Engineering Entrepreneurship

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I would like to start by congratulating Bill Wulf and the National Academy of Engineering for establishing venues such as this to help build and support the international community of scientists and engineers that all of you represent. This sort of community transcends national boundaries, political boundaries, and religious boundaries. It helps create value and raises the standard of living throughout the world. I think all of us participating in this community can counteract the efforts of those who are interested in building barriers and destroying international community. I firmly believe that meetings such as this are the best way to fight these other elements. I encourage all of you to take advantage of this opportunity to meet and establish collaborations with your overseas counterparts to help build stronger ties between our nations.

I also would like to thank Hitachi Global Storage Technologies for hosting this meeting. I'm familiar with Hitachi primarily through its excellent life science instrumentation, which I have often used in my laboratories. Hitachi has a reputation for building extremely reliable and cost-effective analytical tools. It is recognized as a great commercial company, but by sponsoring events such as this, it is acting as an outstanding corporate citizen as well. And finally, I'd like to thank Jim Fujimoto for inviting me to speak this evening.

Let me begin by welcoming all of you to Silicon Valley. This has been my home for the past 25 years, and I don't think there's any other place like it in the world. Thirty-three percent of all U.S. venture capital dollars are invested in companies located within a 50-mile radius, with most of those companies located just a little north of here. About $8 billion are invested locally each year, and there are hundreds of companies incorporated annually within Silicon Valley. This type of activity has been going on for 30-40 years.

I have spent half my career working at large established companies in the valley like Spectra Physics, and the other half I have been involved in venture capital public startups. I started working with four different companies, and the most recent company is Arcturus Bioscience, where I was the founder and CEO for the past eight and a half years.

I'm going to describe what engineering is like at a small company in an entrepreneurial setting. I have always been a little bit surprised how little people know about the entrepreneurial setting and what product-level engineering is like there because it is very distinct from a large company. How does it differ from doing R&D in a large company? How is R&D funded in a VC-funded startup? The financial dynamics are quite different.

VC-funded companies, small companies, are an integral and dynamic part of the R&D infrastructure in the United States. A recent National Academies study, *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future,* poses a series of questions, such as: Can investment in venture-funded startups or expanded investment in venture-funded startups reduce the impact of the demise of major corporate R&D centers, like Bell Labs and IBM? Should we clone multiple Silicon Valleys, or encourage the expansion of existing centers like Silicon Valley and Boston? Should we encourage young scientists and engineers to embark on an entrepreneurial career? Are there enough jobs in this sector? How can we best train engineers and scientists to be productive in a startup setting?

Just what is engineering? In my view, engineering knits basic sciences and society, creating effective commercial products that are of value to society. Engineering is unique. It is the only "-ing" ending department in the list of departments on the Stanford website. I think it

has that form because it really describes an action. When you look up the definition of engineering, it is, “the application of scientific and mathematical principles to practical ends.” I think that’s a very concise statement of what we do as engineers. So then, what is engineering entrepreneurship? I am an alum of Harvard Business School, and I like to quote a definition of entrepreneurship from Howard Stevenson, a distinguished professor there, which is, “The pursuit of opportunity without regard to the tangible resources currently controlled.” A little bit obscure, but basically it says you are going to go for it even though you do not have the money to do what you want to do. When you put these two together, engineering entrepreneurship becomes, “the application of scientific and mathematical principles to practical ends in order to pursue opportunity without regard to tangible resources currently controlled.”

What is entrepreneurship all about, and what are startups all about? If you plot company growth valuation versus time, there are two basic things that are part of growth. There is a transition, exponential growth phase, which is the startup phase, and then steady-state, linear growth phase that is associated with a healthy company.

