Innovating and adapting for tomorrow with "The Woz"

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TRANSCRIPT

SPEAKERS:

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Roger Hobby: Welcome to another Fidelity Rewards+ event. I'm Roger Hobby. I'm the head of the Private Wealth Management business. Today we're going to be talking about innovation and adapting, and we have probably the best person in the world to have this conversation with, Steve Wozniak. Steve is many things: he's a National Technology Awards winner; an actor—we were talking about that earlier; a person who created the personal computer; is part of the Technology Hall of Fame; an award-winning writer; and just an absolutely fascinating person, and described as the purest form of engineering ever out there. So, I'm very, very excited about the opportunity to talk to Steve. And, Steve, we're going to be talking about adapting and innovating, obviously the world that you have lived in for a long period of time. Would you mind starting off by talking a little bit about sort of the early years, maybe the influence, maybe, that your father had on you around getting into engineering, why you wanted to be an engineer, and where you thought your career was going to head, and maybe sort of where it ended up going?

Steve Wozniak: Sure. When I look back, I can see some forces, but never anything like something directing me to go in this direction. My father was an electrical engineer, and kind of one of the earliest memories of my life was going into where he worked and seeing these tubes and pictures on screens. He'd adjust some knobs and take a picture. And so I started seeing, oh, my gosh, that's what an engineer does. Then he worked so hard at our home on his projects at work, and I was lucky because when I got interested in electronics, which was because of my math skills in school, I'd ask my father a question—"How do you make this?"—and he would sit down on a blackboard, and he'd show me and help me. We both got our ham radio licenses together. I was 10 years old then. You had to learn a lot of the mathematics of electronics. To me, it was just interesting because I knew things that other people at school didn't know. This was not done in school. It was not forced on me. My siblings didn't turn out to be engineers. And in school you'd just learn the normal things, and I knew the special thing on the side: electronics.

And then I stumbled, by accident, on a journal only for top engineers, and it had stuff describing how digital logic worked, and ones and zeros worked, and I said, oh my gosh. I taught myself on paper how to add ones and zeros and things, and I said, this is going to be my passion for life. This is what I'm going to do. This is what I love. I didn't think it would ever be a career or a job; it was just going to be the thing that I followed forever. And I taught myself on paper how to design little bits of things called logic that would add up and add numbers, for example, do more complicated things. And I was in elementary school. My science fair projects were big winners in the science fairs, and I was on the way.

Then, in high school—we didn't have anything like computers. We didn't have any books on computers in even the technical bookstores. But my electronics teacher in high school would arrange for maybe one or two students a year to go to an industry once a week and get some experience there, and I got to go program this thing called a computer. Oh my gosh, I get to actually program a computer! And had a lot of fun there. And from the very start, what can a computer do versus what can a human mind do was one of the big issues in my life.

And then I saw a book laying there at that company, Sylvania in Sunnyvale, and this book was called the *Small Computer Handbook*. Oh! I had always searched for any book on what a computer is. So they let me take that book home, and I studied it, and it described the architecture of a computer, like a house, has rooms, and windows, and floors, and things like that. The architecture tells you where the parts are in the computer, and what ones and zeros will cause numbers to get added, and where they'd be stored. And I said, wait a minute: back in elementary school I did logic. I can go back to those early logic projects—in eighth grade I had a little adding and subtracting computer I'd built with hundreds of parts—and I went back and I started on paper figuring out how do you draw these tiny, little elements called logic gates that add up to doing everything that this computer manual says the computer does.

And finally succeeded, and I started getting more and more computer manuals. You couldn't get computer manuals—they weren't in any stores—but I wanted to go to the one place, the library, that might have books on computers. And Stanford Linear Accelerator Center was the high-end physics research place in the world then—brand new—and I drove in on a Sunday, and they just let me in. I parked near the main building, and I tried some doors. The smartest people in the world don't lock doors. (laughter) And there, I got in, and I found a library, and I started reading more about computers that were coming out, mini-computers, and they came with little cards, postcards. You could fill in a postcard, send it in, and they would send you a manual. I got manuals for Varian computers, for Hewlett-Packard computers, for Digital Equipment computers, for Data General computers, for Hewlett-Packard computers.

I got all these manuals, and I would open it up, and it would describe the architecture, where the rooms are, and then I would take the building blocks, kind of like lumber chips, little logic things that I knew on paper, and on paper I would design these computers, and I would design them over and over and over, because it wasn't like a school class. In a school class, you do a project, you're done.

Good. You got a grade. You go on to the next. No, I would go to sleep at night thinking, could I have done that any better? And I forced myself to learn every little trick in the world to reuse chips twice at once, share all the parts of chips, choose the right chips to have the minimum count, the minimum cost, and this just became my life.

I'd go to sleep thinking, is there a way to get this one computer down from 78 chips to maybe 77 or 76? I'd sleep, and I'd wake up in the middle of the night, dreaming, and I'd have answers. This was how I lived my life. It was so important to me, and I'd do the same thing with math problems from school. I was really good at math, winning the math awards in my schools.

