**Charles W. Vest**

Thank you very much. It is real pleasure to be back home again. This is a great state and a great set of universities and I'm fully confident that you're going to win the battle that lies ahead. What I'd like to do this morning is to rather rapidly paint for you kind of a mosaic of what I see going on in the world. It is a personal view. It happens to be centered largely on what I learned as a member of the Academies' committee that Norm [Augustine] so wonderfully chaired. Nonetheless, it is a personal view. I'll move rather rapidly through that and then try to end with a few thoughts specifically about the role of universities.

This is a new century and it brings with it new challenges. This was summarized very succinctly in a meeting I attended this last summer in August by David Gergen, who said that he believes that the next president of the United States will face the most difficult challenges that any president has faced since FDR. As a prologue, because we are so focused on some of the challenges and problems, I do want to state that America today is far and away still the world leader in science, technology, and in our research universities, both public and private. We remain, I believe, the most innovative nation on the face of the planet. But the real question before us is, are we going to be in this same position 10 years from now and does it matter?

Well, I'm among those who believes that it darn well does matter because, as Steve [Forrest] and others have said so eloquently already this morning, we're going to have to compete in the global economy, but we want to do it and maintain our American standard of living. And doing these two things together is a real and daunting challenge.

Prospering in the knowledge age requires people with knowledge. It's a very simple statement, but I believe it's at the heart of what we need to think about. It matters because in this century we or any other nation cannot prosper based on our geography, out natural resources or our military might. We can only prosper based on brainpower. America I believe has a comparative advantage to most other nations in the world. We have a strong science and technology base that has been built very carefully, particularly in the years since World War Two, that coupled to a free market economy. It's built on a base of democracy within a diverse society. So, while we think about problems, please bear these strengths in mind, because that's what it is that we have to draw on.

Following the Second World War and starting with the Vannevar Bush report that Steve [Forrest] referred to, we built what is usually referred to as the U.S. innovation system. This is a very loose, informal organization of governments, academia and industry that really does three things. It creates new knowledge and technology through research, it educates young women and men to create and understand the new knowledge and technology, and then, of course, it ultimately moves it into the marketplace in the form of new products, new processes, or new services. This has been an enormous success. There have been numerous studies by economists that all conclude (while they argue over the details of the numbers), that at least 50 percent of the growth of U.S. economy in the last 60 years was due to technological innovation and a lion's share of that innovation, in fact, originated in our public and private research universities. I often find that business audiences say, "Yeah, yeah, yeah, you guys don't really do anything that important". But here's a list of a few of the major innovations in these last decades in which universities either played the sole roll or the dominant roll in development: computing, the laser, the internet, the fundamentals of the global positioning system, numerically controlled machining--something who's importance to this state and region is enormous, the organization and deployment of the world wide web, financial engineering--the whole concept of pricing options and so forth, the genetic revolution, the lion's share of modern medicine, and so forth. So, we are talking about serious innovations coming from our universities.

If you prefer a longer view, there's a lot of interesting work that's been done by the economist Paul Romer, Stanford University, kind of neatly summarized in this chart which shows the growth of the economies of the United States and of Great Britain from 1870 up and until the mid 90's. And Romer

says, "Everything we know about history, technology and economic theory, tells us an increase of this magnitude would not have been possible in the absence of technological change." In any event, our long-term, basic discovery or frontier research is the key to our future because without it, this innovation system will wind down, and it has to be fed the new ideas from the bottom in order for the products, processes, and economic growth to come out at the top.