Let me start by describing R&D funding in the post-startup or linear growth phase. Basically, engineering takes basic science: biology, chemistry, physics, and mathematics, (a lot of it developed at universities and government labs and also some commercial companies) and then hands it off to engineering: mechanical, electrical, chemical, and civil engineering. The outputs for this are products and commercial services that are useful to society. Society then purchases those products from companies, and this forms a feedback loop. Those revenue dollars then come back to the commercial enterprise to fund engineering and product development. If you take a look at how these dollars are distributed within the company, engineering typically has about 15 percent of sales, so that’s where the funding comes from for R&D. Marketing and sales has a 30 percent share, manufacturing 40 percent, profit for the company investors and shareholders is about 10 percent, and what’s called G&A and finance is about 5 percent. This defines a fairly healthy company. Typically about 10-20 percent of engineering dollars get funneled back into more research or into basic science, either within the commercial enterprises or at contracts with universities and government labs. This is the standard feedback loop for a company that’s in that linear phase. What we do as product development people is develop new products to continue linear growth so that the company can continue to thrive.

The other method of driving research and development is through tax dollars. Society funds basic science and some engineering directly through the Department of Defense, National Science Foundation, etc.

Now let’s consider the early stages, where there is actually exponential growth of the company in terms of its market valuation. During a good part of this, there’s no revenue generated by the company so there's no feedback loop coming from commercial products. How do you go about developing new technology instrumentation in this exponential phase with no commercial products? The primary goal of the engineering team in a startup is to bootstrap the R&D funding. You do this by increasing the company valuation, which is done by reducing investor risk.

This spreadsheet models the growth of a company. At zero, where you just start with a concept, you go to a venture firm and say, “Look I’ve got this idea.” They say your idea is worth, maybe $1 million, and they give you half a million dollars to show them that you can actually build something. They now own roughly one third of your company! Raising too much money early will result in having to give up even more founder’s equity, and this is usually not necessary, but is a common mistake for entrepreneurs.

The first stage that you go through in developing the product is what I call technical feasibility. This stage basically begins by taken the outputs of basic science and end by showing that you can do something useful — not usually in the form of a commercial product

but in the form of a technology demonstration. Once you get through that phase, you reduce risk enough that company value starts to increase. The next stage is product feasibility — where you take the technical demonstration that you've done and develop it into something that is not yet a product but has the look and feel of a product, which is then field tested. The third stage would be doing all of the necessary product development processes (following ISO-9000, for example) to specify and develop a commercial product. The fourth stage is product release where commercial sales begin, and hopefully, shortly after this, the company reaches a break-even point where it no longer has to raise money by selling stock to investors but can support itself through product sales revenue. You see that the company valuation as well as the total investment increases during this whole time period.

What is interesting to note is that in the exponential growth phase, the customer in this stage is not usually someone who buys your products; it is your investors in your company. There are two products – one is the commercial product that you are making, but the other is the company itself. The R&D team is also responsible for "making" the company. This is the product that investors buy by buying stock in the company, and that feeds back and once again creates the source for some basic science as well as supporting engineering. When you start a company like this, in the early stages the investment is commonly almost all in engineering and product development. There are no marketing and sales; there's no profit associated with the company and very little administrative costs. But as you go through the various stages, you start to change where you invest your dollars. Finally at the point where you have a commercial product, you begin to look like one of those companies in the linear phase. Thus, the boundary conditions on this model are correct. It starts being heavily engineering-related with about 60 percent of the investment being in the R&D group. It ends up with R&D being around 15 percent with other functional areas of the company like marketing and sales approaching the funding percentages for a company in the linear growth stage.

The fact that you are not making or selling commercial products yet is one of the major differences with a company in the linear phase. What you are really doing is making a company and selling stock, and that is how you go about funding the R&D. To illustrate this let us set this up as a model to be really quantitative. Let us say we have a goal that in five years we will have a $250 million IPO. That is, the company will be valued at $250 million in 5 years. That establishes a fixed point in time for investors. They say, OK, they can do the modeling and marketing, and they say this is a reasonable product development time and estimate of the market potential for a new product. In 5 years, we expect that if everything goes right, this company is going to be worth $250 million. What does it take for a company to be worth $250 million? These days, if you go to investment bankers and you tell them that you have revenues of somewhere between $30 and $100 million, that you are basically at a break-even point or nearly profitable, that you have an annual growth rate of 40 to 100 percent, and your total available market is about $1 billion, they will probably say they can take you public at $250 million valuation, anytime you want. Thus, what we need to do is create a company that has this type of revenue and growth, and then we will be able to reach the desired valuation in 5 years. The model I am presenting builds the company up to about a hundred people and requires roughly a $25 million investment over those five years.

