AI and You

Transcript

Guests: George Dyson

Episode 95

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Hello, and welcome to episode 95! Those who do not understand history are doomed to repeat it, right? Or maybe the problem is that we should be repeating some history that we're not. Either way, it's time to get a historical perspective on AI on the show again, and so my guest today is George Dyson, who is – well, many things, he is a master kayak builder in Bellingham, Washington state, near me, but also a keynote speaker about the history of computing and the author of *Darwin Among the Machines: The Evolution of Global Intelligence*, and *Turing's Cathedral: The Origins of the Digital Universe.* His early adventures, contrasted with those of his father, physicist Freeman Dyson, were the subject of Kenneth Brower's classic 1978 dual biography *The Starship and the Canoe*. Catch his TED talks, and also his keynote at the Open Source Conference in 2015, when you can see pictures of some of the things we're about to talk about. There's a link to that video in the transcript. I was fortunate enough to be in the audience in Portland for that. Here we go with the interview.

George Dyson, *Welcome to Artificial Intelligence and You.*

Yes, happy to be here. And we're only 45 miles apart.

45 miles and an international border apart. It's so far these days. But let's hope that it gets better. Just to give our listeners an idea of who you are, one of the stories that's often told about you is that you spent three years living in a treehouse. Do tell us about that one.

Yes, that was in my sort of wandering youth. So I was 19. Now when you tell people you spent three years in a tree, they think you have some political agenda trying to save the rainforest or something. But I was happily helping to cut down the rainforest and hung around logging camps and stuff, but needed a place to live near Vancouver and at that time, the entire coastline around Vancouver was inhabited by a lot of squatters. It wasn't that strange, but I just ended up 95 ft up in this big Douglas Fir from which you can see downtown Vancouver; it was only six miles from downtown.

That's a lot of exercise to get to the grocery store.

I went to the store in Dollarton across the inlet and it was it was wonderful. I mean, now of course all these crazy ideas I had at that time that the trees represented sort of a network to slow intelligence are now scientifically respected.

Right, the connection in the biodome is fascinating. Maybe we'll talk about that. Now you have made a name for yourself in the sphere of this show, primarily in the history of computing and perhaps the paradox for so many people in this business, if we think about the typical Silicon Valley resident is that computer science is maybe the ultimate forward-facing discipline. It

attracts followers who can code as soon as they can walk or type and they might argue that they're too busy creating the future to look back at the past. What are they missing?

They're missing a lot. Because I mean, first of all, people have been thinking deeply, some of our deepest thinkers have been thinking about artificial intelligence for 300 or 400 years and thinking about it in a profoundly serious way. And to disregard that is just foolish. I mean, that we, you see particularly in this sort of recent rebirth of neural networks, I mean, you see people absolutely repeating work that was done before just not searching the literature sort of before the Internet things were cataloged differently. The search terms aren't there, but the work was done. And it's quite amazing how ideas from the 18th, 19th and 20th centuries are flourishing now, but being reinvented. So it's just my particular…you don't have to look back, I mean, you can reinvent things, but that's what I do is sort of look back.

And what I found fascinating when reading your books, *Turing's cathedral* and *Darwin Among the Machines* was how much they were, as you say, forward looking in those days when they barely had two valves to rub together and they still wanted to do simulations of intelligent life Turing was thinking about this before he even had the hardware to run it on and and so in a sense, perhaps I wonder if our imagination is not as powerful as theirs, what do you have a sense of their ability to project themselves into the future?

Well, they had a completely clear horizon. They had no sort of existing computing industry to tell them what, how it should be done. So they thought very openly and independent about it. I mean the strange thing is that if you brought either of the two, you know, sort of recognized fathers of it all, Alan Turing and John von Neumann, if you brought them back today, they would be absolutely shocked that that we are still doing everything exactly the way it was done in the 1950s that we haven't really advanced and in a sort of profound architectural way. The machines they designed to solve particular problems were seen as a sort of immediate solution to immediate problems, not the way people would have to keep doing it for the next almost a century.

Do you mean that they saw the von Neumann architecture as a stepping stone, that they had designs beyond that?