But things are changing. We have, as I said, a new century. Being a little bit simplistic, the last century, or certainly the last half of the twentieth century, was largely about physics, electronics, high-speed communication, and transportation. What we see moving into the new century is that, at least in the decades we can foresee a bit, are largely about biology and information, but also about energy, about water, and about sustainable economic development around the world. It's a new century with a new pattern of investments in R&D. The message here is that if you look at R&D expenditures by both industry and government, roughly speaking North America is about a third, Europe's about a third, and Asia's about a third. We are actually a little closer to 40 percent in North America, but you can see what the trend it. This used to be very highly focused in one region of the world. It is now spreading. The headline is very simple. U.S. R&D, as I said a minute ago, is clearly on top but in literally every possible measure, we're losing share. We lead the world in R&D investments, government and industry. We are among the leaders in the pack if you normalize that to our gross domestic products. Some people call this R&D intensity--the amount spent on R&D, divided by our GDP--and we're kind of in the top fourth or so. However, our global share is declining in every category. Between '86 and 2003, our share of domestic R&D dropped nine percent, of scientific publications eight percent, science and engineering bachelor's degree's down ten percent, new science and engineering PhD's down thirty percent, and so forth. Now this is not all bad news because to the extent that this means that the rest of the world is climbing up the ladder, getting smarter, improving their economy, their education. I, for one, am all for that. But we have to recognize that and understand what it implies for us.

It's a new century with new players. Where's the expertise? Here's an interesting curve that I put together from a Council on Competitiveness report that came out earlier this year. It's the young professional work force, which is defined as college graduates with seven or years less experience, in three fields--engineering in blue, life sciences in red, finance and accounting in yellow. And you see, China already dominates engineering, India dominates finance and accounting, the U.S. dominates life sciences. But where will the expertise be in the future?

First of all, let's just look at one metric, the number of first engineering degrees, basically bachelor's degrees, in a variety of countries. And you see the headlines. China is rising in this number astoundingly. By the way, these are the more conservative metrics of this. And we all know that there are issues of quality as well as quantity, but sheer numbers do count for something. Because even though it's not all about numbers, Floyd Kvamme, a senior partner Kleiner-Perkins in San Francisco, and also current co-chair of the President's Council of Advisors on Science and Technology, said, "Venture capital is the search for smart engineers." So, if you want good venture capital returns, you need smart engineers. Unfortunately fewer than 15 percent of U.S. high school graduates today have the science and math background to even consider going to engineering school.

It's a new century with new speed. This little graph is intended to show how things are accelerating. It looks at several of the major innovations over the last century or more and asks, "How long did it take this new product to reach 25 percent of America's population?" It took literally a lifetime for the automobile to reach the point where 25 percent of American households own one. It took the telephone approximately a working career, radio took 20 some years, the PC 15 years, the cell phone 13 years, by the time you get to the world wide web it took 8 years; only 8 years from conception and deployment until 25 percent of our population accessed the web.

It's a new century with new jobs and, by the way, in some macroscopic sense, this curve underlies the subject that brought us all together here today. If you go back to 1800, 90 percent of the U.S. population

lived and worked on farms, feeding their family, feeding the population of a growing country. That, of course, dropped until today it's down to around one percent or so of our population.

What replaced that? The green curve, manufactured goods, physical products, the kind of things that this region has excelled in. But these curves are changing very rapidly again and today 70 percent of our work for in the United States works in the services industry, largely IT based services, but not entirely.

But before you say we can't all flip hamburgers, I think this is the chart we're thinking about. I've just listed a number of countries here, and you can see that the percentage of the labor force that is employed in the service industry is almost a measure of how advanced your society and your economy are. So, the United States and Japan are the two leaders in this area. And as you move down the curve to the developing world, Bangladesh, India, and Nigeria and so forth, they still are dominated by agriculture. In between are economies that had more manufacturing. But this trend of services cannot be underestimated.

It's a new century with new connections among us. Location no longer matters. In his wonderful way, Tom Friedman has told us all that the world is flat, that in 1989 the Berlin Wall came down and Microsoft Windows went up, that we laid 1.5 trillion dollars worth of optical fiber connecting the world. By the way, people missed the point that most of the people that laid this 1.5 trillion dollars worth of fiber are in jail today, but that's another matter. The fact is we are all connected as never before. And as Tom says, "Globalization has accidentally made Beijing, Bangalor, and Bethesda next door neighbors. Many jobs are just a mouse click away."