The way a venture capitalist — and this is really an art form — will value a company at any particular time *t* is they will take a look at where your endpoint is. Assuming you are going to have a $250 million IPO in five years, they will say that the net present value at any time *t* is basically one minus the risk of failure times the value in 5 years. (For people in the life sciences this is effectively P-value times the projected future market capitalization.) This really determines the net present value of the company at any point in time. The main point of course, being venture capitalists, is how can we estimate what the risk of failure is as a function of time? It turns out, at least from my perspective; product development uncertainty

is often viewed as the most significant contributor to the risk of failure. That is why the valuation really follows the product development curve. Venture capitalists are usually sales and marketing people or business people and they feel they can put together a team to market anything successfully or competitively. What they do not understand is the technology, so to them that's the greatest risk — can a basic science concept actually be converted into a commercial product? As you proceed along the development curve, you reduce the risk, and that means that you end up with is a higher valuation.

The main point I want to make is that a major role of the engineering team at an early stage company is to increase the company valuation by reducing the risk of failure. This really distinguishes an early stage product development team from an engineering team at an established company. Increased valuation gives the company greater access to capital, and again gets back to the definition of entrepreneurship. When you start a company you do not have the resources to take it through completion. The reason why you do not is because the cost of capital at the early stages is way too expensive to raise all the necessary capital in the early days.

When you go out at the earliest stage, your company is worth $1 million, and if you go out and raise $1 million it's going to cost you 50 percent of your company in terms of the stock that you have. You want to delay as many expenses as you can out to the time period where your cost of capital is lower. After you release a product, raising the same million dollars will cost you only a small percentage of the company. One of the major roles in engineering is to delay expenses as long as you possibly can in order to preserve founder and early investor equity, and that is distinct from what most engineers do in the linear phase of company growth.

What happens in terms of how the money is invested? Let us say you that you get a $500,000 bonus of investment in the early stage, say with just the business concept and no products. When you get through technical feasibility, you raise $3 million, which carries you through product feasibility. When you get through product feasibility, you raise $7.5 million, and this allows you to complete product development. Working capital is another important concept and is basically how much money you have in your checking account — this is how a company pays salaries, buys equipment, builds marketing and sales, etc. Working capital is what a CEO pays the most attention to, and also plots how good a night's sleep he gets as a CEO. A natural part of doing a start up is that you do not raise money and have minimal working capital in this early stage, such that a CEO most often does not get a good night's sleep during this time period. As you move through the company evolution, more and more of the dollars get focused on the sales and marketing apparatus associated with getting you to this point. Now you are generating your own revenue. You have profitability as soon as you start to see this slope go positive, and you can continue forever.

What is a successful initial public offering? Basically, it is a market cap of $250 million. If you want to get a good investment banker in Silicon Valley to work with you, you have to have at least $250 million of market capital, or else they are usually not interested. You float about 20 percent of this $250 million as the investment you offer for public exchange. The $50 million becomes part of the working capital that you have so your CEO sleeps better at night. If you go through and look at the return on this investment over four to five years, for an early investor it is a return of about 30x, which is good but not great for a high-risk venture capital investment. A late investor comes in and can get about a 7x return over a couple of years. What happens to the founders? The founders start with splitting the company with the investors, and they end up with 15 percent of the company and about $40 million between the founders and the employees. During this whole cycle, about 60 percent of the venture funding goes into product development. That is really the engineering investment of the $25 million raised. Sixty percent of that goes into product development, and the rest goes into marketing, sales, and other things.

Getting back to this definition of entrepreneurship, which is the application of scientific and mathematical principles to practical ends to develop a product to pursue opportunity without regard to the tangible resources currently controlled. In the early stages, one deliberately does not want to have the necessary financial resources to finish the job. If you did, you raised too much money, and you have diluted the company much more than you needed to. Sufficient money is raised at each step just to reach the next milestone, which when reached, lowers the cost of capital for the next round of financing. Following the pattern again just maximizes the overall return for employers and investors.