And I never thought I'd have a job designing computers. I didn't think it was a job. I didn't think it was a career. When I got out of high school, I thought I'd be an engineer, electrical engineer. I told my father I'd be an electrical engineer first and a fifth grade teacher second, and engineers designed the analog stuff of the old days, the stuff that actually worked better than trying to sync voice and video in this digital world. That's why we people who brought this digital world to the world should be forced to live in it. (laughter)

And so, anyway, so here I was, designing these computers, you know, and making a thing out of it, and I thought, when I grow up I'll be designing radios and TVs. And somehow my love for digital drove my life. And in college, you know, first year of college, Introduction to Computers is a graduate course then, and I got an A+ in it. You know, but I wrote every program I could ever write, and I didn't know they had a budget. You're in a programming class, you're writing programs. No. I ran the class five times over budget, which was kind of like $50,000 today, more than out-of-state tuition. So sometimes you do things that are really good in your brain and you get criticized for it, you're doing the wrong thing. That happened a few different times in my life.

So, anyway, I sure came to love it. I told my dad, end of high school or maybe first year of college, I said, "Someday, I am going to own a 4K Data General Nova computer." Why 4K? 4K is the minimum you needed to have a computer language where you could type programs in on a keyboard—teletype in those days. Oh my gosh, and my dad said it would cost as much as a house. I threw down the gauntlet: I said, "I'll live in an apartment. I'll give up the dream of owning a home to have my own computer." Because I knew how they worked, and I wanted one so badly. And that dream stuck with me for life.

These are core values, you know? My core value to teach fifth grade I eventually realized by teaching it for eight years straight, you know, 200 hours per year, per class, and I'd have multiple classes. No, this was a big thing in my life, to know who I was and stay that person for life. You know, I'd worked out a lot of my own personal philosophies and values. My father helped with that. My father never said, "Here's how you should react in a certain case." Maybe it's social. Maybe it's political. Maybe it's engineering. Maybe it's scientific. Here's the range that people go in their thinking, and let us choose. We were to choose. He didn't force his values on us. And I kind of always decided, you know, the

ends always sound too dangerous; I'm going to stay in the middle my whole life. And it helped really guide me, these philosophies.

And the key one of all that came to me was one day reading an article about a rich man trading $50 million companies, [Sumner Redstone], whatever. He worked for Viacom. And I thought, do you want to be that person that rich, being able to do all that? And I sat back and I said, no, if I were on my dying day, I'd want to be laughing about a prank my friends and I pulled. That's the person I want to be: enjoy the feeling of life. And I said, life is not about accomplishment; it's about happiness. How happy are you? Sure, and if getting very wealthy makes you happy, that's your way to happiness, but my formula for happiness was things you feel, so happiness equals smiles minus frowns. And this is a formula that I used all the way even through everything I've ever done in my life, including digital design. But do the things that make you happy, include a lot of jokes with your workmates, when you're in work, when you're doing something productive, homework at school, even. Find a way to have some joy in it, and enjoy it. I mean, I would take home math problems in high school, and we'd be assigned to do the odd problems, from one to 37. I would do every single problem, all the way up to 50, at the end of the chapter. I mean, I just loved it so much. If you love something, that's where you come from: your passion.

And to get rid of frowns was the harder one, but I learned real quickly: don't try to argue and convince somebody of your logical reasoning. They have their own logical reasoning that might come to a different answer. I'm back in Vietnam War days. And I just said, you know, not worth arguing. Don't argue. You don't need to argue. I'm good in my head, you're good in your head, and we go on. If something bad happens to you—you know, you fall down and get hurt, your car gets dented—don't look back and try to blame things in the past, because that's frowns. That's unhappiness.

My formula: happiness equals smiles minus frowns. You don't want the frowns, so just say, okay, what do I do? My dad always said, "Be constructive." What do I do to be constructive? You fix your car. You go to the doctor. You put on a Band-Aid, whatever it is. And so it's more futuristic thinking. And it really helped me get through a lot of designs, and I never had to worry about this is critical, this is my whole life, this is my career, or anything like that, because I just grew up being a person that didn't have worries.

ROGER: Well, you are, by definition, someone who has fallen in love with the process and fallen in love with the journey, and are not necessarily end state–minded, which I think is wonderful, being in the now. Steve, when I think about innovation, you know, the story of you selling your calculator to get the funding for Apple, but the question I wanted to ask was about sort of the Apple II: what do you think—I know you know the answer to this question, but explain to our audience what was the groundbreaking innovation that happened with the Apple II, the technology. And then, second part of this question, then the arc that Apple went on. And I talked about your involvement with Jef Raskin and what happened with Macintosh, and managing the ecosystem, and focusing on the person using it, not necessarily the technology, and sort of that intuitive ease of use. So start with

the innovation around what was the inflection point in the world that happened with the Apple II, and then as it relates to the standard that was set by Apple around just making things intuitive and easy, and how you went about that process, because other companies took other paths, and it's more difficult to work with them than it is to work with Apple in some cases.

