for me at the HITLab. He's a physician, neurologist. He was actually on the staff of my lab at the University of Washington. And he went on and is a professor at UCSD. But he became the medical director of this project.

Thomas Furness:

He said, "I'd like for you to be a judge." And I said, "To heck with that, I want to be a contestant." I want to build one of these tricorder deals. And as it turns out, I got involved. We signed up to be a contestant and started down that road. And then we found out that really this isn't going to take us anything advanced. We're just going to be integrating what's already out there, the cause of the sponsor of the XPRIZE. That's what they insisted. And I said, "Well, we're not going to do any blue sky work." And I said, "I think I'll just do my own XPRIZE." And so I've got together with the rats and said, "Okay, we're going to do this." So I said, "Let's go to work and find out what's really killing people." And as we did the research, we found out, pretty much it's heart disease. That is a silent killer.

Robert J. Marks:

Yes.

Thomas Furness:

When people have heart disease and don't know it. And the way Western medicine works, they only intervene when you have an event, and that may be too late. You have a heart attack and then you die, or you're injured for the rest of your life. And so there's not a whole lot that goes on in preventative heart disease. If you do have a good physician who does an EKG every year, you may be able to pick up on some of this, but EKG isn't too good, actually. So we started digging down and said, "How can we come up with a warning system for cardiovascular disease?" And we stumbled upon traditional Chinese medicine.

Robert J. Marks:

Okay.

Thomas Furness:

Because these have been practicing this for 2000 years of where a traditional Chinese medicine physician will feel the pulse, the pattern of the pulse. They take the pulse with three fingers on the radial artery on your left arm and only your right arm too, but mainly the left arm. And they can tell pretty much what's going on in the body by sounding the body. The pulse actually is like sonar, it tells you what's going on throughout the body.

Robert J. Marks:

My goodness, they must have pretty sensitive touch.

Thomas Furness:

Oh yeah. And I mean, it's a human pattern recognition thing. And they can tell by the timing and the shape of the pulse and things like that, what's going. Well, I didn't believe this. I didn't believe that that was really happening until we said, "Okay, where can we find one of these guys, these traditional

Chinese medicine guys?" And as it turns out, the largest traditional Chinese medicine clinic in the U.S. is over in Poulsbo, Washington.

Robert J. Marks:

Okay.

Thomas Furness:

On the peninsula.

Robert J. Marks:

Yes.

Thomas Furness:

And so, we went over and talked to this guy. He actually came to us and we said, we want to talk to him about this. And then what he did, the first thing he did is he went around the room. There were, I think, eight or 10 of us, rats, around the room. And he went one at a time and felt our pulse and told us our whole history, medical history. I couldn't believe it. None of us could believe it. And he didn't know us. This is the first time he met us. So this was beginning to make a believer out of me.

Robert J. Marks:

You can't argue with success, can you?

Thomas Furness:

That's right. And so we said, "Hey, how would you like to do a project with us? What we'd like to do is instrument you. What we'd like to do is digitize what you're feeling. And you tell us how you interpret what you're feeling. And what we'll do is build some machine learning algorithms and then we'll take those patterns and build a library and be able to recognize what the diagnosis is based upon the pattern of the pulses." And so this would be sort of a holiday kind of thing. And so we started a project. We spun off a company from the RATLab called Pulse Tectonics. And Pulse Tectonics was working on a way to do this measurement. And we raised some money. And in the process, we found something else. We noticed that in some of the patients, some of us, we were using our measurement system on ourselves, there was a strange bump that would occur sometimes and not other times, in the pulse.

Thomas Furness:

We say, "Hmm, what is that? Sometime it's there and some of the time it's not there." And we finally figured out by doing some monitoring over a period of time that this had to do with we're hungry. When we're hungry, that bump appears. And when we're not hungry, it's not there. And we said, "Well, what this is all about is we're actually measuring the shunting of blood to the stomach, to the digestive system that is being basically shut off when you're hungry, but the demand is there. And then when you eat, you're basically releasing that into the stomach." And we found that that was a correlation. And then we said, "Well, we wonder, if we can determine with the pulse, what you've eaten."

Robert J. Marks:

This is fascinating. Okay. What you've eaten, okay.

Thomas Furness:

Yeah. And so we started doing some experiments and we said, "Okay, well this is all on ourselves. Let's do a diet of protein, let's do carbs and whatever and fat, and let's see if there's any difference in the pulse. Sure enough, there's a difference in the pulse. We could tell by looking to pulse what you'd eaten. And basically what it was telling us is how the body reacts to what you've eaten in terms of the way it allocates blood supply. So the more we looked into this, we said, "Good grief. This is a bigger market than cardiovascular disease, the nutrition and diet market." So anyhow, we continued down this line. We had again, have some patents and we're ready to raise our next round of money. We had it identified. And then the Chinese market shut down. Basically the investment resources of China to the USA started drying up.