That right, It was sort of an emergency. It's like first aid. I mean you come in before the doctors show up and just do what you can do. And this was wartime. They were facing deep problems in cryptography and nuclear weapons design. This was a solution. But if you look at von Neumann, I mean he only took out one patent and his patent is for a method of non-von Neumann computing, and IBM bought it and sort of buried it. But it's very much the way we're going now. If you look at that von Neumann patent, it's a it's a way of sort of self modifying non logical or non algorithmic architecture for solving problems, which is which is what we're sort of drifting back to. Right. I mean if you look at the hardware and the software that it takes to run artificial intelligence neural networks these days, if you do that on a von Neumann architecture, you've got all these layers of abstraction that introduce all this slowdown just to do what the

human brain is doing naturally. And so I think this is where people are looking at and I don't know much about the neuromorphic architecture these days; and is that the sort of thing. Von Neumann and the others had in mind that they were going to do when they got around to it?

Absolutely. And I mean the sort of tragedy or the strange twist of fate is that we ended up with a microprocessor where you can just print, you know, these "von Neumann" machines, you know cheaper than dirt and but they were printed from a template so it became very, very hard to change. But if yeah, I'm sure if von Neumann was with us today, he would look at it and say, yeah, I mean get rid of all this. I mean he was he was very clear that is that that the brain did not work in a logical way. It wasn't based on this abstract logic. And so now we have tools and the neuromorphic people are working on this except they still sort of keep simulating it. But there are a small number of companies and parts of Intel that are actually building real non algorithmic chips and that's a very exciting thing. It's going to change everything. It's gonna be driven by, you know, drones and cell phones are the two things that that are driving that and self driving cars if you know Elon Musk would get out of the way because he's not doing that. Which just surprises me. I mean, why are you trying to build a self driving car that is a purely digital system. I mean, there's a real use case for, you know, for either going completely analog or at least hybrid analog digital.

What would analogs architecture is look like now? I mean, to me from my computer science classes, decades ago, analog was something that was in the past that was in museums and just thought about things like knobs and dials on cathode ray tubes. And before that differential, analyzers, things with rods and levers. And we didn't have time to look at those. But now you're mentioning analog in the context of today. What is the bridge?

Well, it's a cycle. It's sort of like what happened in the 1940s. We had all this analog hardware lying around after the war and a few oddballs, figured out how to use this analog equipment to build digital computers. And the difference between analog and digital is a strictly technical difference between computing with discrete functions, ones and zeros, or computing with continuous functions. In fact, that's why a, what we call in America, a vacuum tube in England was called a valve, could operate a continuous sort of flow of electrons. And now we're seeing the same cycle, I think sort of repeat itself where we now have all this digital equipment and the oddballs are figuring out that, you know, you can build analog computers out of this digital stuff and that's what the big Internet companies are effectively doing in a sort of unconscious way; they're starting to compute with continuous functions rather than discrete functions. YouTube doesn't care what the bits mean, It just cares about the amplitude of the flow of bits and computing that way. Which of course, von Neumann was very explicit in his book about why the computer and the brain are different. That that's how Nature does all its control systems or analog control systems, because it's far more robust to operate on the pulse frequency or amplitude of the signal rather than the exact meaning of each bit where you get one bit wrong and then you're got a blue screen.

And that's where Shannon comes in with error correction so that we're able to transmit and store information reliably, but did that in a way, kind of seal the fate of analog computing at that point because it was focused on how to make it either on or off?

It did. But I don't see why we have to accept that as permanent. I mean, you know, Nature did exactly the same thing: Nature uses digital computing for genetics because of the error correction. It's very good for both correcting errors and of course for also introducing significant errors. Which is a good thing if you want to have evolution. But in nature the control systems are analog and the information storage is digital. And I think we're going to end up going this the same way. I'll be dead. But I mean, come back in 50 years and I bet you know, if we do have real self driving cars, they'll have analog control systems, not digital. And I may be wrong, I've been wrong about you know, lots of things.

We all we all have been wrong, especially the last two years have been very humbling. You describe how the early history of the development of these computers hinged very much upon the atomic weapons program, which is interesting: how much that may have or how much part that did play in funding the development. What actually was the role of the atomic weapons program in our computer development?