STEVE: Sure. The day I met Steve Jobs. He was 16 years old. He didn't have albums, and I brought him to my house, and I showed him all the Bob Dylan albums. Strange liner notes that he'd written or been interviewed for, strange lyrics in the songs, and it became a huge part of our life, our young life. Steve Jobs zero, before the known part of Steve Jobs at Apple, and we were really good friends doing things like that for years. But Dylan had this magic coming out of his head. How does a human being think up words like that and lines like that and themes like that?

Well, I was like that for about 10 years in my life: everything poured out of me. Magic. I go back and look at my own work, and I'd say, how the heck did any human being ever decide to go think that way? It was, like, so different than other normal things. So I was not an engineer only; I was an inventor, as well. Come up with that idea, go test it out, make it work, figure out ways to do things that haven't been done. And so that was just a standard part of my life.

Now, the Homebrew Computer Club started, and Steve was far away, and I suddenly got the formula in my head to build that computer I always wanted: a useful computer, where you could type in programs, and see the results on your display. That's like a printer on your TV. Because you owned a TV, it was free, and you just had to know enough to take the chips and put signals into a TV. I was a TV engineer, too. So I took that down to Homebrew Computer Club, and I wanted to help start a revolution where everyone could have a tool that would make them more powerful. I was one of, you know, 250 people that met every second Wednesday. I passed out all of my schematics, all my designs, to everyone at the club, and I helped some of them even build this computer.

Then Steve Jobs came into town and he saw it, and it's not like that movie where he found me in a basement and took me to a club. He'd never been to the club. I'd been there every day since it started, and I took him down to show him the excitement. And he said, "We should start a company." Well, that first computer, the Apple I, became the Apple I, it wasn't even designed by me as a Steve Wozniak computer; it was a Steve Wozniak terminal to connect to the ARPANET, the forerunner of today's internet, when there were only six computers on the whole ARPANET: UCLA, UC Santa Barbara, MIT, and some others. And I modified it quickly by putting a microprocessor on it, which is brains, and some dynamic memory, which is affordable 4K memory, and made that computer.

And then, of course, I had to get permission from Hewlett-Packard. I would never leave that company. I loved my company. I was designing the hottest products in the world: the handheld scientific calculators. I had built these little machines with switches and lights that looked like computers you see in movies. I'd built one five years before. Actually, the day I met Steve Jobs, I was building one. And that's what everybody else was trying to say: here's the computer you can afford.

And there were switches for up is one and down is zero, and up is one and down, and all this ugly, unhuman stuff. I was past that. I was at Hewlett-Packard where if you press a 5 on a calculator a 5 pops up in the display. And I wanted computers like that, and by now I had my terminal you could type to, so I built my own little computer to show off.

But before we ever shipped that Apple I, once Hewlett-Packard turned me down five times—I wanted them to build the personal computer, and thankfully they turned me down because Hewlett-Packard back then only built equipment that engineers used with dials, and they would have made a boring computer. Me, I was into fun and games. I had designed Breakout for Atari. And I said, what if these games someday were color? The Apple II computer was the first time ever that arcade games, a whole industry being started by Atari Corporation, from Los Gatos, California, where I live now, that whole industry, the Apple II was the first time arcade games were color, black and white moving to color. Just imagine if games were only black and white, and that was still a step up from when games were only text, little lines of words you could answer.

And, secondly, the Apple II computer was the first time ever that arcade games were software. A nine-year-old kid could write a program moving colors on a screen and make a good game in one day. Before that, it was a skilled engineer like me putting a thousand wires and a hundred chips in my brain and hooking them all up and getting all the signals right, and taking half a year to a year to make a working game. So this was a huge step for games.

It was a fun machine. And we showed my Apple II computer, which I had done everything on it myself, all the hardware, software, we showed it to a couple people before we ever even delivered an Apple I. We knew the Apple II was the machine that would make an industry and a company, and not the Apple I. And the Apple I was a little holding spot, you know. We had a little partnership.

People think we had a company in a garage. We never talked about what a computer might have in a garage. We never did any engineering in a garage. We never did any drafting on the drafting tables. We never did any of the technician work, hooking up the wires, solving it, looking at signals and figuring out what's wrong and fixing it. We never did any software. So we didn't have telephones or desks. The garage was a tiny, little stopping point to deliver some computers to the local store for only a brief period of time, rarely more than one person in a garage. So it wasn't this idea. You really had a company, like Hewlett-Packard did.

