Good afternoon, ladies and gentlemen.

I want to talk a bit about international competitiveness in the 21st century. First I want to thank the president of the university and the faculty members I had an opportunity to visit with today in tours around the university. I think engineering research universities in the United States are about the most exciting places to visit, with their enthusiasm, energy, and potential wealth creation that is the outflow of these institutions. You'll hear a bit more about that during my comments. I would like to start this discussion by giving you, in good engineering fashion, the boundary conditions of the equation that I am trying to solve, without using PowerPoint or slides or actual equations. But the boundary conditions, as engineers know, are very important to the solution of the problem.

The first boundary condition is that competition in the 21st century is hard. I was trying to think of a simple way to describe something that is difficult, and it occurred to me that I had, just a month or

A video of Dr. Barrett's lecture is available at: www.stevens.edu/lecture.
two ago, gone to Anchorage, Alaska to watch the start of the Iditarod dog race. The reason my wife and I went was that one of our employees from our ranch in Montana actually was running the race again this year. She did it for the previous 11 years, and so we went to wish her Godspeed in this journey. For those of you who don't know anything about the Iditarod dog race, in the early 20th century, there was an outbreak of diphtheria in Nome, Alaska. There was no way to get the vaccine there because the ocean was frozen. They didn’t have airplanes. They didn’t have roads. And so the only way to get vaccine from Anchorage to Nome was, in fact, a form of Pony Express, but using dog sleds rather than horses. There were about 20 mushers, and their dog teams lined up in serial fashion, handing the vaccine off one to the other. It took them about three or four days to get vaccine from Anchorage to Nome, and the problem was solved. Somewhat later in the 20th century, in the 1970s, somebody had the bright idea—let’s redo the Anchorage to Nome dog sled race. One thing led to another, and today, it’s approximately a 1,000 mile race. It’s not serial; it’s not a relay. People who start at the beginning have 16 dogs in their team, and they have to go through a series of checkpoints, and cover 1,000 miles on their own in the fastest way they can. There are one or two mandatory rest points to make sure the dogs are okay, but it’s a rather strenuous competition.

“...Competition is tough... but business, education—just about anything good that happens going forward is going to have a lot of competition. And if you’re going to succeed, it’s hard work. So be prepared to work hard.”

In fact, it’s a hard competition. You don’t just drop in and say, “I’m going to run the Iditarod.” You train your dogs. You train yourself. You have the right equipment. You have the right mental attitude, and you have the right plan. It’s a hard competition. By the way, our employee finished seventh this year, which is pretty dang good. We’re very proud of her, but I use that as a metaphor. Competition is tough—and not just the Iditarod, but business, education—just about anything good that happens going forward is going to have a lot of competition. And if you’re going to succeed, it’s hard work. So be prepared to work hard.

The second general boundary condition I have is that market shares are won and lost during periods of transition. Transitions can be technology transitions, marketplace transitions, world wars—all sorts of things. Hardly ever are market shares changed dramatically just by a frontal attack with the same product against an incumbent in the marketplace. You need some sort of transition, and I think you all know the obvious examples. Kodak used to be a great American company with film. It’s just emerging from bankruptcy because film went away—we now just collect electrons on flash memory. A company called Digital Equipment Corporation (DEC) was preeminent in mini computers, and IBM was preeminent in mainframe computers. DEC went away because the personal computer came along and replaced mini computers. And Ken Olsen, the CEO at that time, didn’t believe in personal computers.

If you look at the cell phone, which is a real-time phenomenon, there used to be a company called Motorola. Motorola missed something called the analog-to-digital cell phone transition. Then there used to be a company called Nokia. Nokia missed the digital-to-smartphone transition, and now there’s a
company called Apple. But you all recognize that Samsung sells way more cell phones than Apple does. So when I say, “Do you remember Motorola? Do you remember Nokia? Do you remember Apple?” you get the sense of transitions that take place very rapidly in the marketplace. There was a transition also at the end of World War II, when the United States emerged as the only really undisturbed First World nation, and the manufacturing base of the United States was left intact. In fact, it grew dramatically as a result of World War II.

