

Jurvetson: Writing the Code of Life

There aren't many investors as sharp, quick or multi-disciplinary as Steve Jurvetson, Managing Director of Draper Fisher Jurvetson. His firm is a leading venture capital firm with affiliate offices around the world and one of the most active energy and clean-tech investors. Steve was the founding VC investor in Hotmail, Interwoven, and Kana. He also led the firm's investments in Tradex and Cyras (acquired for \$8 billion), and in pioneering companies in synthetic biology and molecular electronics. Previously, he was an R&D Engineer at HP [HPQ], where seven of his communications chip designs were fabricated. His prior technical experience also includes programming, materials science research and computer design at HP, the Center for Materials Research, and Mostek. At Stanford, he finished his BSEE in 2.5 years and graduated #1 in his class. He also received an MSEE and MBA from Stanford, and serves as Co-Chair of the NanoBusiness Alliance and President of the Western Association of Venture Capitalists.



Steve Jurvetson

Josh Wolfe: The late science fiction author Sir Arthur C. Clarke once said: "Any sufficiently advanced technology is indistinguishable from magic." What's some magic you've seen lately?

Steve Jurvetson: Some of the most interesting magic I've seen recently is in the domain of genetic alchemy, where you can change one organism into another by swapping DNA. We are on the cusp of being able to write the code of life as if it were a poem or computer program. That gives us a whole new set of capabilities, in what I would call a second generation of industrial biotech, where we don't just cut and paste from nature, but we actually write code from the ground up however we choose.

Five or 10 years ago, folks would have said it's impossible to change one organism into another by swapping out 100% of its DNA, yet this has been demonstrated in the past year by Craig Venter and his team at Synthetic Genomics. This is just a precursor to the ____ *Continued on page 2*

next step, which is putting a fully synthetic chromosome into a single-celled organism.

Have you invested in this science? How does it work?

Yes, I sit on the board of Synthetic Genomics, and we have two other investments that are also in this new generation of modifying organisms for building chemicals. They're really focused on designing systems to produce evolved organisms to do useful work. They do this by starting with an organism that naturally makes a small amount of a chemical of interest. Then, they'll analyze its metabolic pathways and cripple the organism along all dimensions except for the one they want to make chemicals. Therefore, in order to survive and reproduce, the organism is forced to evolve to produce more of the chemical that you desire. Some early work in this space by a company called Genomatica has shown a 20-fold improvement in yield from this directed evolution technique.

What's the business case for developing highly advanced technology to produce what are essentially commodity chemicals?

It is true that some folks are going after commodity chemicals, like fuels, where you're selling into a huge global market with commodity price swings. What they're betting on, though, is price position. Although they won't have IP protection for their end product (you can't patent ethanol, for example), they can create protected pathways to make chemicals that are far more cost-effective than any other petroleum-based process. So whether these new processes are consuming waste feedstocks, or stranded feedstocks that were too expensive to ship around previously, or true free wastes like CO₂ from the air—you are unlocking value with this technology.

Another interesting aspect to this directed evolution approach, and what separates it from prior generations of biotech, is that your process can actually get better over time. In past production systems, organisms would "drift" over time—that is, they mutate away from producing the chemical you want, because it is a profligate waste of their resources and energy. But in directed evolution, you've tightly coupled the reproductive pathway of the organism to the chemical of interest, so as time goes on, even if you're not trying to modify the system in any way, the process itself gets better over time instead of worse!

How can you apply these concepts of natural selection, evolution, and mutation towards startups?

Well, in one example, I would rather bet on a population of startups—a rich ecology, if you would—to solve the big intractable problems of this world instead of a single large corporation (a monoculture). As investors, the analogy we like in startups is that new entrants generally propagate the most disruptive change. If you think about the Cambrian explosion of body plans, or the rise of mammals, these were not the organisms that were best suited for their environments—they were really wild experiments in different sorts of space and possibilities. Similarly, the startups today that are really making a difference in changing the world are a bit odd at first. They're out of the mainstream, and they're usually stressed in some strange way. They're incredibly new, innovative, and different, and the majority of them will fail; some 70-90% will probably just disappear from the fossil records of business startups entirely. But, those that do succeed are the ones that are really worth watching, and the degree of their success overshadows the aggregate loss of all the failures.