So then this Apple II computer was going to be big. Other people recognized it. I mean, everywhere I went it was like half the chips of the Apple I, 10 times the performance in every way, and, as I mentioned, those color game features, and it was just unbelievable. One portion after another after another, I would cut five chips down to two chips down to one and a quarter chip. I mean, I just played all these tricks. And I didn't do it to start an industry. I didn't get involved with Apple to start an industry or a company. I didn't even want big money; all I wanted was other engineers. I was shy. I wanted other engineers to look at my designs on paper and say, "Wow," to appreciate, you know, how my mind was working. That's what I wanted, and certainly got it.

Well, the Apple II computer, you can't start an industry without money, and the trouble is there was no industry. And Steve Jobs wanted to be important. You can't be important without a company that makes money, and makes tons of products to deliver to people. And so he did all the business thinking, took us searching for money with existing companies, with venture capitalists, and he ran into this angel, the perfect angel, Mike Markkula, who wanted to do something in electronics. He was young still. He wanted to do something, and he felt that we were on what might be the next big thing in electronics in the world, and that's how you become a billion-dollar company in five years. And I thought he was just using big words, big numbers, and you can do that if you're successful. So at first I said no to starting Apple and taking the money, because I only wanted to design computers, and I can do that moonlighting like I had for a year already, designing two computers, lots of input/output and things, and I could still do that, and I didn't need to start a company, and if I started a company, I'd get kicked out.

And finally a friend taught me: you can start a company and stay an engineer for life. You don't have to go into business, where people are talking behind your back and trying to push you out of your job so they can get it. And I finally turned around and said yes to starting Apple, and it was a very good decision for everyone.

ROGER: And you're still there, right? From my understanding. Are you still an employee there? You still get your employee discount?

STEVE: You know, that magic was pouring out of my brain for 10 years, and I appreciate it so much, and Apple II was the best thing I'd ever do in my life, really. And I remain so loyal. That company is everything I am. So, yes, I've always received a paycheck, every single week since we started the company. I'm the only person can say that. I mean, they talk about how I left a couple times. Well, I did: I went out and did other things, other little start-ups on the side, but always had my Apple salary and whatever the employment agreement was when you start a company. (laughs)

ROGER: Well, we're very lucky to have you there. I want to touch again on the ease of use, the intuitive nature of the Apple ecosystem, the role that Jef Raskin played specifically, maybe even through a little bit of resistance, from what I gather. But it's the touchstone and one of the key, defining things that we all love about the technology. I got a new iPhone the other day, and when you turn it on it asks you, "I found your old iPhone; would you like me to move everything over?" And it uses the words that are intuitive and self-evident. How did that start? Because that's antithetical to sort of the industry in general, and philosophically it's been one of the big points of differentiation. Would you talk a little bit about that?

STEVE: I'd love to. I'm glad you brought up Jef Raskin. And even before we met Jef, I'm sitting there thinking, oh my gosh, you know, a computer should act in human ways. Type on a keyboard like a typewriter. You see it on your TV like a printout. It was very much a human way, instead of all these switches and lights and toggle them and put in a bootstrap program, ones and zeros in the

memory, and nothing you could even afford, really, to do the easy job. So it's kind of making these things familiar to humans, is easiness.

Jef Raskin came, talked to Steve Jobs and I, and, believe it or not, this was actually just outside the garage, just outside the garage door. And he explained that you could build two computers with different chips and different connectors, but they'd both do the same amount of work. But one of them, if you put a lot of your work in and your effort in, to make it obvious and easy to use—Don Norman, who worked at Apple for quite a while was an expert in this—you make it easy to use and a human being can walk up and get a lot more done, and understand it, and feel better about it, and be more motivated. And that stuck with me.

Now, Jef joined us and ran publications, and we made a rule: if the engineers came up with a bunch of new features, but the publications department couldn't describe it to normal people, couldn't put it into easy description that was understandable, they had the right to rule the feature out. Couldn't go into the computer or the product. No, it had to be understandable by humans. Jef was just amazing. I mean, he just wanted things to be intuitive. And when we got to the Macintosh, and the Lisa computer, the first mouse-based computer, he said, "It's intuitive." What's intuitive? Well, you want to do something, what do you do? Do you memorize it? That was the older approach, even the IBM DOS approach. No, you look at some words on a screen that might suggest what you want to do—file, edit, things like that—and then you have little icons that pop up, and an icon of a paintbrush paints, turns your cursor into a paintbrush. This is just so intuitive and logical, that you don't have to memorize everything; it's just sort of obvious to you.

And to this day I wish that all of our technical equipment were more intuitive. We took a huge step there at Apple, but everything kind of goes back. You know, and you can't create all the apps and the app writers, and so there's a lot of that intuitiveness. Sometimes you see a program that is beautiful, easy, it understands me, and sometimes you don't.