But it's a new century that also brings new debate because there are those who say, "By golly that's great, but location does matter". That there is a sort of power in regional clusters of innovation around particular industries, where a range of expertise and small and large companies come together. That the proximity of small companies and corporate laboratories to universities in increasingly important, and while venture capitalists will say, “I'll invest wherever there's a good idea,” the fact is venture capital networks tend to have some location because they know the people, they know who the good CEO's are, they know where the quality is and so forth.

I believe both of these views are correct, but in any event globalization is the new reality. Now when we talk about globalization we usually start with what we might call manufacturing migration, something that this region is deeply and appropriately concerned about. When a new product is launched, say in the United States, it's initially manufactured here and the next thing you know the manufacturing core has moved off to Taiwan and maybe from Taiwan to Korea and next to China and ultimately to Vietnam.

This is happening in field after field. Is it inevitable? I don't know, but it's serious business. And the *Gathering Storm* report and even its executive summary are filled with factoids about this.

Here are just three points. Between 2000 and 2003, foreign non-Chinese firms built 60,000 manufacturing plants in China. In 2004, just three years ago, chemical companies closed 70 major plants in the United States, tagged 40 more for shut-down, and of the 120 major chemical plants under construction around the world, 1 is in the U.S. and 50 are in China. These are serious numbers.

It's a new century, and this is very important, with new innovation models. They all go under roughly the heading or rubric of open innovation, that I think was actually coined or at least is the title a book by Henry Chesbrough at the Harvard Business School. In his book, he points out something very simple. To compete today companies have to integrate the best ideas, no matter where they originate, whether it's in other countries or in other companies or laboratories, increasingly in their own competing organizations. And because of this, new dynamic business models are needed that recognize this open, connected world, with changes in licensing, partnering, joint venturing, and so forth.

Looked at particularly from a large company model, we have in this new century new enterprise models. A very interesting paper written by Sam Palmesano, the CEO of IBM, in *Foreign Affairs* about a year ago, in which he lays out his view of what he calls the globally integrated enterprise. And this is, by

the way, precisely how IBM works today. He says this supersedes the multinational corporation, which was basically a company clearly headquartered in one country, doing a lot of it's core activities with a lot of the brain power--the R&D, the treasury functions and so forth, and then manufacturing and selling in other parts of the world.

He thinks we've now gone a step beyond that, driven by globally shared technologies and standards—an extremely important word, standards--built on global information technology infrastructures. But the focus has moved from products to productions, and that a new borderless strategy of management and operations for integrated production and value delivery is developing.

Now, in a very simplistic way, to show what Palmesano is talking about, since IBM is largely a service company in terms of what he's thinking about here. The service enterprise is going to look something like this, where I've just showed a bunch of boxes. If you're going to put several functions together to perform a service for a bank of a manufacturing company, whatever it happens to be, you're going to divide it into a lot of different sub-component functions. And these are going to be done in different locations in different countries and then simply integrated together. This goes back to the idea a moment ago that you go to the best people, the best place to get each specific little function done.

So our service companies are moving in this direction. Manufacturing projects already look like this, but with many more boxes and many more countries. For example, the new Boeing 787, the new plane that Boeing is coming out with that's in this fierce competition, as you know, with the Airbus 380. The new Boeing 787 has 132,500 individual engineered parts. They are produced in 545 different locations around the world.

It's a new century with continuing new importance of small companies. Those are sort of large company views. Small companies--this is a slightly busy chart, but what it simply shows is the number of jobs created annually in yellow in small companies, in blue in large companies. This is a few years out of date, these data go back to about 2003, but the message is pretty clear that as important as large companies are and will remain, it is the small and medium firms that have been driving the job growth in the United States.