Robert J. Marks:

I see.

Thomas Furness:

This was even before the current administration.

Robert J. Marks:

I see.

Thomas Furness:

And so all of our money was going to come though this money, this next tranche of funding was going to come from China. Because they were the market, they were going to be where we introduced it because we thought, "Well, why would China want this because they have the traditional Chinese medicine practitioners?"

Robert J. Marks:

And it would be more open to Chinese sort of culture.

Thomas Furness:

Yes.

Robert J. Marks:

Yeah.

Thomas Furness:

Not only that. The traditional Chinese medicine practitioners, of which there are about a hundred thousand on them, said "We want this. And the reason we want it is we have no way of documenting what we've done. It's just one of those things we go feel the patient and give them some herbal medicine to make them better. And this way we have a record of it. And not only that, we can give them this system to take home so that we see what happens during the day."

Robert J. Marks:

So you could make it that cheaply, then?

Thomas Furness:

Yeah, oh yeah. Yeah, it was going to be. Really, the most important part of it was the database. I mean, that was the most valuable part of it. And so we would make these things for, they'd be 15 bucks kind of thing.

Robert J. Marks:

Whoa.

Thomas Furness:

In quantity and then it would communicate with the cloud and access this database and the machine algorithms and things like that. And it would spit back to you what was going on and what you needed to take in terms of herbal medicine. Now these are Chinese herbal medicine, which is different than what we get at the drug store here in this country.

Robert J. Marks:

Yes.

Thomas Furness:

Now, the other reason they wanted to do this is because they wanted to be legitimized in Western medicine.

Robert J. Marks:

Of course.

Thomas Furness:

Because they're looked upon as sort of spooky medicine. And that was another reason for this.

Robert J. Marks:

Well, I even know, the chairman of our department has a son that's both a medical doctor and practices acupuncture.

Thomas Furness:

Oh, yeah.

Robert J. Marks:

And I know acupuncture has had the same sort of pushback.

Thomas Furness:

Yes, yes. Absolutely. And so anyhow, this guy by the way, also practiced acupuncture and we've talked about that too, and how it's relevant in this situation. So anyhow, that started the Pulse Tectonics company with all these different variations. It's sitting there ready to go once we can get the money. We were trying to raise like \$5 million to take it to the next step, to where we can field a bunch of units and start building our database with that. So that is another spinoff that came out of the RATLab. There is another one that is sort of interesting. A colleague of mine, again the guy that I worked with on this



XPRIZE, who is a physician, MD, PhD, urologist, we were really interested again about vision and what's happening with the retina. And here in the RATLab, we took one of the bedrooms and we converted it into a chamber, a light isolation chamber, to measure the light that comes out of the eyes.

Robert J. Marks:

Out of the eyes.

Thomas Furness:

Yes. We know that photons go into the eyes. And of course the quantum energy is released in the retina and using the dopsin molecules that send electrical signals eventually to the visual cortex. But we looked at the structure of the optical pathways and we said, "Hmm, there's almost like U-turn there. And we're wondering if there isn't a feed forward loop." So we built this chamber. We put in some detectors, photon detectors, cool detectors. And we started measuring photons that come out of the eyes.

Robert J. Marks:

Now clearly there's not enough photons coming out of the eyes where you can see somebody in the dark is there?

Thomas Furness:

No. No, this is what was called ultra weak photon emission. And so it is, you have to use photomultipliers in order to count these photons. But it's clear that there are photons that come out of the eyes, and these are in the visible spectrum. These are not a byproduct of normal metabolism, infrared or whatever.

Robert J. Marks:

Yes.

Thomas Furness:

So that is another area that we're continuing to explore, because if there's something there, if this has something to do with what's going on in brain, with brain chemistry, then we have a portal, potentially a diagnostic portal into the brain, especially with people that may have cognitive impairment, mild cognitive impairment, Alzheimer's, things like that. So again, this is a one of those stumbled upon kind of deals. But I could do it in a RATLab and I could do it cheaply and not have to worry about going through the whole university system.

Thomas Furness:

And so that was another reason for having it. I can tell you some more stories. For example, I was hired by a company to be unnamed, to actually build a virtual cockpit for them, for new search and rescue helicopter.

Robert J. Marks:

Oh.

Thomas Furness:

And so one of the bedrooms, we converted into a helicopter simulator, and this was a virtual cockpit for helicopters. What causes a real problem with search and rescue is these pilots are flying in these awful conditions, weather conditions, and they don't see. And we were going to provide a way for them to see and a way to hover, station keep, rescue people, things like that. So we built a simulator to test some of our ideas, just like I did at Wright-Patterson Air Force Base, and had developed a whole new way of providing a cockpit for helicopters. So in the process of all of this, my rats, were getting all kinds of experience. And then they went on, the ones that went on from there. Well, they loved it. And then they use that as a stepping stone to get the responsible jobs in the industry.