I started thinking about Jef Raskin's work at Apple as meaning the human or the technology: which is more important? And Jef felt you put the work into the technology to make it work in human ways. For example, you don't call a screen a screen; you call it a desktop, because every human being knows what a desktop is. And you use normal, human, understandable language so the humans don't have to modify their ways much. If that makes the human more important. If the human has to, "Oh my gosh, I'm a slave to the technology, I have to learn these procedures and these structures and do it this way," it's like the human had to modify themselves to adapt to the technology, then you made the technology more important. You can go both directions, and there's examples of both ways to this day, but I always want things to be intuitive. What I use is the word—when I use a new app or something, or an app that modified itself—is this human, more human? Meaning, does it let me live the human life?

Two experiences I had at Apple in my life really took me there. One was when the Newton message pad came out, where it was a tablet you could write with your own human muscles, and the first day

I got it—I didn't really know that much about it; I'd been off to school getting a degree—I was in the airport with my kids. I got a phone call, and I wrote a little message on this thing called the Notepad. I wrote a message to myself: "Sarah, dentist, Tuesday, 2:00 p.m." Okay, a reminder that I could look at later. How great.

And then I'm looking around for menus, like I do on a new program on the computer, and there's a button called Assist. So I tap Assist, and it opened up my calendar, Tuesday at 2:00 p.m. It put the word "dentist," and it grabbed Sarah out of my contact list. And I froze, and I said, oh my gosh, I wrote something for a human, a reminder to myself, and this machine understood what I was talking about. I said, forever, I want to live in the human world and have machines know what I meant.

From that point on, I would take my Newton message pad. If I wanted to call my friend Jim, I would handwrite the words: C-A-L-L, call, JV. And I'd hit the Sys button, and it would go beep-beep-beep-beep-beep-beep-beep. And I got myself out of the structured world, into just a thought, a human thought, living in the human world.

Now, here came Siri. My wife and I were overlooking Lake Tahoe, and she asked, "Is that the largest lake in California?" She's from Kansas. And I said, "I think it is." And I spent 20 minutes trying to find search terms to search it on Google and everywhere I could search, and anything I could ask a question, lakes in California, Lake Tahoe, size of lakes. I could never find if it was the largest. And then, just as a joke, I only had one other app on my phone. Apple didn't own it; it was a third-party app called Siri. I said, "I'll ask Siri a question no human being can answer." And I smirked at my wife, and I said, "What are the five largest lakes in California?" And one, two, three, four, five, and Lake Tahoe was number three back then. It's two now by the way they judge it.

What a shock. This was another total internal shock. I wonder if it can do math. I said, "What are the prime numbers greater than 87?" And it started a list, starting at 89 on up, the way a human would. It acted like a human to me. That's what I call humanist, is if a machine acts like it's a human who's a friend, helping me. And forever, if I can, I don't want to learn the structured way to tap things on my phone; I just want to speak commands from Siri and get it done. And you have a thought, you speak it, simplest, most direct way. And that's the humanist that Jef Raskin was really getting into that we had to put into computers once we had the technology, you know, low enough cost memory and storage and all.

ROGER: Well, it's a wonderful story, and we're all very thankful (laughs) that it is intuitive, as it is for those of us that are consumers of those products. We do, as you know, Steve, have a number of our investors on the call here from Fidelity, and I think from their perspective, if we've got access to one of the greatest innovative minds ever, I would be remiss if I didn't kind of ask you a couple of questions. I know you don't like to prognosticate, so I'm going to be a little more specific. If you are an investor, and you're looking at companies that have great engineers—not good engineers but great engineers, because I know you draw a distinction there—what do you look for? How do you tell? How do you kind of see that sort of angle early on so that you can kind of be thinking about

them as an investment? And are there technologies—I've heard you mention magnetic memories and the cloud and maybe quantum computing—are there technologies that are on the forefront that you know are going to make a big difference, we just haven't gotten there enough, either with enough bandwidth or enough momentum behind them? So the two questions are: what makes a great company, with great engineers? And what are some of the technologies that you're excited about coming down the pike?

STEVE: The greatness of the engineers are often hidden in a company if it's large enough, and then how do you tell? Where's the company that has not only engineers that are well trained but inventors that can think up new things, never been done, and have the passion to put them into existence? And the trouble is, as an investor, you get befuddled by levels of management, especially middle management, that is given different assignments, to make sure I get something done by a certain date for my boss, so I get the bonus, and they're less concerned about are there other options that we could do to really change this world. That gets lost a lot of times. How do you see inside? You've almost got to look for an example and see it starting. You can't really interview people.

One of the problems is, okay, you assemble a team and a company develop a project. And you need this skillset and that skillset, five skillsets, and you hire them all. You interview a lot of people, and get some people who are really good at those skills. But you didn't look into are those people going to get along together. Do they have similar personalities that mesh, or personalities that conflict? And, you know, when you've got a happy team, you're a lot more productive. Whenever I ask a young person if you like your company, if they say they like it, they like the people they're with, and if they don't like the company they don't like the people they're with. It almost always boils down to that. We don't have psychologists involved enough in the hiring process.