That transition allowed the U.S. to become the superpower and, really, to have very little competition in the way of manufacturing for almost a 30- or 40-year period, and gain tremendous market share around the world. That’s changing to some degree now. The reason it’s changing is there’s another transition that took place starting about 20 years ago, which was the end of the Cold War. That brought Russia and Eastern Europe into the mainstream, free economic system. About the same time, India decided against a socialist, isolationist approach, and joined the world’s free economic system. China did exactly the same. If you read Tom Friedman’s book, *The World is Flat*, if you read Clyde Prestowitz’s book, *Three Billion New Capitalists*, you know the transition I’m talking about.

I think it’s entirely appropriate to ask the question: With this transition of half of the world’s population almost overnight joining the world’s free economic system, who is going to lose market share? Who’s going to gain market share for the biggest economic transition the world has ever seen? You’re seeing some of that play out today, and that will be somewhat of the theme that I’d like to talk about. That’s the second point—market shares are won and lost during periods of transition—and we’re in a huge transition today.

Third point is that what’s important today is how much value you add to whatever you do. That determines your wage rate; that determines your standard of living. And education usually determines how much value you add to whatever you do. So, in fact, education is extremely important in the world if you want to have a stable middle class, or if you want to have a high standard of living.

Fourth point is that the flow of money and ideas is really, to a large part, unimpeded—it crosses national boundaries. Money will go to the point of highest return. Ideas can go anywhere for implementation. People with brains can work just about anywhere in the world around us.

Last point, fifth point, is that I think we all understand, especially at a place like Stevens, that the 21st century is a century of technology, the century of innovation. It’s not the century of natural resources, although fracking and the issues that John Deutch talked about certainly are going to have an impact, a geopolitical impact on how the U.S. interacts with other people, and especially if the U.S. becomes energy independent. But the 21st century is not so much about natural resources, it’s about biotech. It’s about new materials. It’s about IT communication. It’s about all those areas of innovation around us. So you’re either involved with that, or you’re not.

I probably should add there’s a sixth boundary condition, and this is in deference to a gentleman that I worked with at Intel for 35 years, Andy Grove. He was my mentor there, and Andy was famous for
saying—and managing according to this saying—that “only the paranoid survive.” The reason I bring that up is if you’re not paranoid, then none of the first five things I’ve said will mean anything to you, because you won’t be worried that someone is sneaking up behind you and trying to steal your position. The reason, frankly, that Andy was paranoid, and that Intel was paranoid, was that we operated under something called Moore’s Law; and you all know the various substantiations of Moore’s Law—the number of transistors doubles every 18 months, and processing power doubles, and memory density doubles. But there was another format of that law, and that was: The company looked at itself every year in both January and December. And in December, it asked itself the question, “How much of the revenue in December comes from products that were not here in January?” The answer was roughly 90 percent. The company today is a $50 billion company, so you say, “$45 billion of the revenue in December comes from products that weren’t here in January. I had better keep up with product development. I had better not miss the transition, or it’s going to be, remember Intel?” Try to remember—only the paranoid survive—as we go through this.

With those boundary conditions, if you’re the head of a country, what do you do to try to be competitive? Just about every country in the world is asking that question today. What should we do to be competitive in this century? As nearly as I can tell, there are only three levers that the head of government can pull, or that countries can pull to make their economies competitive. The first one is very simple—education. You need a well-educated workforce, or you’re out of the game. So you want to have a good primary, secondary education system, and a good university system. You want a well-trained workforce. The second, obviously, is if you have smart people, you need smart ideas, so you have to invest in research and development. That usually falls into two categories—the federal government ... central government, is usually responsible, more or less, for most of the basic research that takes place. And corporations are involved in the applied or developmental research that takes place. When you have a constant flow of research, you get things like what created the semiconductor industry.