It's a new century with new frontiers of engineering. So let's start moving from the moaning and groaning to the exciting opportunities. We have really two kinds of frontiers in technology and engineering. One is usually called the bio-info-nano frontier. This is the domain of things that are getting smaller and smaller, faster and faster, more and more complex. But also there is the macroscopic frontier where we have to deal with the big problems of energy, environment, health care, manufacturing, communications, logistics, and so forth. These are things that are getting larger and larger, more and more complex, and are of extremely great societal and economic importance.

Now within our universities in particular we all know that in this exciting bio-info-nano sphere that the difference between science and engineering has almost disappeared. Everything has to be done on an interdisciplinary basis and you're discovering new things about nature at the same time you're developing new devices and processes. And so our science and engineering are merging--very important and a lot of experts in this room about that. But I'd also like to point out that on these larger-scale things, sort of engineering systems of the world, in my view, social sciences, management, and indeed, humanities and communications play a very big role because these are things that not only have to be developed in the laboratory. They have to be sold politically, economically to the world and this also, I think, brings new opportunities for synergies.

But the big excitement, I believe, is going to be bridging from the small stuff to the big stuff. This is where bio-based materials that leave smaller environmental footprints and manufacture things more cheaply, more effectively, or biomimetics, the use of the study of how nature has designed things and then to put that over into engineering design; the potential out there of personalized, predictive medicine; the role of synthetic biology; the role of biofuels and so forth. This to me is where a lot of the action is

and where folks like you who wonder where does the future lie, and what can we do from more of a green field point of view, need to think about.

So how does our great nation respond and how does Michigan respond? Again, personal views. Number one, we join the fray. We don't shirk from it. We don't put our head in the sand. We not only join it, but hopefully we lead it. We conceive and create the most sophisticated, high-value-added jobs, because if we lose those, we're going to lose a lot that lie underneath them.

We take on the great 21st century challenges: energy, environment, water, feeding the world, our health care delivery and world health, the issues of aging (a topic I'm increasingly interested in), and there will be great market opportunities. And I hesitate to tell this story with Mr. Dingell in the audience, but I had what I think of as an out-of-body experience talking about some of these things to the Senate Energy Committee last year. And I made the statement in Q and A that, if our country and our companies develop these great new green technologies in the future, there going to be a huge world market. And one of the Senators said, you know I've never thought about that before. Well, that's really what it's all about. This isn't about problem solving, it's about opportunities, and economic ones at that.

I think we have to focus on fundamentals. Going back to what I said, prospering in a knowledge age requires people with knowledge. Therefore we have to invest in education and research and encourage innovation and entrepreneurship. We have big obstacles to overcome and we have to start, in my view, with K-12 education, particularly but not exclusively in science, technology, engineering, and mathematics.

Now here's the STEM education issue in a nutshell. This is a few years out of date, but it was a study of the teaching of mathematics and science in 20 countries. They polled a group of U.S. students and here is how they ranked. They were number one in agreeing that they were doing well in mathematics. They were number three in agreeing that they were doing well in science. But the same kids, when they actually took the test, performed number 18 in mathematics out of 20 and number 17 in science. This is our great failing. We've gotten so used to being on top, telling ourselves how good we are, that we're forgetting the substance.

So can anything be done? Can anybody make a difference? Let me tell you a little story very quickly that I think means a lot. because the answer is yes. Here's what one individual, Peter O'Donnell did in the Dallas Public School system with his own money that he had made as a successful entrepreneur over the years. Don't worry about the details of this, the point is, he went into 10 public schools in the Dallas area and invested money in incentives for training teachers to teach math and science and English at the AP level, and also provided some modest, direct incentives to students by literally giving them a little check if they took and then passed successfully the AP exams.

Here are the results. I would not have predicted this. I would not have believed it. I wouldn't have like it philosophically, but you can't argue with facts. Starting in the blue, the first year of this program, this is the number of kids each year with passing scores on AP exams from these 10 schools. Is this just rich white kids in a suburb? No, look at the minority AP passing scores, the blue curve at the top versus the national average and, in fact, the state of Texas average at the bottom.