It was, in a sense, it was almost inevitable because you at Los Alamos we put the most brilliant scientists and mathematicians, not only in the United States, but of course from it was a large British contingent of Canadian contingent and then all the people fleeing Eastern Europe because of the disaster there. So, you know, all these extremely clever, smart people were work together with this with these problems that required a whole lot of numerical hydrodynamics to solve. And Richard Feynman was there. And so it was just almost inevitable that they would start to build computers because they needed them. They had human computers and they had they were given every single piece of equipment that IBM made at the time, you know, free access to all the resources and I think that something is not recognized with it at that time, IBM maintained strict control over there equipment. You could not modify IBM equipment. In fact, most companies just simply rented. It was like the old telephone system. But Los Alamos was given a special exemption that they could mess around. You know, and tinker with their IBM machines. And a lot of computing just came out of that from people like Richard Feynman figuring out, what can we do with these sort of rather non-intelligent office machines and make them make them do much more, much more powerful things.

Was a lot of that classified, did it only emerge after some decades?

It wasn't strictly, I mean, the good thing we did in America was we didn't keep the computing classified. In Britain. They did. And it was it was a huge mistake. They didn't want to admit what these guys have done and women had done during or so the stuff that came out of Los Alamos was pretty freely adopted on the computing side. And it changed of course those people went then went out into the world. And that that's I think I would say what gave the United States the lead in computing that they had.

You mentioned human computers. Were those at that time mostly women?

Yes. And they all have very interesting stories. You know, I got to talk to a few of them and it was just such a rich time and sort of irresistible.

Was it a time of greater empowerment of women? Did they take a step back after that?

Yes, of course the war opened up all these spaces because the males, were moving through the university system much faster into wartime positions, positions were open. Discrimination was lifted and and it was very like when my father came to the institute in Princeton in just after the war, four of the physicists were women. Which I think has never happened since, you know, not until recently have there been four women physicists there? So there was, during the war, everybody was working on this stuff to their ability not to whether people thought it was the proper thing to do right.

And the same in England, most of the calculators at Bletchley Park were women, hut eight and and so forth. And then somehow that once it no longer became necessary for the war effort that patriarchy reasserted itself, I guess?

Yes. One of the heartache calculators talked to his in Victoria. Olive Bailey and she I came to Victoria and gave a talk and she came up after the lecture was the last person in line. Just just boundless energy bounded up on stage. And he said, “We all loved Alan so much. We were so sad to see him leave hut eight,” when he left hut eight which was her group. He was so wrongly represented in that film made to seem sort of you know, antisocial and clumsy. He everybody loved him.

They have to have a certain narrative to to succeed in that sort of thing. But how then would you give us the flavor, the essence of the man there and maybe the wind. We can contrast that with the other giants of the time

Of Alan Turing?

Yes.

Well, I mean he had a tremendous sense of humor and we forget that that’s I was seeing that in Ukraine right now. I mean that that was the British secret weapon. It wasn’t the codebreaking or the atomic weapons or whatever. What you know what helped Britain win the war was the British sense of humor no matter what happened. They kept a sense of just dark humor about things and that gave them the strength to withstand the impossible odds they were in before America joined the war and the film about touring kind of missed that. They didn’t capture that sense of humor. I think that’s what you know that’s what Putin is up against now. I mean he’s fighting against a comedian.

That’s a good point if you know it’s so tempting to play alternate history games and try and imagine what it had been like if Turing had lived longer. Every time I learn more about what he did. I am I’m just stunned at how prescient he was. What can you say about his relationships

with people on this side of the Atlantic who were he was working with? He did come to Princeton, right?

Yes he did his thesis there. Now at least there's books about it and stuff. But it was it also he already was bored with sort of deterministic computing. So his thesis was about non deterministic ,machines, he called them "oracle machines." That that would work logically for a certain number of steps and then do something completely crazy and analogical and he knew that that was the path to real AI the path to real AI was not in infallible perfect machines. And so he was definitely onto something and if yeah if you could be in the modern environment. Uh huh. Where a his yeah, you know his sexuality wasn't a problem in getting clearance to work on interesting stuff and he was because we were right at the, beginning of the genetic, both the genetic revolution and the digital revolution. He was deeply interested in both those things. I mean, just just would have jumped right into it.