During this whole process, there are two separate functions of a successful engineering manager. Because you start with the minimum number of engineers, you do not have the infrastructure necessary to fully develop products. You build the engineering department as you go. This distinguishes it from an established company — you do not have the structures present, you do not meet ISO-9000; in fact, you develop the ISO-9000 compliant processes as you go along. This is part of the fun of being on an engineering team in a start-up — you are building infrastructure as you go along. One of the benefits of the early 1980s, when Japanese companies were introducing just-in-time processes and competing very effectively with U.S. companies, was that it gave rise in both Europe and the United States to the ISO-9000 movement. ISO-9000 basically codified how you went about building an infrastructure. It did not tell you what the infrastructure should be, but it provides the outline, and most serial entrepreneurs come in having done ISO-9000- compliant infrastructure-building several times. This was not the case back in the 1980s when everyone had to do it in their own catch-as-catch-can way. Now most people who are in this business know ISO-9000 and can build rigorous transportable and transparent product development infrastructure as they go through. Again, the team develops simultaneously the product and the product development infrastructure. An engineering team is developing both the company for the investors as well as the commercial product for the ultimate customers.

The other thing that an engineering team does — which I certainly enjoy doing as a part of these startups — is establish the corporate culture. You define the relationships between engineering and the other functional groups within the organization — marketing and sales, manufacturing, and finance. In an established company those relationships have already been defined.

To conclude my talk let me mention once again the *Gathering Storm* publication I mentioned earlier, which compares the different contributions from the various ways that R&D gets funded. If you look at federal funding including all of the standard government agencies, the feedback loop through tax dollars is about $75 billion per year. Established companies provide about $150 billion worth of R&D dollars through their products with 15 percent of this feeding back to basic science. And what about venture startups? Total investment throughout the United States is roughly $25-30 billion per year, and about 60 percent of that actually goes into designing and building products; therefore, about $15 billion is in this feedback loop supporting engineering at new companies.

To answer some of the questions that were posed by the Academy report: Will the investment growth in venture-funded startups reduce the impact of the demise of major corporate R&D centers? I think it helps, but the amount of dollars that get invested by established companies in basic science is just so much higher. I do not think that this can begin to replace what was at Bell Labs and IBM Centers of Excellence that now are not as dominant. Should we encourage our young scientists and engineers, people who are at universities, to go on to an entrepreneurial career path? For people with the right personality, there certainly is an upside reward. I think there are enough jobs in this growing area, particularly here in Silicon Valley.

Should we clone multiple Silicon Valleys or encourage expansion of existing centers of startup activity? I do not think that you can easily clone Silicon Valley. One of the major reasons is that Silicon Valley has reached a critical mass. As an engineer in an entrepreneurial setting, I can join a company, stay with it for two to five years, and have confidence that at the end of that time, I will have multiple opportunities to join another company. That is because several hundred companies per year are created here in Silicon Valley. If I look at other cities where there are interesting startup opportunities, if your company fails, you have nowhere to go. Having this critical mass is an extremely important part of having a self-sustaining entity where you can create start ups.

Venture capital does a great job of feeding into new products and technologies in established companies. However, with the demise of the large corporate research labs, I think there is more basic science and technology development and early commercial implementation occurring at small businesses, but I do not think it's going to offset what we miss by losing those labs. In the pharmaceutical industry the whole process of offloading early-stage high-risk portions of product development is commonplace. Drug companies now routinely offload their drug development to VC-backed or early-stage drug companies. They assume more gracefully the early developmental risks of taking these drugs through the approval process, and in general, they are much more efficient at going through these early stages. The larger pharmaceuticals leverage their distribution networks and sales to distribute effectively to their existing infrastructures, and that works out very well. I believe there is a growing trend in other high-tech industries to go down that same road. Small companies seem to be of growing importance to other industries, working or translating this basic science into products that are useful to society.