What does it have to do with anything? Look at the six-year college graduation rates of the kids who took the AP subjects through this program versus those who did not. So some simple things can help. They can at least prime the pump. They can start the upward quality trend.

So how do you bring this to scale? Well, this idea moved from the *Gathering Storm* report to what is now in the America COMPETES Act of 2007 that was mentioned earlier and also Peter and a number of us from around the country formed something called the National Math and Science Initiative, which has raised a lot of money from Exxon Mobile, from the Gates Foundation, from Dell computer, and are beginning to port this concept out into a number of states on a competitive basis. There's a second part of

this that has to do with the training of teachers. I won't go into it now, but you will find it if you read the *Gathering Storm* report or at least in the executive summary you'll see it.

So I believe that at every level we really do have to implement the recommendations of the *Rising Above the Gathering Storm* report. I'm not going to spend a lot of time on this, but I just want to remind you that this had its origin when Senator Lamar Alexander and Senator Jeff Bingeman, Republican and Democrat, came to the Academies, later joined by Mr. Boehlert and Mr. Gordon, simply asked the question, "What are the top ten federal actions that we can take in priority order in order to increase our chances that our science and technology base can help us prosper in the twentieth century?"

Now because of time I want to just skim these. It's all available to you, but we have four basic recommendations. One we call "10,000 teachers who can influence 10 million minds". It is built to a large extent on what I showed you on the AP work, but also on incentives to have universities educate young men and women in science, math, and engineering disciplines, working with education schools and others to simultaneously prepare them to move into classrooms.

"Sewing the seeds" has to do with increasing, after almost a 40-year lull, the federal investment in long-term basic research, particularly in the physical sciences and engineering to, sort of, begin to catch and integrate with the wonderful growth in the life sciences and a number of other things that we believe will help build strength in the right areas, the needed areas in our universities.

"Best and brightest", the goal is to offer scholarships, fellowships, and also in fixing some of these issues around deemed exports and visas and so forth, to increase the number of U.S. citizens earning science, engineering, and math degrees, but simultaneously to keep making America the great magnet for the world's best and brightest to come here, to study, to work, to contribute to our society and ultimately the improvement of the whole world.

And another of the specific incentives for innovation, I only want to focus on one here, which is the last one, "affordable broadband access." Folks, the United States is nowhere close to the top any more in the connectivity of its peoples and institutions to real broadband access. This is a big danger.

So what does this cost? Well, just costing out what we recommended is about two billion dollars per year. That is a lot of money, but the question is "Can we afford not to make this investment?"

Where do things stand? Norm [Augustine] mentioned a little bit of this in his videotape. The Congress passed the America COMPETES Act of 2007, perhaps the longest acronym ever invented. It stands for Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science. It passed by unanimous consent in the Senate and by 367 to 57 in the House, an astoundingly bipartisan effort. I just cannot emphasize that enough. Likewise I cannot emphasize enough the supportive role that the business community across the country played in encouraging Congress to pass this. And I want to tell you, I'm sorry he's not here in person, if I had to name one hero, particularly in the end game of getting this bill passed, it was certainly your Congressman, Vern Ehlers, who did an amazing job of getting the business community behind it at the last minute when things got a little tough. I'm eternally grateful. The bill authorizes $43.3 billion of expenditures over the years 2008 to 2010.

But as has been said, this is all great, but it's not yet been appropriated. Very simply put, I think the outlook for research is good. The maybe means that if we had macroscopic problems, if we moved back to continuing resolutions, what have you, it could be a victim. But the President's American Competitiveness Initiative is entirely consistent with the first year of the research-oriented piece of the America COMPETES Act. But I believe, and again this is speaking as an individual. We really need to push hard on the education components because ultimately, if we don't push these education components and do what we can to catalyze improvement in K-12, we'll be in trouble.