Bell Labs, which was not a government laboratory in reality, but was a government laboratory in practice, was a public monopoly, so it was very much like one of our national labs in the 1950s, where Bardeen, Herring, and Shockley invented the transistor. That got spun out by having Bill Shockley leave Bell Labs and go to Stanford, or go to the West Coast, set up Shockley Transistor, incorporating people like Gordon Moore and Bob Noyce into the semiconductor industry. A few years thereafter, with some research, Bob Noyce and Jack Kilby at Texas Instruments independently came up with the idea of an integrated circuit. About 10 years after that, Ted Hoff, and a few others at Intel, invented the microprocessor. About 10 years after that, the IBM PC was born. And after that, the Internet information explosion happened.

That’s kind of a simple measure of what investment in research and development can create—huge industries out of an idea. And it’s terribly important in the economy going forward to do that. So: smart people, smart ideas—those are two of the levers you can pull.

The third one that governments have some control over is: How do you set the right environment for all this to happen? This is the sort of thing that Congressman [Rush] Holt worries about in Washington, D.C. What should we in Washington be doing to set the right environment for innovation in our country?
There are a whole variety of things, everything from the rule of law, to intellectual property protection, to corporate tax rates, to immigration policy.

“You have those three things, and if it really works well, you get a vibrant economy with new products. One of the reasons for being at Stevens today is to re-emphasize how important research universities are in this equation.

How many of you have ever heard of a company called Microsoft? By the way, when I say, “Remember Nokia?” you all know that Microsoft now owns Nokia. And when I say, “Remember Google?” if somebody replaces Google, you know that Google owns Motorola. But Microsoft has an R&D budget which exceeds the National Science Foundation by quite a bit. You would think that if anyone were going to challenge Microsoft in their business plan, their business model, it would have to be an equally-sized, powerful research organization—an IBM, an Oracle, some massive software corporation that has a big R&D budget. That’s the only way that Microsoft would be challenged. How has Microsoft been challenged and who has challenged them over the years? I think that you could probably summarize that they’ve been challenged three or four times in their career. And each time they’ve been challenged, it’s not been by another major corporation, it’s been by a bright idea coming out of a research university with one or two people—Mark Andreessen, Internet browser, University of Illinois; Jerry Yang, Internet directory, Stanford (go Stanford!); the two Google boys out of Stanford. You could probably throw Linux or Linus Torvalds in this and his open source software. So here you have a corporation in the United States, probably the biggest R&D budget of any corporation, not being challenged by equivalently large corporations, but being challenged by individual ideas out of research universities. So: the browser, the directory, the search engine, open source software. Those are the challenges, and if you wanted, you might throw Facebook in there, and a few other things. But that’s the power of a research university, and that’s why basic R&D is so important, because it spawns and creates those ideas.

Does this mean that it’s happening in the rest of the world? If it’s obvious and visible here in the United States, other countries must see this as well. What is most of the world doing today with regard to their universities? They recognize the U.S. research university is a national treasure. It is a fundamental building block of economic strength of this country. So everybody’s trying to copy it. You cannot go to a Chinese university and not find six collateral relationships with U.S. universities transferring research agendas, curriculum and researchers. The Russians just paid several hundred million dollars to MIT for the MIT intellectual property, not of any scientific intellectual property, but the intellectual property of how to run a major research university. That’s the Skolkovo project just outside of Moscow. You can’t go to a Middle East country, the oil-rich countries, and not find a university which is modeled after our research universities. Everybody’s copying that competitive aspect with us.
What else are they doing? They recognize that having an R&D budget—national R&D budget—the larger, the better if you want to be successful. And there’s empirical evidence that if you plot the national economic health of countries versus the percent of your gross national product that you invest in R&D, it’s a pretty good linear correlation. Countries like Israel and Finland, small countries, compete very effectively on the basis of a high percentage of their GNP going into R&D.