Such a loss. I always wondered why he didn't moved to America to escape the persecution in the UK?

Well, I think the America Edgar hoover was would have been after him and I think it would have a hard time here. It's too, it's too bad. There's um, what he said in his private letters and there could be some truth to that. He disliked how the Americans had showers and not bathtubs, you know, being British, you like to take a good hot bath in a big tub and he gets to New Jersey and they're all taking showers and it's little things like that. I mean, he had other reasons for going back to England, but we didn't, we didn't treat him, I'm speaking as an American, we didn't treat him that well.

You were talking about biological systems there and you describe Nils Barricelli and his digital universe at five kilobytes and creating some sort of, was it a cellular automaton?

Yes, it was before the modern sort of invention of cellular automata, but it was it was it was that idea. And yeah, you think about that, that's the that's less memory than an icon takes up on your desktop, I mean, it's just an incredibly small amount of memory, but that's all, that was all the memory there was. So he used it and then just had this crazy life where he just wandered around wherever there was a new computer being built would try and scavenged time on it to run these universes that he was building.

What was he trying to do, build self evolving digital life forms?

Yes, he wanted to see what how evolution--I mean, he by trade, he was actually a viral geneticist. He was interested in phage genetics which are these sort of between viruses and bacteria. Very interesting, wow.

I mean, it's stunning to think of that being done in 5Kb.

Yes. So he wondered how did the genetic system in nature evolved and sort of said, let's do it in a computer sort of like a laboratory experiment and see what happens. And of course it was

amazing how all of this phenomena evolution started. And he'd learned very quickly you had a diversity problem if you had a closed universe. So he would run free universes where the organisms could move back and forth between different. You know, that's I mean, that's this whole metaverse thing we're being sold now. I mean that's the fatal flaw. If any company tries to maintain it as a closed system, by definition, you know, it'll never come to life.

Did that work get picked up; did it get eventually turned into what we call it, genetic algorithms or did it wither on the vine?

No, it's that's it, the amazing thing. It just completely died out. And you know, I showed up and found these boxes I was looking for, were the relics of the von Neumann project and it was a box in the basement, you know, covered in dust and dirt and grease. And it contained all the punch cards for one of his universes. But the scholars who came later never -- well one or 2, but but the only person I ever met was Alvy Ray Smith who founded Pixar but had studied cellular automata as a student and he knew about Barricelli's work and when we met each other it was like, oh, you know that, but almost the work was, it was just too far ahead of its time. And he was, he was, he was a crazy oddball guy.

That's an interesting connection there with Alvy Ray Smith because I met him once long ago when I was interviewing at Lucasfilm and they had just come up with the Star Trek II animation of terraforming the planet, which it looks a lot like biological systems. It's fractal based, you have to let it evolve itself, you can't control that whole animation. But this is fascinating. One of the things I'm wondering about to go back to Turing and the Turing Machine. And and that was a stroke of genius where he envisaged this device as a thought experiment to prove that anything which mapped onto that was compute was a machine that could compute any computable function. And he envisaged it as this thing that ran a linear tape beneath the head and would make a mark, read a mark or erase a mark, and then move the tape. And it had a memory store and a program. And I've wondered whether that where the people took him to literally, I mean it wasn't long after that we got magnetic tapes and we got paper tapes and it was a very digital model, but it's not the only way that you could instantiate the Church-Turing thesis in hardware. I wonder whether that was something that inadvertently shaped the way our hardware evolved?

Yes, I mean, it's shaped it ever since. It's just, it really is extraordinary, how one--now it's sort of unpopular Great Person theory of history that one person steps in and changes everything. But in Turing's case it really, I mean, he had this crazy idea and but proved it in a mathematically rigorous way. I mean a paper that was just at the time seen as just mathematical logic, not with any practical use. And then in oer the next 50 years it just absolutely changes the way the world works. And people have argued forever like, "Oh what did von Neuman didn't read Turing's work or you know, other people were doing it. It would have happened anyway." That may be true. But I mean it, you know the book is called Turing's Cathedral because it's just this enormous cathedral grew out of this one very, very, very clever statement.