So to conclude, let me say a few words about the partnership, about governments, universities and industries. What can we do? There's not a lot that's original here, but let me just give you a few quick thoughts.

I think we always have to remember that the role of universities in this country, and especially that of our great public universities, is simply creating opportunity. Creating opportunity for people, for our students, creating opportunities for our states and regions and for the nation and world. This is our mission. It's what we're in business to do. It's what society expects of us. But increasingly, and as Mary Sue Coleman put so eloquently, we really have to do this today in partnership. Nobody stands alone. Government, industry, and universities have to find the right ways to work together.

So what can governments do? Well, that's a large part of what you're here to discuss today, but I would say we have to start facing our real challenges and opportunities. Education, life-long training of the American work force, to really tackle these daunting problems, these huge problems of energy, of environment, global warming, globalization, getting our health care system efficient and under control, water, nutrition, security, one could go on and on. But these are the big challenges.

This is why David Gergen said this next president has his or her work cut out. We have to inspire the next generation. I really think that our government leaders can do more to inspire kids. Because if kids aren't inspired, guess what? Nothing's going to happen. Because I'll tell you, if you go to Singapore, if you go to Vietnam, if you go to China, they are inspired.

We have to break open the regulatory and litigation logjams that are stifling our industries. You heard Norm [Augustine] say that American industry spends three times on litigation than what it spends on R&D every year.

We have to promote understanding, and I'm optimistic about this. We have to promote understanding that funding basic frontier research and helping to fund advanced education is a key bipartisan function of the federal government.

The government can help build regional innovation clusters, help build centers of excellence, things like the Discovery Innovation Institutes that came out of another Academies study.

And I know you all are talking about the potential of energy here, and by the way, you saw earlier in Steve [Forrest's] talk about the East coast, West coast. I have to tell you, when it comes to energy, this is a much more level playing field. You can start that game anywhere, certainly including here.

I believe that we have to fund the America COMPETES Act, which came out of *Rising Above the Gathering Storm*, President Bush's American Competitiveness issue, the Council on Competitiveness National Innovation Initiative and so forth.

And this is a little bit narrower topic, but I think we need to establish ARPA-E, which is a new component within the Department of Energy to stimulate some lean and mean management of interesting new research portfolios in industry and university and bring some new players to the table.

What can universities do? Well, first of all, and I know I'm preaching to the choir, the number one thing is we have to be excellent. We have to be the best we can be, the best in the world. And we have to be true to our fundamental mission of education, scholarship, and research. Above all else we have to be good at our core mission.

We have to think objectively and we have to speak truth, whether it's popular or unpopular. I believe we have to be serious partners with government and industry and that does not just mean send the money, trust us, that means being partners. We have to work with industry, but not try to be industry. I've done a lot of work building alliances with companies and so forth at MIT, and I frequently find that industry often understands better what the university is and isn't good at than we do ourselves. We have a huge amount to offer, but don't try to kid yourself that you are industry. But there's a lot we can do for and with industry.

And I think we should foster what I call knowledge integration communities. This is a concept that came out of a partnership that Cambridge University and MIT formed a few years ago, where at early stages of developments by research programs, we would engage people from government, people from the entrepreneurial community, sort of regional experts, the kind of people that are in this room and kind of keep everybody in communication and talking on the way through.

At first the most reluctant partners are, not surprisingly, the university faculty. But you get an interesting problem, and our silent aircraft project was a great example--cutting down the noise in landing and taking off or aircraft, people really get into the swing of it. And you can do great things together. And then because everybody's in communication, when it comes time to hand of the research results, you've got a community that understands it and is ready to move it into the commercial domain.