You have education. You have R&D, and then you have incubators everywhere. You have people trying to replicate venture capital, or to replicate Silicon Valley everywhere—Chileans with their Start-Up Chile program. Twice a year, the Chileans solicit business plans. If you have a business plan and you’re selected, here’s your $50,000 check, come to Santiago and create your business. The reason for doing it that way, rather than a spin-off from the universities, is they don’t have the research universities that the U.S. has. They’re soliciting ideas from other universities, other smart people. I’m familiar with Finland because my wife was ambassador to Finland for a while, and I was able to study that country in detail. One of my favorite startup activities there is Startup Sauna. Yes, there’s this big hangar, and there’s all these startups in it, but right in the center is a sauna that you can go in and contemplate your idea and how to progress, move forward with it. There are a lot of creative approaches. What does all this mean here in the United States in the 21st century? Just look at the numbers: the U.S. has, by far, the biggest gross national product, the biggest investor in absolute dollars in R&D, by far, the best collection of research universities in the world, by far, the largest number of Nobel Prize winners and other prize winners in various scientific, technical competitions.

“The U.S. has, by far, the biggest gross national product, the biggest investor in absolute dollars in R&D, by far, the best collection of research universities in the world, by far, the largest number of Nobel Prize winners and other prize winners in various scientific, technical competitions.”

But now I want to go back to Andy Grove and what Andy Grove would say: Yeah, but those are all lagging indicators. They’re not forward-looking indicators; they’re lagging. Nobel prizes are usually awarded 20, 25 years after the fact. Yeah, your universities are okay, but everybody’s copying them. Yeah, your R&D budget’s the biggest in the world, but is it growing? Is the federal government really increasing their effective R&D? And I want to discount weapons systems and some of the other things the federal government does which get counted as R&D. But what’s happened to the proposals to double the National Science Foundation budget, the Department of Energy research budget, the NIH budget? Those are lagging indicators. By the way, if you think your universities are so great, how many of you in this room are familiar with the ACM, the Association of Computer Manufacturers, who run the “Nobel Prize for software” competition between students at the research universities? It’s been run since the mid-1970s. For about the first 15 years, teams from the United States’ universities won this contest every year. Every year. I think in 1990, New Zealand snuck in there somehow and won the award, then the U.S. came back. The last time the U.S. won this award was in 1997. This year, the top-placed U.S. team, I think, was Carnegie
Mellon. Finished eleventh. This award now has become the domain of Russia, Eastern Europe and the Far East. If our universities are so great, why can’t we win this award?

Are these lagging indicators? Should we be paranoid? There are lots of other indicators you can look at. You can look at K-12 education. I’ll talk a little bit about that. We’re mediocre at best in the OECD [Organisation for Economic Co-operation and Development] countries in that area. You can look at the World Economic Forum, which does a competitiveness ranking of countries. We used to always rank number one. Last time, I think we were number seven, and falling rapidly.

You can look at the indicator that the U.S. has the best workforce in the world. One way to measure that is, what fraction of the U.S. workforce has a post-secondary degree, a university degree? We used to be number one in the world. We’re now number 13 or 14. We’re the only developed economy in the world where—I can see a lot of gray hair in the front here—people our age are better educated than the 25- to 35-year old cohort coming along. Only OECD country in that category. We’re falling in that. You can look at many other areas. One of my favorites is California, the home of Silicon Valley. The California education system, especially in K-12 math and science, rates in the lowest 10 percent of the U.S., which rates in the lower third of the OECD countries. So the home of Silicon Valley has a terrible infrastructure building up for the next generation. If that’s not enough, let’s look at the venture capitalists in Silicon Valley for a moment. What have they done in the last decade? They bet heavily in an area where Washington, D.C. suggested they bet, which is alternative energy.

We’ve had the interesting vision of venture capitalists investing heavily in alternative energy, and then turning into lobbyists going to Washington to increase the subsidies on the green investments that they made, so they can get their money out of it. Now what could be worse than Silicon Valley, the whole of venture capital, turning into Washington lobbyists? If that’s not a lagging indicator, or a leading indicator, I don’t know what is.

I would conclude that we haven’t really decided to compete in the 21st century yet. We are a little bit over-comfortable, overconfident that we are the world’s largest economy, the world’s largest investor in R&D, have the best universities. We’ve been that way for 30 or 40 years. It’s always going to be that way. We don’t have to do anything different. If someone asks us to run the Iditarod dog race, we’d fail miserably because we’re not willing to work hard to do it. What do we need to do, besides blame other people and besides try to prop up the middle class, which may not have the skills necessary to compete around us? I always like to go back in time and look at the last great surge of the U.S. economy, which was effectively during the Clinton administration, or the second half of the 90s, which was driven by three things. And they’re absolutely technical characteristics, which are what we’re talking about today.

