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A GLIMPSE INTO THE FUTURE

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Sometimes someone expresses what is on my mind so well that it is simpler and easier to just send you their writing. The following is an excellent example of just such a time. This is from John Mauldin, and at the end of the letter you will see a link to his writing if you'd like to hear more. These are exciting times for the world, and to be an investor. What is coming may be even bigger than the internet! Here is a sneak preview.

We are in an era of accelerating change, moving toward a future that will be profoundly different from the past we grew up in. But what will the nature of that change be? What will the future look like? For the last 7 days I have been in an executive program designed by Singularity University (www.singularityu.org) to give some insight into that complex question. We looked at a number of technological fields, lectured by experts assembled to give us some idea as to where current research is and to where it is going. We visited some of the cutting-edge companies here in Silicon Valley.

I, Robot

I think the positive surprise takeaway (for me at least) was how far we have advanced in artificial intelligence and especially robotics. Artificial intelligence has been promised to us for decades, and has been a disappointment for so long that I have consigned it to the dustbin of my research. Ditto for robots. I mean, seriously, if the Roomba (a glorified vacuum cleaner) is the best we can do after decades of work, how are AI and robots going to change the world? This is hardly the world that I grew up reading about in Isaac Asimov's brilliant *I, Robot* sci-fi series some 40 years ago.

It is all well and good for a single-purpose robot to be designed to make a spot weld on a car, but a general-purpose robot seemed a long way off. As far as AI goes, I am reminded of the old joke about a young geek who specializes in AI sitting at a bar, and this gorgeous blond comes up to him and they begin to talk. One thing leads to another and they end up in her room, where he proceeds to spend the entire night telling her how good things are going to be. AI has been a lot of talk for decades, and as with our geek, not much more.

The robotic sessions were led by Dan Barry, a three-time astronaut and veteran of many space station adventures (as well as appearing on *Survivor!*). What I saw onscreen and heard about has made me rethink my doubts about robotics. There are significant strides being made in mobility and utility in robotics. I saw robots walking on four feet through very difficult terrain, on ice, and up stairs. Robot "hands" are a lot further along than I had thought. Mobile robots on wheels, and walking balanced on two feet, are working today.

The ability of robots to recognize their surroundings, to differentiate between a table and a glass on the table (which is a very difficult thing to program), to pick up the glass, etc. is advancing at a fairly good pace. Dan is an enthusiastic advocate, and it was

easy to get infected with his vision, but I can see a robotics industry in the 2020s actually having some significance in the US and world economy. We explored all manner of potential uses for robots, some with more economic potential than others. I am often asked where the jobs of the future will come from. It may be in robotics.

I was particularly drawn to the personal assistant robot. It is actually plausible to design a robot to be the "maid" in a home, to be able to purchase groceries, to assist the elderly, etc. These are the repeatable types of tasks that can be programmed and learned. We may only be ten years away from a nascent and powerful new industry. Now, this is not the robot of *I, Robot*. It will not have intellectual conversations with you. But it will respond to voice commands and clean up, put away toys, etc. Cooking, however, other than microwave foods, is a LOT harder. You will have to make your own omelets for a few decades.

The Mauldin Test

When (if ever) do we get computers that are self-aware? Alan Turing proposed in 1950 what has become known as the Turing Test of a machine's ability to demonstrate intelligence. It proceeds as follows: a human judge engages in a natural-language conversation with one human and one machine, each of which tries to appear human. All participants are placed in isolated locations. If the judge cannot reliably tell the machine from the human, the machine is said to have passed the test.

One participant suggested that in the future, as we get closer to true AI, computers should be tasked with designing the next generation of AI and computers. I pointed at that if we were to do so, then the Turing Test might not be the best way to determine if we had true artificial intelligence rather than just extremely sophisticated programs. I proposed the Mauldin Test. When a computer tells us that it no longer wishes to program a smarter computer, we will have arrived at the point of self-awareness and survival instinct. I suggest that is true AI. Just a thought.

Who Stole My Nanotech?

Ralph Merkle regaled us with the promise of nanotechnology to make anything and everything. Very tiny molecular machines would assemble all manner of things, from roads and homes to furniture to computers. The problem is that this was pretty much the same speech he was giving ten years ago. Not much progress has been made in the ensuing decade. This was perhaps the most disappointing note at the conference for me.

Let me differentiate between nanotech and nanoscale. Nanotech is the ability of very small machines to build useful objects one atom and molecule at a time. Nanoscale is the technology that creates very small objects to do useful things. An example would be carbon nanotubes, which are proving to have all sorts of useful properties.

There is very little money being put into actual nanotech research. We are at least two decades and hundreds of billions away from Merkle's (and Freitas' and others') vision, if even then. It is still in the arena of pure research, far from any potential commercial application. And there does not seem to be a lot of research in the field.

Nanoscale, however, is a different story. Batteries made from carbon nanotubes hold tremendous promise for better storage (by 400 times less weight per watt output). Filtering of seawater to produce fresh water, increased computer speed and power - there is a long and rapidly growing list of nanoscale advances.