Also, the best things I did in my life were partly because I didn't have the resources, the money, and had to design them small enough I could afford them, but also I'd never designed them before, those particular things. I'd never worked with those technologies before, but I had a mind to put together, and wrote the books that I hadn't read on how you design a disc drive, for example, or how you do disc soft? I just guessed that this might be a way that'll work. And, really, I call it writing the book yourself. How do you find if a company has those engineers and is going to be at the forefront of out-of-the-box, new world thinking? Those are the home runs, things you didn't expect, but they involve marketing. They involve the people, what people want. What's going to come out might be a great, great product that's really good at what it is, but it just might die on the vine. It might not get noticed. There might be other alternatives that come out from elsewhere that people decide to go with. So investors usually pick large, ongoing companies for—you know, it's hard to invest in pure, raw startups. You're guessing. It's a risky investment. Big companies that you don't know they can control their markets by other means, other than just engineers, and what products you're going to come out with. Incremental: you know what to do next if you're already in position.

But ROI, the main thing is, the investor, especially if it's small and you've found some good engineers, still what they're doing, is this going to ever amount—is there a path I could see or visualize that's going to give me a return? And you also want to be aware of disruption. Companies should have disruption departments that totally focus. They don't report to the CEO. CEO has to do the important thing: make the money day to day. But the chief disruption officer should report to the board of directors and have a little group in another city that works and thinks independently, and analyzes what's coming, what might make a change, what might we do that changes the world, what are the effects, what are the possible courses, almost like the psycho predictions of the Foundation series.

ROGER: So looking for companies that even have chief disruption officers, and have organized it that way, is an interesting and positive sign that that company is committed to that development.

STEVE: Skunk works projects are often assigned by a CEO.

ROGER: Yeah. What are some of those? We talked about magnetic memories and quantum computing and bandwidth and cloud, but what are some of those areas that if you were to stand up a skunk work disruptive team, what would you have them focused on?

STEVE: Oddly enough, I'd probably focus on things that weren't necessarily worth big business, you know, any interesting ideas, and let them spend maybe some of their time, some percentage of their time—not everybody in the company—but try to run this out into something, and you'll spot if you ever hit a really big home run. But you're educating. Anybody who works on an idea of their own comes up with every trick they can, and thinking hard about it, because it represents them. You view their program, you view them. And they try to do excellent jobs, but their brain never forgets the steps they took, and the next time they'll have those steps and can work out new ones and new ones, and build upon that, so the genius of your company can go up.

ROGER: Well, I'd love to hear you talk about some of those technologies that you really think have the opportunity to be an inflection point, as it relates to whether or not Moore's law is going to continue. You and I have talked about that a little bit, but where are some of the areas that are interesting, they may not have an application right now, but you look at them and you go, that's just fundamentally different?

STEVE: Yeah, sometimes it's hard to tell. Kind of the key to every business nowadays is software, so you definitely want to make sure they have really good software people. If you were training your own kids, train them for software. Quantum computing is one of these interesting ones. I remember LaserDiscs. They were talking about it, about 10 years it took to develop and finally come to fruition. Some lower-level technologies have to just arise to make it possible. Quantum computing has such incredible promises in some areas, maybe, and we don't seem to ever get to where it replaces general purpose computers.

So I kind of like to sit back and say I like things that I see myself the path. I'm not a quantum physicist. I see the path that it's really going to be here. I want things that'll solve all problems. I don't want things that are just only a few, little, small categories, or applied to a niche marketplace. I want things that are very general, just my whole life grew up that way.

We have personal assistants now. Have gotten pretty good, but they can only understand sentences up to a certain level. They have never gotten like a real human. And you can ask real simple questions that are common in the human world, like in a hockey game who hit the winning goal, who got the winning goal. There is a method, there is a formula for that. I don't think any personal assistant will ever come up with the answer, despite the fact they've got contact with every single thing in the world. Wolfram Alpha's gone the furthest in kind of understanding like a human mind; they just don't think like minds. But I want personal assistants to improve. The better they are, better it is for us. And someday we'll have personal assistant robots—robots that actually move around. Maybe they'll even have feet and learn to balance.

We haven't really seen that happen yet, and part of the reason is think about even a young child learning to walk. That's a brain. That's intelligence, and we don't know how our brain's wired. We use the word "artificial intelligence." To me, AI more often means algorithmic idiocy, you know. Not idiocy, but it's a shortcut. It's a partial solution that works, but not in every case. Think of a self-driving car. Everybody's talking about that for the last five years especially. "Self-driving cars are coming! They can understand things. They can see other cars. They can see signs." The trouble is if there's ever one thing a little different—a human put up a sign, or there's some yellow, orange letters scrolling along, and it has words like "Detour on South Street, two exits." What computer understands what South Street is, or what detour is? It doesn't understand things in the world. It's kind of like you show Google 80,000 pictures of dogs, can recognize dogs faster than any human, but a one-year-old kid knows what a dog is. It's got these limbs that are kind of hard, and kind of soft, and they're flexible, and the dog has eyes and a head, and it decides where it's going to move. The child knows what a dog is, and a lot of our artificial intelligence doesn't know that way, never fully had artificial intelligence sitting back saying, "Hmm, what should I do today?"