And the machine is just a stroke of genius. And he could have left it as symbolic logic for mathematicians. But he said, well you could imagine this machine and then proved how it would be equivalent to that logic.

Yeah.

You were talking about going through those boxes of um records from the early days and I have seen your presentation about the notes they took them. And it's really amusing that how humanizing they are because of the frustration and they wrote their frustrations down on paper. And they're exactly the sort of things that we experience now, although we don't usually have the time to write them down. But just the same kind of cursing at the computer for not doing what you told it to do and not what you wanted it to do.

Yes. And they and those notebooks document to me a really fundamental and important transition. I mean history has transitions from, you know, the age of the dinosaurs to the age of mammals. But it's rare that you find the actual documentation of when that transition happened. And in those notebooks which start when they first sort of get the machine running at all in 1950. And then they get it running well in like 1953 and 1954. And the notebooks of course document complaints. If everything's going well, nobody usually makes a note. But if something goes wrong, then there's a note in the notebooks. And at first almost all the problems are hardware problems, you know, vacuum tubes not working right. Just classic hardware problems. And then they get the hardware running well and it eventually shifts to where the hardware is running smoothly and all the problems, our software, our code problems. But in the middle there's this transition where when they have a problem, they're trying to figure out is that the hardware or is it the code? And they argue a lot about that. And we now live in a world where almost all our problems are--I mean, what we call a hardware problem is usually it's actually a software problem, you know, you don't have the right driver for years, microphone or something. We very, very, very rarely in the modern world do we actually have a computing hardware problem.

It's reminds me of a quote by Maurice Wilkes at Cambridge, where he was walking down the stairs and he realized for the first time that most of the rest of his life was going to be spent debugging programs he'd written.

That's the world we live in now.

Thinking about these again, I just want to use the word Giants of computing because they're so iconic and that you're describing them in an environment where they're all working together and it's, I don't know enough about them to know how egotistical they were. But some of them certainly sounded that way from the from the descriptions and that might go along with the territory were therepersonality clashes?

Yes. I mean there were certainly personality clashes between groups. The big one being that the big American wartime machine, the ENIAC or MANIAC was really masterminded by Eckert

and Mockley who were really the builders of that machine. And then and then von Neumann stepped in and sort of whether he took the credit or was given the credit, he transformed that machine into something else. But there was a bitter conflict between those two sides that still survives. There's people who are on the von Neumann team around the Eckert and Mockley team and they will argue forever about who wrong. I found some smoking guns. I mean von Neumann really was pretty unethical and actually unscrupulous and how he was free to go build his own computer, but he didn't have to sort of undermine their work and he and he did. But within the teams it was sort of like being on a ship or an airplane or something. You had to work together. I mean if you have a bomber crew or something, it may not like each other on the ground, but when they're in the air, they so because those big machines at that time really were a team effort. It took it took engineers and coders and you know, to cooperate to keep the thing running. So I think there was that sense of cooperation.

How had that landscape shifted by the 60s? Because the space program is often cited as the impulse for the development of the microchip and soaked up a lot of the available computing power.

Yes. And the microchip changed everything because suddenly you could you could have a perfectly working computer for almost no cost. And then the interesting thing became of course writing the codes for it and then connecting those computers in interesting ways. So there we there we get this sort of meta level of innovation where we we start having networks, how do you get computers to communicate?

But I think I mixed up the history some; I think the integrated circuit didn't come until near the end of the space program in the 60s. I mean they certainly they were using core memory for the Apollo mission at that time.

Yes. I mean there's a space, there's the manned space program and then there is the, you know, the unmanned surveillance space program like the Corona project and stuff, which really the, the Silicon Valley we know the sort of Fairchild came out of that satellite reconnaissance world, which is again, another example how secret, you know, secret government projects will lead to these, you know, founding of industries.

And actually that I've got to mention the intersection of computers, space program, secret government projects, and your work is Project Orion. And you've written about that, which was--well, tell us what was Project Orion?