Now what can universities bring to the table? Number one, and we're seeing it today, is convening power. There was a study done about two years ago in Europe and the U.S. about a dozen universities that were in areas that had undergone substantial economic transformation. And the question was, what do universities do that is important? Now, I would like to tell you that the most important thing was the research and education, but the number one factor came out to be their convening power. The fact that they were a place where people like you folks came together to talk these things through and get to know each other is something which never happened in their individual sectors. So, convening power is important.

Of course, knowledge transfer. Most effective knowledge transfer comes from people, your graduates, moving off to do things; your faculty getting involved and so forth. As John Armstrong, the former research VP of IBM used to say, "The most effective vehicle for technology transfer is a moving van." It still remains true. It's about people.

And finally, and I think we have an as yet really unrealized potential to help elevate K-12 education. University interaction with large companies comes in many forms, simple consulting, faculty and research scientists, providing companies a window on future technology through some knowledge of the research your doing.

And I believe that strategic alliances between universities and large companies are important. But I have to tell you from experience at MIT that you can only do a few of them. It's not the role of American industry fundamentally to support research in universities. But when you find things that are of real mutual, strategic interest and the company is willing to support them financially and intellectually at a sufficiently high level and for a long duration, you can really do some good work. And I won't get off into it now, but I'd site particularly MIT's alliance on biology-based materials with Dupont. These are really exciting things. The faculty and students get great experiences. The company gets benefit. But they have to big enough and of real strategic interest to both partners so that you get the attention intellectually of company thought leaders together with your faculty. You have to recognize up front that you need to agree on the goals, you have to recognize the differences in time scales of getting things done for natural reasons in universities versus industry, and above all you have to build trust. We would sort of review these partnerships, we had five or six of them, and trust always came out to be the number one thing that both sides said was important.

Interacting with small companies, in my experience, is a much harder problem because it does cost money to get things done in a university, and small companies often legitimately do not have the budget to do it.

But what can you do? You can foster the entrepreneurial spirit. You can celebrate the importance of transfer of knowledge. You can help people understand the concept of risk in America. You can have business plan contests.

We had a great one at MIT that has real money at the end of the chain that you use to form a real company. But the important thing here is that you bring real experienced entrepreneurs and ventured

capitalists and so forth in as mentors for the student teams. And it's just been amazingly successful and replicated by a lot of places around the country.

You have to work in your technology transfer decision making with real VC's and so forth. How are you going to invest your money? What is it you are going to try to patent? Those have to be real business-based decisions.

Internship programs. If you can find the support to get kids out to spend some time in entrepreneurial companies, these can be life-changing experiences for them.

And I don't have time to talk about it, but if you're interested look on the MIT website under something called the Deshponde Center [web.mit.edu/deshpandecenter/], named for a great donor and entrepreneur, Desh Despondee, who created for us a little endowment, a pool of financial support, to sponsor research by faculty and students on technologies that seem to have an interesting commercial potential. The idea is that over time it becomes self-sustaining because if it's commercialized, if the companies hit it big, then they'll have at least a moral commitment to returning some funding in to help this pool grow. It looks like a neat model and one that we struggled a long time to find.

Let me close with a few hard lessons. I always tell this to groups like this. Nobody planned Route 128 around Boston and nobody planned Silicone Valley. One of the things I think we are struggling with today is that these two areas in particular grew somewhat spontaneously because you had a lot of bright people and a lot of bright ideas. And they both launched at sort of early stages the concept of venture capital risk-taking and so forth. But nobody had a master plan for either of these; they sort of grew organically.

I also have to quote, because sometimes I find that industry or even government thinks you can get work done for free in universities, is that unfortunately we have real costs, whether a public or private institutions. As Bill Bowen, former president of both Princeton and the Mellon Foundation, likes to say, "Excellence cannot be bought, but it does have to be paid for."

Again, trust, mutual understanding is the heart of effective partnerships. I think we need to stick to the basics, stick to the main events, and not to the sideshows. So, that's my quick trip through all this stuff, and I hope it helps in some small way to get your day started. Thank you for the opportunity.