So how does Silicon Valley do it? Part of the reason why Silicon Valley is so successful is that it has been at it for 30 years. It has evolved an infrastructure for supporting and nurturing new companies. It has the legal services for corporate law and IP matters; accounting support for audits, salaries, and benefits; and technical services such as machine shops and clean room maintenance. You can form virtual companies and save on those very precious early dollars. Another key element is its proximity to world-class universities and two major government labs, which supply the engineering talent and collect the profit. Stanford, Cal, Berkeley, and the University of California, San Francisco, as well as Lawrence-Berkeley Labs and Lawrence-Livermore are all within a 50-mile radius.

The most important part though is the critical mass. It is large enough to supply security for serial entrepreneurs like me, who change companies every five to ten years in order to stay working in companies in the early exponential growth phase. There are enough companies created to provide the security that you need to be confident you will get a job in 5 years if you chose to leave. It also helps if you have great weather and it is just a fine place to live. If you are up for the opportunity to participate in starting companies, particularly in a great place like Silicon Valley, I encourage you to seriously consider this. It is an exciting and rewarding career option.

QUESTION AND ANSWER

Q: I was surprised to see the breakdown of spending – only $15 billion in the venture capital area versus $150 billion in the large companies. I wonder if perhaps that does not underestimate the value of the startups. Of course, you touched on some of these issues, but one of them is the fact that these small companies can be helped by the infrastructure. Second, the risk at a small company can be a very strong motivator to get your job done well. I was wondering if you might comment on whether this underestimates their value.

A: The number I mentioned in my talk was $25 billion in total investment; $15 billion is the amount that just goes to R&D. But you're right — $15 billion did compare with $150 billion. Remember that this investment is high risk capital and probably should be a much smaller number than the amount invested by larger companies where they look for lower risk R&D investments. The $15 billion invested by venture capital probably compares favorably with the high-risk portion of the $150 billion invested by larger companies.
I think there is strong motivation when there is a small group of people focused on meeting aggressive milestones, and the result of not meeting the milestones is that you are out of a job. That is a strong motivator to achieve success. If product development effort falls a little bit behind in large corporations, other products provided a source of revenue and funding for R&D, and the inertia of the company takes over. I think there is an efficiency that comes from the paranoia or excitement in a startup environment that you cannot find easily at a large-company.

Q: The growth component is typical of a very successful good startup company. The reality is some successful startups never go public and are purchased. What I am trying to understand is, does that have to be planned for? Do those companies necessarily have to look to be purchased? If so, is that reflected in their spending profile?
A: A common platitude is, "Companies are not sold, they are bought." What you do is go out and plan to be a successful IPO, and in the process of doing that, you generate enough interest from companies that might want to acquire you so that you get acquired. Now it is always in the back of your mind as an exit strategy, and as a matter of fact in some ways it is a more pleasant exit strategy than going public. The advantage of an acquisition is immediate liquidity at the purchase price for the investors. This is usually is a much more graceful exit strategy. A lot of companies would prefer to be acquired, but they go along with a facade of going public because it can be very difficult to market a company for sale.

Q: Do you find that those companies that have been purchased get their funding differently, or what is it a function of?
A: I do not think there is any strong rule.

Q: You talk a lot about financial models, and then you briefly showed one slide with 15 people. What traits are you looking for in the first 5 people that these companies hire as engineers?
A: The important thing is communication skills. Can they interact effectively with their peers? Can they work in a multi-disciplinary environment? Particularly in biotechnology, you are developing products that are based on a variety of disciplines, so you need to have people who can be fluent in more than the discipline they were trained in. You need to have people who are open to learning new things and can communicate extremely well.

Q: So it's not the technical skill?
A: No, to a large extent not. You need one or two people with an idea in the founding team. You need a visionary, but that usually can be just one person.