Yeah, it was a grand dream that you know, didn't never even had the chance to fail. So this was pre NASA. We've forgotten NASA didn't exist until 1958. Sputnik went up in 1957. So there was an interim period where the American government wanted to do anything, were looking at all possible options to do something spectacular in space. And one of the options was a nuclear explosion-propelled space vehicle, which was originally the idea of Stan Ulam who was now in a sort of independent film about him, which is pretty good. He was Polish came to America on a $300 visa to give a series of lectures and got him out of Poland all with his younger brother. The

rest of the family were killed. And he always looked at everything differently. So it was almost when everyone was saying oh this is terrible thing, that's going to destroy everything. He saw that the parts of the test tower were 100 ft from the center of the fireball and survived intact. So he thought, how about using bombs to propel missiles instead of using missiles to propel bombs? And that idea was taken up with wild enthusiasm by Ted Taylor who was a friend of my father, and they worked together. So worked together on a very serious project to build a 4000 ton Earth surface takeoff spaceship that their planned voyage was to go to Mars in 1965 and then visit the moons of Saturn in 1970 with a crew of about between 50 and 100 people.

So it was envisaged that this would take off from the surface of the Earth?

Yeah, probably from Nevada or from a barge out in the Pacific.

Using nuclear bombs for the ascent?

Very small. And the thing we forget is that in 1958 we were exploding over 100 megatons of fission equivalent in the atmosphere every year, just for military tests. So it was one of the things that, that served multiple functions that it actually would be very useful as tests and, and it would course deliver people to Mars and Saturn without, without adding to the fallout that we were already--of course when we stopped testing bombs in the atmosphere, then it became impossible. I remember a science fiction novel Footfall by Larry Niven and Jerry Pournelle where they had people build one of those--actually they built it at Bellingham in the inner harbor.

There used to be a science fiction conference here and they were here for the conference and kind of took that scene. It's a big, horrible, big pulp mill here, the kind of place you would do something like that.

Destroy most of the surrounding area and its takeoff. That was, I just remember that. So that was in a, in a way that seems like a larger-than-life era. I mean era larger than life era of conceiving of atomic bomb powered spacecraft, 4000 ton spacecraft and, and so much in in a way it seems like our vision has narrowed. If you look at the landscape today of what's being done, it seems like there's a bit of a renaissance of innovation. Is there anyone that you look at today and think, yeah, I would, I would put them up on the same level as those guys?

It's very hard to say because you usually don't see those people until later. Like Orion was secret at the time. Nobody really knew about it until later people started putting it in science fiction novels. So I don't know. But you know, I think we live in a sort of sad world where now, I mean, you can't you know, you can't get on an airplane with a Swiss army knife. So it's in that time the risks were seen much, much differently, for better or worse. So, I'm rather disappointed in the current supposed space renaissance is still just chemical rockets. I mean, it's the same thing we did in the 1950s and 1960s. It's not anything fundamentally new.

I know. I mean, there are still projects to do laser launched spacecraft and tethers, but they just very small prototype, nothing like the scale that we need. And they've been in that that phase for decades.

Right, laser makes sense, laser or microwave propulsion where you keep the energy source on the ground, don't carry your energy with you. So, there are things that could be done, but we're for some strange reason, we're not doing them.

Wow, Is this a fascinating conversation? I thank you for giving us this tour through history. I feel like I got the privilege of just being transported back to those days for a few minutes with those people who, somehow the stars aligned to bring them all together and do that amazing work at one time. How did you have fall into being that kind of historian?

Sort of by accident. I mean, as you know, I was, you know, completely preoccupied and consumed with kayaking, the history of kayaks in the North Pacific, that's all I did and that's what I was known for. And I wrote a book about that. And then, one day I got asked to write an essay for a magazine in Japan about nature and technology. The assumption being I would write about kayaks as natural technology for some reason, I don't know why I was just bored or irritated; why does everybody want to hear the same thing all the time. And I wrote an essay about this was in the very early like 1990, I wrote an essay about computers taking over the world sort of like organisms. Um and the Japanese loved it. And then an American book agent read it and literally called me up and said, you know, there's no deep book about--the kind of the Internet was just starting to surface in the public imagination. There's no book about the sort of deep history of that and got me a contract within a week with Addison-Wesley who were the only people at that time publishing non-textbook books about things like artificial intelligence. So that became the book *Darwin Among the Machines* that was written here and in the beer cooler of a tavern on the Bellingham waterfront, right next to where the pulp mill was. And that the book was written in here without the internet. So that was the last book about the internet written without using interest books from interlibrary loans. And somehow that that book just it's luck. It's like baseball, you you've got to have all the right people on the basis. But that book came out just when, you know, in 1997, 25 years ago now when the Internet suddenly became was known among scientists at the time but suddenly became sort of known to the public and that was the right book at the right time.