I talk a lot about the importance of science and technology and driving the economy. I do so on the basis that most studies show that the U.S. economy—over half of the growth in the last several decades—has been driven by the high-tech sector. And so if we’re going to have growth in the 21st century, it’s going to be equivalently driven by the high-tech sector. I’m not demeaning the Shakespeare specialists in the audience. I’ve had the pleasure to attend one of their classes last night and talk about
Shakespeare and what Shakespeare would do in the boardroom. I’m not demeaning liberal educations. I’m just trying to stress the importance of science and technology to the country’s future. We don’t all have to be scientists and technologists and engineers, but enough of us have to be, and enough of us have to be good enough at it to be competitive going forward.

But what happened in the ‘90s? There were three separate things that happened. One, this guy Gordon Moore, way back in the ‘60s, coined Moore’s Law. And what did Moore’s Law say? “You can double the memory density processing power every 18 months.” If you sit there for a moment and think about that, what that means is memory and processing power become free, and they essentially are free today. You get free MIPS. We used to call them MIPS. And then we got to teraflops, and teraflops are outdated now, and you have to go to petaflops, and then exaflops. But computing has become free. We’re following Moore’s Law. Computing is becoming free. The communication guys, not the wireless guys, but the guys who ran glass fiber around, and things like that, quickly figured out you could push more and more photons down glass fibers every year. Faster, in fact, than you could increase Moore’s Law.

All of a sudden, communications became free, or almost free. These two technically-driven events take place, and then there was a third one. Bob Metcalfe was looking at the initial formation of the Internet and he said, “You know, the network becomes more powerful as the network becomes bigger.” In fact, the network scales at the square of the number of nodes in the network because that’s how many communication paths you have. So Metcalfe’s Law, which basically said the Internet becomes more powerful the more users there are, was the foundation of the last great surge of what I would call economic growth in the U.S. It was the Internet era, and it was driven not by just using what you had yesterday, it was driven by Moore’s Law—the photon law, and we built out to over a billion users of the Internet, and a ton of technical work took place to make that happen. It was forward-looking, but everybody believed in the technology, and we pushed it.

Now, what does it take to make that happen again? My contention is no single company is going to do that. It’s going to have to be driven by technical innovation, research and development. That research and development are going to take place in two big pieces—one at our tier one research universities and our national labs, which are kind of an adjunct to our research universities. National labs do really big science that you can’t afford to do here at Stevens or at most universities. It’s the sort of things that you see at Oak Ridge, or at Berkeley, or at the SLAC facility at Stanford. Big science coupled with the personal investigator-type research you have at places like this—that’s one component. The other component is what the private sector does—the Intels, the IBMs, the Ciscos, the Hewlett-Packards—those companies and their contribution to research, which is not so much basic as it is applied. It has to be a combination of those two groups.

This is what was in the works back in the early 2000s, when the government asked the national academies to do a study on competitiveness in the U.S. and I’m sure that Norm Augustine, when he was here, talked about it because Norm was chair of the “Rising Above the Gathering Storm” report, and I was honored to work with Norm and Chuck Vest and several others, 20 of us, on that report. We were looking at these features and said, “The United States is not really competing and not really
serious about competing, and what do we need to do?” And that report listed education. It listed investment in R&D. It listed the environment, an environment which incentivized investment. One of the recommendations we made back then, by several of us, including Congressman Holt, who worked on this for years, was: Let’s double the NSF budget. Let’s double the DOE basic research budget. Let’s continue to grow the NIH budget. I wish we had been successful with our report in 2005. Many of you have seen the follow-on report, which was “Rising Above the Gathering Storm II,” or affectionately referred to as, “Rapidly Approaching a Category V.” It basically said, by 2010, we were further behind than we were in 2005 when the report was written.