What's also interesting to me is that today's economic crisis is also a form of market disruption. If you think of a company like Tesla Motors, pursuing the all-electric car, what better time to compete with **General Motors** [GM] and Chrysler than when they're floundering on their backs! In a sense, today's crisis is like a forest fire running through the ecosystem of the economy, clearing out

the mature monocultures of the past and allowing a more heterogeneous blossoming of new startups to emerge and redefi-
ne markets.

What are some other non-obvious insights you've had about businesses?

The larger a company is and the more money it has, the less likely it is to innovate and succeed. Frankly, I believe that teams of between 3-7 people are more productive than any other size, and that's one of the main reasons that big companies cease to be innovative. This also applies to governments, non-profits, and certainly to startups.

Some of the most innovative companies give us clues though that big size does not imply big teams. **Google** [GOOG], for instance, confines many of its teams to less than five programmers to keep things very chaotic. W.L. Gore will actually take growing divisions and, at great expense, physically break them apart and move them across town so there are never too many people in one place.

So limited capital and human resources make companies more innovative. Do you think there's an analogy to caloric restriction extending lifespan?

In evolution, you don't find innovative mutation occurring at the warm core of the herd—it's the organisms at the brink of starvation that change. In microbial populations like cyanobacteria, the organisms literally switch modes from storing fat to just mutating like crazy if all else fails. They literally up their mutation rate when they're deprived of all essential nutrients. That's how bacteria learn to live in places like nuclear reactors, and I think the same type of concept is true for startups.

You have interesting personal passions in areas like rocketry and photography — how has that influenced your role as an investor?

What I do see as a connection between these hobbies and my career is that it plays into my desire to nurture and maintain a childlike mind. Many engineers and scientists have playful spirits. I think it's important to be open to new ideas and flexible in one's thinking and pattern recognition skills. Additionally, it helps not to iterate too long on any one theme or idea, and finding a little bit of diversity in your diet of intellectual pursuits can spill over into a variety of (sometimes surprising) areas. For example, in addition to photography serving as an artistic pleasure, it also serves as a mechanism for brainstorming with a huge population of people (now 10s of thousands) via a blog for those who have an interest in the quirky things I take photos of!

Ahhh, the virtue of ADD leading to IRR (Internal Rate of Return)...

Our business is a short attention span theater. I don't think we're quite at that full diagnosis of literal ADD, but on a spectrum, we're certainly tilting that way. Being easily distracted, and frankly, interested in many different things, is an asset because it helps you spot something that doesn't fit a framework. In our businesses, we like to say that we're looking for unique ideas from passionate entrepreneurs who want to change the world. That very first modifier—unique ideas—by necessity implies that you're not iterating in any one industry for too long. You're always looking afield for something new and different that might not fit the frameworks of the past.

What is a technology that you wish existed but isn't around today?

Better sources of portable power. Battery improvements haven't been nearly as

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good as they should be. Also, when I look at the globe at large, better water purification technology is needed. (Despite the fact that it's not a personal need right now, I sympathize with the planet). It seems to me like the biggest gap between an enormous market need that's obvious to all and is only going to get worse, and frankly, not a lot of innovation relative to that need.

What's your favorite book and what's the most recent book you've read?

Kevin Kelly's "Out of Control" jumps to mind as my favorite, and I think it has been standing the test of time. The most recent book I read was Seth Godin's "Tribes"—short but fun, and I recommend it highly.

What is one thing you wish that other people would learn or have a greater appreciation for?

I would find it hard for any scientist or engineer not to immediately think: "wouldn't it be great if the entire world was free-thinking and open-minded to science and rational thought, and able to look at their own non-rational belief systems with a degree of externality?" It's Pollyannaish to want that, but I just can't imagine any good geek not wanting that if they're honest with themselves. **ET**