If I could wave a magic wand and put you in charge, king for a day of, take your pick, Google, IBM, Microsoft, Facebook, Amazon, which one would you find appealing the most appealing to, to run for that time. And what would you do? What would you tell them?

Well, I think sort of no question Google is the most interesting because they have a lot of hardware. Wwe forget how much actual transpacific cables and real hard stuff Google controls. It can be ah, you know, you can do all sorts of them and then they are, they're doing amazing things with it. So I would choose google and I would just be, When, when I first had contacts with Google, they were very shy about saying anything about AI didn't want to talk, they were

afraid people would be scared of it. So they didn't talk about AI and now I think they have the same fear, why does anybody want to talk about analog computing? So if I ran Google for a day, I would say, hey, guess what? People, we are an analog computing company. You know, people think we're a digital computing company, but actually we are the planet's largest, most effective analog computer and we should embrace that and recognize it. And why do we have computer science departments that have an endless list of classes on codes and algorithms and teach no classes on analog control systems, which is arguably as important, if not more important.

Well, what would you recommend people look for to start finding out more about that?

I think I read the old literature, I mean about analog control systems and I think that probably the most interesting sources now are in biology because it's the same control systems that that work and genetic networks and you know, the biologists are sort of in some ways still ahead of the computer people and that's they're worth listening to try and understand. We need to understand the nervous system of a fruit fly before; and there are still mysteries there.

Right. I'm reminded of the Open Worm Project. Nematode worm's got 302 neurons; we're trying to figure out how to build a model that does what the worms do. And that's challenging enough.

There's a great paper about that called the *Best of All Possible Worms*.

Thanks. Well, that's something for our listeners to go look for. That's an arresting title. Ah, what would you like people to look for that? You've been doing your books will put links to those and anything in particular where they should go find out about you. I try I don't have any social media presence or any of that. I just sort of live in my 19th century world. Most recent book is, I think it's also my last book. I'm not signed on for another book. And oddly enough, I think it's absolutely my best book and it's been the least successful. So make of that what you will.

And that's *Turing's Cathedral*?

No, it's *Analogia*, which is which is deeply about these analog questions and about the subjugation of the native population in North America, all sorts of sort of, all my ideas in one package. But with a fundamental theme of how analog computing is coming back.

Well, let's look for that, then. Thank you very much, George for coming on *AI and You*. It's been a real pleasure.

Thank you.

That's the end of the interview. George's most recent book is Analogia: The Emergence of Technology Beyond Programmable Control, is about why analog computing is destined to regain control and there's a link to it in the show notes and transcript.

In today's news ripped from the headlines about AI, the United Kingdom's National Health Service has just deployed a new AI tool that can diagnose heart disease in just 20 seconds, while a patient is in an MRI scanner. It would normally take a doctor 13 minutes or more to do that after the MRI, and the British Heart Foundation determined that the machine was doing better than three doctors they compared it to. It's currently being used on 140 patients a week at University College London hospital, the Royal Free Hospital, and St. Bartholomew's. About 120,000 heart MRI scans are performed each year in the UK, and researchers say this will save about 3,000 clinician days per year, letting the specialists catch up on their waiting lists.

Next week, my guest will be Alison Gopnik, who is a professor of psychology at UC Berkeley, and she is an expert on how babies learn. She has given a TED talk, and been on the *Colbert Report* and the *Charlie Rose Show*. What do babies have to do with AI? Here's the connection: Alison is the subject of a chapter in Martin Ford's book *Architects of Intelligence, The Truth about AI from the People Building It*, talking about how kids' brains may hold the secret to building better AI. Amazing perspective and learning opportunities for people wanting to know how to create artificial general intelligence. That's next week on *AI and You*. Until then, remember: no matter how much computers learn how to do, it's how we come together as *humans* that matters.

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