A big piece of that was increasing the R&D budget, and that is, I think, one of the absolute keys that you have to have going forward. If you look around the world today, there are absolutely, I would contend, no secrets about what the hot topics of the future are. Every geographic area has its list of the key areas to focus on in the 21st century. The EU has it. The Russians have it. The Japanese have it. The Chinese have it. Everyone has it. What do they have? Biotech—marriage of biology and engineering. Whoopee. Everybody knows that, so everybody’s investing in that. Biggest, smartest investors win. New materials for all sorts of reasons. Continued development of computer and communication technology. Alternative energy. These are the hot topics. These are what people are investing in around the world today. We either out-invest and outrun those people because they’re copying what we’re doing today, or we fall into that category of ho-hum.

“I am amazed that an Intel or a Microsoft has an R&D budget larger than the National Science Foundation.”

Let me not dwell on that dreary fact. Let me talk about another dreary fact: K-12 education. We have some absolute pockets of brilliance in K-12 education in the United States. Those of you who haven’t seen it, U.S. News & World Report puts out a ranking of high schools in the U.S. every year. They just did it two days ago, and you can find the top-ranked high schools in the U.S., and they are superb schools. They can compete with anybody, anywhere. The Washington Post does a similar study. They announced their results about 10 days ago. Similar result, a lot of [the] same schools on the lists. So we know how to do it, but if you look in the United States, on average, our kids do very poorly in the OECD rankings in mathematics, science, problem solving.

We tend to rank in the bottom half, quite often in the bottom quartile. I was reminded of this very recently. The Associated Press put out a headline and a little story blurb underneath, and it said, “U.S. Does Well on International Test.” They weren’t talking about mathematics or reading or science, they were talking about “problem solving,” where the U.S. ranked right in the middle of the OECD countries
on problem-solving capability. The headline meant to say, “Ranking in the Middle is Doing Very Well on an International Test.” That’s what we’ve come to now in terms of positive spin on poor performance. But in regard to K-12, let me just briefly recite for you the major studies on K-12 education of which I’m familiar: “Pursuit of Excellence,” published in 1958 right after Sputnik went up; “A Nation at Risk,” published in 1983. You remember the comment by James Harvey in that document which said, “If another country imposed upon us the mediocre K-12 education system we have, we might well consider it an act of war.” He was trying to get Washington’s attention with his verbiage.

In 1992, the governors met at the National Governors Association and said, “Yes, we have a problem; by the year 2000, our kids will be number one in math and science in the world.” In 1999, John Glenn chaired “Before It’s Too Late,” another commission, which concluded it is almost too late—we haven’t made any progress. In 2005, the “Rising Above the Gathering Storm I” came out, which said, “it’s getting worse.” In 2008, two things happened—there was a 25-year update to “A Nation at Risk,” which concluded nothing had happened, not because we didn’t know what to do, but because of political impediments. Also in 2008, the governors met again, and in 1992 said, “We were only kidding, now by 2020, we’ll be number one.” In 2011, President Obama said by 2020, we’ll be number one. In 2013, the Council on Foreign Relations (CFR), hardly a committee or group of people who you would think would be involved in educational reform or concerned about K-12 education, basically said K-12 education is the biggest threat to our society that we can see for two reasons—one, you can’t have a prosperous economy without a knowledgeable workforce, and second, CFR is always worried about national defense. They concluded that roughly 75 to 80 percent of the young people in the United States were ineligible to serve in the Armed Forces for one of three reasons—they were incarcerated; they were medically unfit; or they couldn’t pass the entrance exam to get into the Armed Services. What did every one of those studies from 1958 onward say? I’ll paraphrase it. It said our kids should have 12 years of math. Our kids should have three years of science. Our kids should have a foreign language. Our kids should study computer science. I thought that was amazing. That’s from 1958. We should treat our teachers as professionals and pay them accordingly. We should have a longer school day, a longer school year. And most importantly, we should look at what the rest of the world is doing because they’re out-educating us, as far as our young people are concerned.