Q: Who should be the CEO, and what should be the role of others?
A: You know, that is a really good question. Before I felt comfortable being CEO of a company I spent a good portion of my first 15 years in Silicon Valley at a midsize company where I had really made it a point to understand some of these feedback loops and mechanisms, how R&D gets funded, the business dynamics, and the marketing and sales process. Because of this experience, I felt comfortable being CEO. I was comfortable doing it, but only because I had been in the private sector, knew how businesses worked, and

basically knew where I wanted to go. A CEO needs to be very comfortable doing two basic things: recruiting people and raising money. You do not do a lot of science when you're a CEO, not only because you don't have time, but because most of the time your scientific staff doesn't want the CEO doing science. You need someone who is really going to focus on the business side of things. It helps to have a vision for the company, to understand the technology well enough to be able to make the strategic decisions, and to be able to question the scientific staff. The CEO should be someone in your founding group who really wants to fully commit to the CEO role, even if this person has a technical background, they must be willing, for the most part, to leave that behind and really focus on the business. There are other things important for a CEO — you have to have good communication skills. At times you have to give the same presentation 100 times, like when you are raising money. I traveled to New York City and gave the same presentation seven or eight times in a day to different potential investment groups. You have to be comfortable communicating your vision.

Q: I'm sorry; can you answer the second question, which is what should be the role of all of the other members of the founding group?
A: It is hard to answer this question in general. One main thing I can say is that each should have a stake in the company. All of the founders need a real strong motivation for success. If they are from a university and keeping their tenured job there, I would not consider them to be truly a part of the company. They have got to really have their focus on making the company successful, because it is a tremendous amount of work to go through and build the infrastructure and meet the necessary milestones. The founding team has to be completely committed to what they are doing and not have divided loyalties.

Q: How long have you been in this business, and also, what companies have you been associated with, and where are these companies today? How about the venture startup?
A: I have been in the startup business in Silicon Valley since about 1989, when I was a founder at Spectra Physics Laser Diode Systems, an independent company that was wholly owned, but it was an independent profit center and a start-up. After that I worked at Biometric Imaging for 3 years, a startup company that was venture-funded, where I was vice president of research. Then I started Arcturus, where I was CEO and Chairman. These are the companies that I have been involved with in a variety of positions.

Q: Are they public companies?
A: No, Arcturus is an interesting story. It still is a private company; it followed some of these curves I described but kind of compressed. There were four of us in the initial product development team. I founded the company in July, 1996. In August, we determined what problems we were going to solve; we had our first prototype by December. There were two of us in the company at that point — a technician and myself. I did the optics and electronics. We were shipping beta versions about three months later and sold our first unit in June, and that was with 5 people in the company. By the time we got to 15 people, which was in about a year and a half after we started the company, we were profitable. We went through a series of funding steps in there. We had an angel funding step, and then an A, B, and C round in that time period. It turns out that Arcturus is a special case because it actually was a vertically-integrated company developing products for cancer diagnostics. We develop laser-based instrumentation which was also a very profitable product line in the life science research market. Arcturus has about a thousand instruments out in the field that sold for a couple hundred of thousand dollars each. We moved into the linear growth phase with our life sciences instrument work and stayed in the entrepreneurial, venture-funded phase with our diagnostic business.

Q: Is there something that you can identify that the State of California and universities in the area have done in order to foster this entrepreneurial environment?
A: Certainly Stanford has one of the most liberal attitudes toward professors being involved with companies. I have been on both sides of that, and I've liked it when they've been working with me, and I've hated it when they were part of the competition. I think Stanford can be viewed as a role model for how to encourage students and professors to be involved in the local industry. That is no small part of what caused the initial nucleation of Silicon Valley.

Q: You're not crediting the state of California for that?
A: No, and actually most of the companies incorporate in Delaware because it is much better for them. Arcturus is an exception in that we have incorporated in California, but the tax laws and the incentives to incorporate are better elsewhere.
I do not see a hundred Silicon Valley's throughout the country being optimal. I think venture funding is going to consolidate into big areas like Boston, San Diego, and the Bay area. What is unusual about Silicon Valley is that it is a leader in biotech, semiconductor manufacturing, software development, search engines, etc., and San Diego is primarily biotech and pharmaceutical.