If we ever do get actual molecular nanotech, it may look more like biotech, as we slip in on nanotech from the side. After all, combine a few cells and you eventually get a human being. For some, this is the path to robust nanotech.

Water, Water Everywhere, Nor Any Drop to Drink

And speaking of water (above), I was hoping to hear that we were further along with the cheap purification of water. I queried several venture capitalists, who see literally thousands and thousands of business proposals. While lots of people are working on it, they are aware of nothing on the near horizon. Water may be my #1 concern about the future. It is an intractable problem and one that must be solved. There is Microsoft- or Google-type wealth awaiting the team that creates an inexpensive way to purify water. Water management will be a major issue in the future. There are those who think we will go to war over oil or energy in the future. I rather doubt it. Water rights are going to be the issue that will divide nations and peoples unless we can find new technologies to create cheap supplies of fresh water and move it to where it is needed.

The Promise of Biotech

Ok, I am on record of late with my view that biotech is going to be a bubble in the latter part of this decade. I am actually starting to invest in smaller-cap biotech companies that hold what I think is significant potential intellectual property. In conversations with my fellow attendees, I think the consensus is that biotech holds the most immediate promise for transforming our lives.

A little background. The human genome project was launched in 1990. It cost \$3 billion. At the time, detractors said it was a waste of time, as it would take a thousand years - and they were right, if you assumed then-current technology. It actually took only 11 years (to 2001), as new technologies were constantly invented. Craig Venter started Celera in 1998 and finished in a dead heat with the government for a fraction of the cost, at around \$300 million.

Where are we now? Ray McCauley of Illumina told us of a machine they make that can do the entire human genome in one week. The cost of the machine is \$750,000. He predicts that by 2013 the cost of doing your personal genome will be around \$100, and in the future the cost will be as little as \$1.

A prize has been offered for the first team to sequence 100 human genomes for \$10,000 each in ten days or less. The \$10 million USD prize, donated by diamond prospector Steward Blusson, will be claimable until the deadline of 4 October 2013. Many scientists around the world think it is highly likely the prize will be claimed before the deadline, probably substantially before.

Moore's Law says computing power is doubling every few years? That's so slow and old hat by biotech standards. Genome "power" is doubling every six months. It will be routine for you to get your own human template in a few years.

Those expensive toys that do your genome? Jun Wang (for some firm) in China bought 128 of them. That is the equivalent of being able to process the entire NCBI genome databank every 15 minutes. Although Ray would not say, I got the impression the Chinese simply opened their checkbook and said "How many will you sell us?"

Put this into context. Arguably one of the true US experts on stem cells, Mike West of Biotime, is also going to China to do a joint venture with the leading stem cell researcher there. They will be in human trials soon. (It's the same story with International Stem Cell Research, which is going to Russia.) Mike lamented to me over dinner that he could not get the trial speed he needs here in the US. There are a lot of other areas of research that are going offshore, too. Biotech is an area where the US has a clear lead today. We are in danger of losing that. Someone at the FDA needs to start a program that can keep up with the warp speed of change in the biotech world, or watch our lead go to the rest of the world, which is quite willing to leapfrog us. For all the talk about jobs, you would think someone would pay attention here.

DIY-Bio

I don't know how I feel about this next one. It has possibilities for both good and evil. Do It Yourself Biotech (DIY-Bio) is becoming a real movement, akin to the movement created by computer nerds in 1975, looking to build their own personal computers. But the real difference now is that this time they are connected by the internet.

The movement is just what it sounds like. The equipment and technology to do genetic experiments is getting cheaper and easier to access. Literally, some people do it in their closets. Want to drop a duck gene into a pig cell? That could be fun. Do you get a pig that can fly? But you can also test the water ecology around you and do other quite socially useful things, and even have a chance to stumble on a real advance. One teen group in New York recently bought a lot of fish from various restaurants and stores. Their genetic testing determined that 35% of what was sold as a particular type of fish was something else. Just cover it up with sauce and who can tell?

I like the idea of ten thousand people randomly working on solutions to real problems. But, and this is a big but, playing with genes seems a little problematic to me in a non-lab setting. The presenter pointed out that there are all types of really bad bugs out there, and the human race has survived, but somehow that did not allay my concerns.

The next presentation was from Special Agent Edward You of the FBI, who told us that the FBI is paying attention. That made me feel better, until he basically said they were not sure what to do. We can't dial back the clock, but some self-policing mechanism needs to be set up. As one person pointed out, we require all sorts of licenses for people who want to dive into the ocean. Increased complexity (diving into caves, for instance) requires additional licenses.

I am generally your basic libertarian. Let people do what they want to do - but I think I draw the line here. Access to equipment, materials, etc. ought to require some sort of license and some awareness training. Call me old-fashioned, but just as we don't let kids randomly experiment with uranium, maybe we should think about how we go about playing God. Don't get me wrong, I want people experimenting and pushing the edges. I just want someone supervising the sandbox.

Random Takeaways

OK, the next few pages are going to be short paragraphs from my notes, with no real connections among them. Very stream of consciousness. Take a deep breath and dive in.

The major cost of biotech is people. China has cheap people, and that may give them an advantage.