So true consciousness has some possible values in this world, of machines becoming our best friends, and our best guides, and making us so much more capable, but will it come or it won't? It's very, very hard to predict. Every little example of what's called AI today, which is just like machine learning, steps that boil down to a set of formulas, watch what you do a lot and then you know you're going to probably want to do that again. Those are mathematical algorithms. We used to say that, oh my gosh, computers are smart when they beat us at checkers, but they can never beat us at chess. That would be real intelligence. No, they beat us at chess, you know. The trouble is we don't know how our brains wire. We don't even know that our memories are in the brain. You and I are having a discussion, we'll remember it. But wait a minute: where are those memories stored? There's nothing in any book on memories in the highest-level psychology courses, which I took, that says that they're in the brain, for sure. We know processing centers are in the brain. We can prove that. We can't prove the memories are there.

And I came up with an observation 40 years ago that's more accurate than in any of the books, a correlation as to where memories might be. You lose two things between the ages of six and 10: your childhood autobiographic memories, and you lose your teeth. So I was trying to point out how absurd our ideas that we know where memories are is, but nowadays if you google memories and teeth you're going to be shocked what you find. And test for Alzheimer's in saliva and gums.

ROGER: I got you. Yes, so (overlapping dialogue; inaudible)—

STEVE: Okay, and other technologies are abounding that we talk about, you know, but I feel robotics is a good one to get into when you're young. Find young people that have actually built complete robots, because they had to go through some mechanical engineering steps. They had to go through motors and the power drive and the voltages, and making sure things don't burn out. They had to put together with microprocessors and then program them, and have sensors bringing in different types of sensory information, and taking actions based on it. Somebody who builds their own robot, that's one person that had an encapsulation that knows how to make something, and that's the sort of person that someday is going to make a little robot that sits in your driveway all night long, cleaning your car, one square centimeter at a time, and when you wake up the car is cleaned, is washed, you know, and that would be such a great project, like a Roomba. Kind of like Roomba Pluses are going to come.

ROGER: Well, I love those ideas, and I'm the first one to sign up to have it clean my car. I had my teeth taken out, so I'm worried now about my memories. Do you mind—we have about 10 minutes more—if we take a few questions? I got a few questions from some of the people that are in the audience. I'll dial some of these up?

STEVE: I'd love it, yeah.

ROGER: Great. One of the things that people are talking about is what is the future of the virtual world, the virtual technology world, linked with bandwidth, and how does that work? And then the second question, if you want to bleed them together, is—it's not virtual: what is the future, from your point of view, as it relates to space, and human beings sort of interacting with space on a more regular basis?

STEVE: I'm glad to hear that question. As an engineer all my life, I never wanted to go into, oh, there's psychic domains, and you can know what another person is really thinking, and I paid attention to that a lot in my psychological studies, but I don't really like to get into that. But then you get into VR these days. What an immersive... I mean, television is an immersive world, and VR, you, like, are there. Your emotions go there. And so it's very emotional. And I think the things that grab your emotions, say, "And this is great," are the things that go on and become big in life forever. You know, when you experience it yourself and feel it, you kind of know what's likely to make it, what's not. And AR is a very different thing.

Now, for virtual, I've watched live basketball games, virtual. I'll be right under the basket, almost, and they'll dunk it. And I've watched concerts—Coldplay in Chicago, you know—and you're in different parts of the stage, and you're watching the audience, you're watching the group play, and it's just so heartfelt in me. I just hope that that world comes. And then I thought about how do you get VR like that to be real, because you've got, you know, the bandwidth to do a good video, in a narrow range. You got that multiplied 10 times around, 10 times the other way. That's like we need a hundredth the bandwidth that can do decent video to do really perfect VR, you know? And then we got speeds. We need faster processors, and the whole works. So there's still some challenges. There's still some challenges. It's not like, oh, we've just solved it once we can show one level of VR.

I love this idea of living in an alternate universe, like *Ready Player One.* When I listened to that audiobook before the movie, oh my gosh, it just grabbed me. I want that world. I want that world to exist. There's a movie out right now called *Free Guy,* and I love it. He's living in an alternate universe. He's just a program. Somehow he develops intelligence, I mean real consciousness and feelings, and love becomes a big part of the movie, even. And I love that, that there can be people on the outside, people on the inside. There was a TV series briefly called *Upload,* where you could be uploaded to one of those alternate universes. So those are some of my favorite science fiction that I ever read, and I really hope that goes somewhere. (laughs) I mean, we created it with our computers, the ability to have these imaginary worlds far beyond things. Before that, all we had was movies and books. Well, I guess we did have some, (laughs) but we've taken it to another level.