Sixty years of study, the latest OECD ranking shows us flat, and some areas of the world improving dramatically, especially in Asia. Now, with this backdrop, how can I be positive about the future? I’m positive because (a) I think people are finally becoming aware of the situation, and (b) there are some positive signs, not that they’re without trouble, but there are positive signs. We have examples, points of light of people who know how to do it well. I run a charter school called BASIS. We have two of the top five schools in the country. Those are the only two of our schools old enough to be ranked. My goal is to have 10 out of 10 to show it can be done. We have Common Core, which is, let’s raise the standards and the expectations on our students in K-12. We have university presidents who are starting to say, “You know, our supplier, K-12, is not doing a great job. Their output spec should match our input spec, and if it doesn’t, they should fix it.” That’s a voice which has been absent in this area for far too long. We have higher standards. We have points of light. We have Common Core. My friends, the
Republicans—I am a Republican, but I abhor some of the things my party does—have a current tirade against Common Core, calling it an Obama innovation, or invention, subverting the local control of schools. If anybody argues that to you, send them to me, especially if they're a public official. Because if they're a public official saying that, they're too dumb to be a public official. And if they believe it, they're too dumb to be a public official. There are opportunities here. We are focusing on increased international competition. We need to do that. We need to fix our K-12 system, not so everybody can be a scientist and engineer, but so our citizens can understand the issues facing us today as a country. And those who don't even go to college can have the basic skills to be an auto mechanic, or a welder, or a productive member of society, and earn a good living.

Today, most of the graduates of high school don’t fit in that category. So there’s an opportunity here to move ahead on K-12. Now, why do I still have hope for the United States? Go back to my second boundary condition. Market shares are won and lost during periods of transition. The world is in a huge transition and technology is continuing to move forward, which means technology will give us transition after transition going forward. If we get hold of those transitions, like we did with the Internet, we can be a world leader. We can win market share. It’s very simple. If we look at biotech, are we investing enough? Will we be the leader in this marriage between biology and engineering? If we look at the marriage of communications and computing, if we look at just having silicon chips with computing functions on them when we can have silicon photonics combined with the compute capability, can we continue to extend Moore’s Law for another 50 years using that capability? That marriage of silicon photonics and silicon computing is happening as we speak today.

Can we grab the simulation capability that is rapidly replacing experimentation in the world today? As we get more and more supercomputers, and you can do more and more material synthesis, biological analysis, medical analysis from a simulation standpoint, will we do that? Then I ask you rhetorically, do we have the biggest supercomputer in the world in the United States? Congressman [Holt], do we? No. The Chinese do. Now, at Oak Ridge, they have an 18- or 20-petaflop machine. It’s a pretty darned big computer, but we are not on track to be the leader in that space. Others are. Are we on track to take advantage of the next generation light source, the X-ray free electron laser? There is a small one of these at Berkeley. SLAC at Stanford has a contract with the DOE to build a big one, a multi-megahertz pulse soft X-ray light source that you can image molecules and watch chemical reactions as they take place. Will we take advantage of that? Will we actually build it? Will the DOE continue to fund it? Will we be a world leader? By the way, even if we build it and fund it, I don’t think we’ll be a world leader because there are three equivalent facilities being built around the world today in that space.

So are we serious about competing? I want to conclude by saying the “Rising Above the Gathering Storm” published in 2005, was a wake-up call to the country. It didn’t say anything new. It didn’t say
anything that hadn’t been said many times before, but it put it all in one place from an unbiased entity, the National Academies—the National Academy of Science, the National Academy of Engineering, and the Institute of Medicine. It fulfilled a national academies’ charter, as set out by President Lincoln to advise the government on critical issues in this area. It called for a number of things to happen. One or two of them happened, but most of them haven’t been touched.

So I want to encourage all of you, before you vote this fall, get your copy of that 2005 document, or the 2010 document, read it and say, “This is what we need to do going forward. This is what the country needs to do if it wants to catch the next transition, to grow its market share and not continue to lose market share.” If that is too big an ask for you, then I’ll refer you back to Andy Grove, just be paranoid.

Thank you.

A video of Dr. Barrett’s lecture is available at:
www.stevens.edu/lecture.