In regards to the DIY-Bio movement, one of attendees behind me said, "OK, does this mean in the future we buy 99-cent bio apps for our iBiophone?" Think about that for a second. Just a few years ago, the thought of 100,000 iPhone apps for a few bucks or even pennies or free seemed ridiculous. Now it is commonplace. By the way, I met a young kid from India. He has an app to turn my letter into a very easy iPhone app and is also programming for the rest of the phone world. Watch for me on your phone in a few months. It is indeed a brave new world.

The theme of the conference was accelerating technology. Things are going faster and faster. I had a thought. Our bodies can take only so much acceleration before we pass out. Will an increasingly fast world have the same effect on our minds? Is there a limit to how much change we can adapt to? Just a question; not sure of the answer.

Greg Papadopoulos, who is the Chief Technology Officer of Sun Microsystems, gave us his thoughts on the breakthroughs that are likely to happen and will change the world as we know it. New approaches to energy efficiency are on the horizon in 5-10 years. We will see a major breakthrough in memory, which will make the ability to remember (store) things really cheap. He speculated that there will be a new energy technology that will come out of left field to completely change the energy equation. By the way, this prediction showed up several times, from a variety of speakers. (I must admit that is also my personal prediction as well.) Greg thinks we will have silicon photonics by 2020 (think faster, more powerful computers). Quantum computing is way out there, but biocomputing may be here in the mid to late 2020s.

Steve Jurvetson, the #1 most influential geek (according to *Wired*, I think) simply blew us away. I would like to tie him to a chair for five hours and find out why he invested the billions of dollars in the scores of companies he has helped launch. He is focusing on clean tech, as is a lot of Silicon Valley. He sees 5,000 business plans a year. He talks about how we are soon in for Perpetual Future Shock. There are 6×10 to the 21st microbes in the ocean. There are microbes that only exist in certain parts of the ocean. We have only begun to explore the world. It is going to take a long time to switch to renewables. Maybe by 2030. He is blown away by how many incredible ideas there are. This is a guy who did his EE major at Stanford in 2.5 years and was #1 in his class. Intimidatingly smart.

As an aside, someone mentioned that at the TED Talks a few weeks ago, Bill Gates made a major commitment to nuclear energy. Did you know that the nuclear waste we already have could power the US for centuries? The technology exists to use it, as France has done for a long time. If someone truly thinks the US should be energy independent from foreign oil, this is the path. And it is green! Why not government-guaranteed loans for nuclear power and a requirement that every state or locality find a place to put a nuclear plant in their area. Pick a locale. If you choose not to put one "in your backyard" then you pay double for your power, which makes the power for the areas that choose to have nuclear plants free! That would attract some voters for nuclear plants. We need to stop sending money to the rest of the world for oil. Now that is stimulus you can believe in! (OK, off my soapbox.)

Another speaker saw potential game changers in low-cost photovoltaics and a smart grid. (Let's hope he's right!) He also speculated and laid out the technology to use CO₂ as a source for fuel. Basically, you take CO₂-emitting sources and use them to feed biofuel farms. Seems plausible.

Christopher deCharms, CEO of Omneuron, blew me away. Seems they can recognize patterns in your brain when you see certain (simple) objects. And they are teaching patients to control certain regions of their brains that have to do with pain. They are having some success, although he stressed that it was early and the tests were rudimentary. That aside, that we are even potentially in that world is amazing.

Jason Bobe from the Personal Genome Project at the Harvard Medical School talked about how they intend to first publish (publicly) 100 personal genomes and then go on to 100,000 in order to create a database for researchers to use to find correlations between certain genes and diseases. I plan to volunteer to be part of that initial 100, if they will take me. I really don't care who knows my genome, and if it will help move the science forward I am more than ready.

They are also moving beyond the human genome. They can now "sample" your blood to see what kind of exposure to certain diseases, metals, cancers, etc. you have had and then relate that to your genes. That is going to produce some very powerful and controversial results. But what we learn is going to give us clues to how to fight all sorts of diseases.

Jason noted that people who participate have no guarantee of being anonymous. It seems some young man a few years ago, upon hearing that he was the offspring of an anonymous sperm donor, did some research and found out who his father was. "Surprise! I'm your anonymous son!"

In the future, the world will get turned on its head. Instead of 15 minutes of fame, you will only get 15 minutes of anonymity.

The day before something is seen as a breakthrough, it is a crazy idea.

One guy was asking for dollar bills and other small foreign currency. They are doing DNA samples to see where and how many people have touched a particular dollar bill. In the not too distant future, you'd better be careful who you pay with cash if you don't want to be traced.

Dr. James Canton gave a very interesting talk on the future of the internet. He predicts that within 3-5 years we will live in a blended reality. Everything will be connected. The internet will become self-assembling. In the near future, information will find you rather than the other way around. Future networks will mimic living ecosystems. Web 3.0 will be the Collaborative Web. Not human to human, but human to machine to avatar to network. I am not sure what that means exactly, but he was quite convincing.

Information that finds you? Will there even be a need for me in the future? He too thought the really big surprise in the future would be a new source of energy, not to mention a new search topology with more predictive analytic search.

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