Robert J. Marks:

Excellent, excellent.

Thomas Furness:

And several of them, I'd send to Australia and New Zealand to work on their graduate degrees and based upon the experience they did here.

Robert J. Marks:

And so that's where you got the HITLab at the University of Canterbury and the University of Tasmania, right?

Thomas Furness:

Well, yeah. I mean, one of the things, there is a story about the HITLab, in especially in New Zealand, what happened of course, when I was working in my office at the university and I got the call from a Dean's office saying, "There's a delegation from New Zealand who would like to come see your lab." And I said, "Okay." Apparently they had, I don't know, they'd found something online and they thought it was interesting. And so they came and I found out that they were members that Seattle and Chrysler, New Zealand are sister cities.

Robert J. Marks:

Oh.

Thomas Furness:

And they were up here as part of the sister cities delegation with the mayor and some university folks and the so-called Canterbury Development Corporation, which was basically their government incubator kind of thing, to start companies in New Zealand. And so they show up in my lab and I show them around, tell them what I'm doing, we've spin off all these companies and we're doing this multidisciplinary, transdisciplinary activity, where we generating all the patents, things like that. And they said, "Can we do that?" Now at that point, I thought, "If I play this right, I'm going to get a free trip to New Zealand."

Robert J. Marks:

New Zealand's beautiful too.

Thomas Furness:

It is.

Robert J. Marks:

Yes.

Thomas Furness:

And I'd been there when I was in the Air Force. I actually had worked with the Royal New Zealand Air Force some. And as it turns out, one of my PhD students, in electrical engineering actually, Mark Billingham, was about to finish and graduate in EE. And I introduced them to him. And I was looking around for a job for this kid. So anyhow, I told them, "Maybe I should go to New Zealand and check it out." And they said, "Oh, would you? Would you come? I mean, we fly you down business class, bring your wife. You can take some time off and get around and things like that." And I said, "Oh, maybe I'll do that."

Robert J. Marks:

Yes. The beaches in New Zealand rival those in Oregon. They're just beautiful.

Thomas Furness:

Oh yeah. Well, as it turns out, when I got down there and they showed me around and we had a blast just driving around the countryside and they asked me, "Well, what do you think?" I said, "Well, maybe I should come back. I have a sabbatical coming up and I could spend six months here taking a look and see what we can develop." And so they offered me an Erskine Fellowship to come back and spend six months. And then they introduced me to the prime minister, the deputy prime minister, all of the ministers. And the government said, "We're going to do this. And we're going to form two entities, the HITLab New Zealand Research Center, hosted by the University of Canterbury, and the HITLab New Zealand Limited, a company owned by the university and by the University of Washington, that would develop the technology once it happens in the research center.

Robert J. Marks:

Let's remind listeners that HITLab stands for human interface technology.

Thomas Furness:

Right. So what happened, we started the lab. And oh, by the way, one of the things that had to happen is I needed to be in New Zealand every year from January to the end of March during the winter quarter.

Robert J. Marks:

Oh, I'm so sorry. That's when it rains in Seattle, right?

Thomas Furness:

Yeah.

Robert J. Marks:

Our joke used to be, it's like living in a car wash during that period.

Thomas Furness:

Pretty much.

Robert J. Marks:

Yes.

Thomas Furness:

So the New Zealanders gave us a permanent residence visa. We bought a home and we lived in New Zealand every year for three months, during that period of time. And we started a lab, it's booming. My student became the director. He stayed for 12, 13 years. Now we have a new director, they have gobs of money, gobs of students, spinning off companies and it's wonderful. Now what happens is the Aussies see this. Aussie all looks over the pond and says, "What are these Kiwis doing?" And they came over and said, "Gosh, if the New Zealand people can do this, surely we can do it."

Robert J. Marks:

Of course.

Thomas Furness:

So they wanted to start their own lab, HITLab, that would be a sister to the New Zealand lab and to the HITLab at the University of Washington. And so they did, they started one in Tasmania. And it didn't grow as fast, but another one of my PhD students in electrical engineering became involved in that one.

Robert J. Marks:

My goodness.

Thomas Furness:

Yeah. So that's how it happened.

Robert J. Marks:

So you're all over the world right now. Tom, I'd like to continue for one additional podcast because we still haven't talked about ARToolworks, your NSF grant and I wanted your opinion on some of the futures of virtual reality. So could we do one more?

Thomas Furness:

Sure. We'll do it.

Robert J. Marks:

Okay. We've been talking to Dr. Tom Furness at the University of Washington. He's the grandfather of virtual reality and started virtual reality when he was an officer in the Air Force. And as you heard in this podcast continues to do exciting things today. So until next time, be of good cheer.

Announcer:

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