ROGER: Yeah, no, and I've been to an arcade and had the thing on, and with the massive amount of programming power, and it really does impact you viscerally, on a personal basis, and you can see how that concept could be extended to just about anything and everything, and it's an interesting thing.

STEVE: It's not just that you're watching the surface of Mars; you are there.

ROGER: That you're there.

STEVE: Yeah. Or under the ocean.

ROGER: Speaking about the surface of Mars, in a non-virtual world, what do you think about this question that is talked about around space travel, about man's desire to colonize or to make space travel a more common thing? What are your thoughts on that?

STEVE: I have mixed thoughts, because part of it is those of us—we can afford it now. We always want to explore and search and discover new things. We are curious. We're born curious, and that's part of it. But what percentage of, let's say, your wealth or what you've made out of this world should go into some of this exploration that, you know, it's pretty hard to see how conclusive it is? And let's say we're going to get to Mars. Are we going to get to Mars in a hundred years? Two hundred years? Five years? Try to do it in five years and prove something? And how much money

should we put into it? There are a lot of things in this world that don't have, you know, enough money, and they could be moving further up the economic scale to become a lot more like us. So I have mixed feelings about that.

Obviously, getting to the moon, what an exciting, great thing. And what have we done in the last 20-some years or whatever, how many years, 30 years, and what did it bring us in terms of, like, more computers in our house, more money, more of a life, more fun? These are questions, social questions that are not easily solved, answered. But there's always a line in the sand. Where do you draw the line? I'm for discovering Mars, I'm for Mars exploration, or I'm against it. That's binary. What you should do is think out how much should we put into it, and that much should go into it. Are we above it or below it? Should we put more in or less in?

So I have different feelings about that. Right now it seems to be like it's a few rich people wanting to be famous is a lot of the money going into it, to tell you the truth. Now, I'm with a company, Privateer, and we're not going off into those exploratory things. We're looking at real problems. It's kind of like you have dirty skies, you don't like it, and we have all this space junk floating around that could, you know, knock satellites out and all that, and we just want to do a good service for humanity and clean it up. So it's a limited range of things that's only good for humans, and we'll see how that goes. But it's not like trying to say, oh, we're going to the stars, and look at us, we want to be more famous. No. Our company's called Privateer. It's not NASA; it's private.

ROGER: Well, the last question I'll ask before we wrap up is: you have been an amazing role model as it relates to philanthropy, and as it relates to giving and being a part of the difference-making, and using your wealth to not necessarily double and triple and quadruple it but to actually give it back and be involved. Philosophically, how do you think about philanthropy, and would you mind sharing your philosophy with our investors?

STEVE: Most philanthropy is people that got very, very wealthy, and by the time they die they generally give a lot back, even if they were kind of not giving while they were alive. It generally winds up in a lot of good, charitable ways, you know, uses and all that. My ideas on it were very minimal. When I grew up, I formed my philosophies: you should always be giving good, help other people that don't have as much. And then when I had a lot, I gave it all away, really, to, you know, arts groups and museums and things like that when there were good people involved. Don't give it away just to give it. And I didn't ever want any acknowledgment for it, really. I never once gave money and said, "But you'll have to do this." No. It's only unlimited, you make the decisions, because I'm trusting your brains. I meet the people. You're really giving more to people to let them do something that they're capable of doing, they couldn't otherwise.

And philanthropy, it's good, and I wish more people thought of that, but even the person who just helps a young kid tie his shoe is doing a philanthropic act. You know, you're helping somebody. Teachers: teachers are my favorite people in the world—I'm married to a teacher—because you're helping younger ones that don't know as much as you. That's mentorship in business, mentorship.

Mentor people that haven't gone through what you went through, and you know some things that might happen or that they should think about. Advise them, help them.

And you mentioned me as kind of a role model. Well, as an example: that's how I want to be the best in the world. I set up my ways as an example, but I don't tell other people, "This is how you should be." I don't want to be directive. You're not my slave. I just somehow can't take my head there.

ROGER: Well, we're very lucky, Steve. We're going to wrap up. We're very lucky across three dimensions: first of all, for the time today, to hear from you, to engage with you, to listen to your stories and your wisdom, and the thoughts around innovation, as well as adapting to new types of technologies; your voice of innovation and sort of thinking about the future, and areas that we can kind of be looking into as part of our investors; and just, you know, thank you for the impact that you're made on many of our lives, as it relates to just what you've done as a career.

So this is part of our Voices That Matter series. I want to thank you, again, Steve, for the time. I want to thank all of our clients for their patronage, as well as the time that they've taken today to listen to us. Please take the opportunity to provide some feedback, if you get a chance. This is for you, to hopefully help continue to educate and inform. And I've been super lucky to be a part of these conversations, and, Steve, I'm very, very fortunate to have had the time to spend with you today, and we really, really appreciate you taking the time and sharing your thoughts with us. Thank you very much.

STEVE: Thank you very much for knowing so well who I am.

ROGER: Oh, it's my pleasure.

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