Q: What percentage of startups would be considered financially successful?
A: I do not know if I can give you a number on that. If you ask most venture capitalists, they will say maybe one in 10. If you ask how many companies do venture capitalists actually get their money out of — I would not necessarily call that financially successful —I think it is over 50 percent. That gives you an idea of the range. I have never seen good statistics, and it really depends on the time. There of course have been two bubbles that we have gone through recently. With the "double bubble" trouble that we had in e-commerce and telecom, if you look at the statistics there was a vast percentage — I would estimate 90 percent of the companies — that went under and did not go anywhere. So the success statistics depend on the timing and market conditions.
There is a role for early product development within small companies, because the venture industry is tolerant of high risk and subsequent high failure rates. That is not necessarily the case for established companies that have to carefully monitor their expense rates and the bottom line for efficiency. This is a very risk-tolerant industry, which is one of the reasons why it will continue to grow and thrive in a number of different sectors.

Q: How is China influencing what is going on in Silicon Valley?
A: My impression is that during the telecom boom many companies moved manufacturing operations to China and then shut down their operations as the market evaporated. It still is considered to be a good strategic policy to have offshore manufacturing, and China is one of the most recognized areas where that is a good investment. I would be very curious to hear if that is happening in Japan as well. I assume that it is and is the same motivation for moving things offshore is present in Japan. My impression is that this is happening less presently. I think people are seeing China as being more of a market opportunity than as a place to ship your labor intensive manufacturing process, but that also depends on the industry. What I see more and more happening is service industries, not manufacturing capability, going overseas. I have a friend who is a CEO who hired about 50 Indian lawyers trained in American law to search for documents in companies involved in litigation. They pay trained lawyers $15 an hour. They just hire the lawyers over there, transport the material, and have them search through the documents. A lot of it is not manufacturing as much now as highly trained, very cheap labor sources.

Q: Bit of a negative question — what kind of people should not buy into the stock or equity of a company?
A: I am not sure how to interpret your question. But let me try… Well, definitely risk-averse people should not make this type of investment. You have to ask yourself if you are willing to put 10 to 20 percent of your net worth on the line with a venture. If you cannot comfortably say yes, I'm willing personally to risk that much, at least as the founder or entrepreneur or in starting a company, then I am not sure it is a good idea to be a part of a founding team or one of the first couple of employees.
As far as an engineer joining a startup, again, if you do it in the context of Silicon Valley, there is very little risk. If you enjoy the idea of creating infrastructure and culture and having the challenges of building things from scratch, when you have the critical mass like a Silicon Valley you do not need to think of running this company for 30 years. I would not do it in Minneapolis, because there just are not as many options. In a place like Silicon Valley, San Diego, or Boston, where there are other options, I think it is different.

Q: I am from a university and also a regional venture fund and a university venture fund. We just started to follow the U.S. scheme, and we are struggling to find people who can manage these activities. A few years ago, I established a Management of Technology Department and a risk management company incorporated with the Graduate School of Economics and Law. However in Japan, there is still taxation on startups. Even venture capital firms, they said, look like banks. Tohoku University established a corporation, and we in the university had to get the money to do this. It is very risky. I also insisted that professors and also local citizens become interested in economics. Two weeks ago, I visited China and learned that almost 20 or 25 years ago, the Chinese government established very similar laws concerning commercial activities from universities, yet they were very supportive. They want to invest in many kinds of ventures. Because this is happening in China, the industry is regulated. Now we see that we need strong cooperation between economic entities and the government. JST, which acts as a governmental fund for startups, is the main sponsor of this symposium. In my view, it is not a true venture capital endeavor if professors or managers of a venture want to continue pursuing their research and do not create products.

Q: I have met people from several companies who have moved from the Bay area to the Boston area for the simple reason of the cost of housing. But the question I have is, what makes you think the contribution of big corporate research investment is declining?
A: I probably was not explicit enough. Investment in what I call basic science has declined at IBM as well as at Bell Labs. I think investment in R&D is probably the same or growing in the near-term if you define R&D as technology behind products. My comment was more that investment has disappeared in basic science, which feeds into engineering.