

REMARKS BY GEORGIA TECH PRESIDENT G. WAYNE CLOUGH
“The Innovation Imperative and the Research University”
NACUBO Annual Meeting, July 10, 2005

It is a pleasure to be invited to be part of your program for the 2005 NACUBO annual meeting. Universities – especially those of us who are public institutions – are increasingly called upon to do more with less in the way of financial resources. And talented, knowledgeable business officers have become more essential than ever. At Georgia Tech, we have been fortunate to have the services of your member, Bob Thompson, and his staff, whose collective talent and acumen have helped us create a forward-looking agenda and grow our campus even in challenging times. Much of the progress our institution has made can be attributed to Bob and his group of hard working folks.

This morning I want to speak with you about the increasingly important role of research universities for our country as it is challenged to compete in a rapidly moving global, innovation-based economy, and about what universities themselves need to do if they are to participate. It is an interesting opportunity to be conducting this discussion on the heels of the general session keynote by one of the foremost economists of our day. I am an engineer, not an economist, and I am not going to pretend to have any expertise about issues like the impact of the federal deficit or the appropriate use of fiscal stimulants. But one of the broader themes that emerged in the course of Allen Sinai’s talk was the growing interdependence between the U.S. economy and the economies of other nations around the world.

The same idea can be extended to higher education. We are used to thinking of ourselves in national terms through our benchmark studies, rankings and competitive processes. But in the future, our context is going to be set by global circumstances as other nations ramp up their efforts to compete in the innovation economy and commensurately increase their investments in their research universities. Along with this trend will come an inevitable shift in the dynamics of how talent is distributed around the world. The author Richard Florida refers to it as “the new global competition for talent” in his recent book, *The Flight of the Creative Class*. Of course, major universities in the U.S. have long thought of themselves in international terms, but in the past our position allowed us to dictate the terms of play. We were able to pick and choose from the best of a long list of international student applications, and we knew that our corporate partners were largely confined to U.S. universities for first rate research. Today, the currents of change are sweeping us along with our corporate partners, and we need to anticipate and provoke change, not just respond to it.

Over the course of the past several years I have been privileged to chair an initiative of the National Academy of Engineering called the Engineer of 2020. Our goal has been to attempt to gaze into the crystal ball of the future – anticipating the ways in which the world will change in the coming decades and recommending ways that engineering education should change to produce a graduate who is prepared for the challenges that will lie ahead. This approach turns on its head the approach that engineering has relied on in the past of reacting to change after the fact and trying to play catch up. I believe many of the findings are applicable to the larger university environment, not just engineering.

As we undertook that task, we discovered that even at its best, predicting the future is dicey. Back in 1950, *Popular Mechanics* printed an article predicting what life would be like in the year 2000 by extrapolating forward what was happening in research labs at the time. It accurately anticipated teleconferencing and the widespread use of fax machines. But the writer failed to foresee the invention of the microchip, which sent technology spiraling off into all kinds of new directions. Personal computers, laptops, and cell phones, are

nowhere to be found in that article. Instead of the Internet and e-mail, the article envisioned the postal service zipping paper mail around in little rocket-propelled airplanes.

To avoid falling into the trap of literal extrapolation to predict the future, the Engineer of 2020 Project used scenario based planning, a technique designed to consider a range of possibilities, some of which were dictated by technological change and others driven by external factors like socio-political forces. One only has to consider how we arrived at our position today to see just how important external factors can be in shaping the outcomes of technology and university outreach.

Today our lives are filled with technologies that we use daily and take for granted, but which did not even exist just 20 years ago. Most of these were developed in the United States in the heyday of our domination of the innovation sector. The computer of 20 years ago featured a nine-inch text-only display, had no hard drive, and cost more than \$4,000. Digital cameras did not exist and there was no commercial Internet. There was no E-bay or Amazon or any of the remarkable conveniences we use almost daily. Today we not only have many new technologies that we take for granted, but they are converging and merging. People talk on their computers with Voice-over-Internet-Protocol and send e-mail from their cell phones.

But, technology is not the only thing that changed rapidly during the past two decades. Twenty years ago the Berlin Wall was still standing, and the world was dominated by two political power blocks – the communist world of the East, anchored by the Soviet Union, and the democratic world of the West, anchored by the United States. Then the Cold War ended and the political barriers that had separated the world dissolved. Trade barriers between many nations came down, and people gradually began to think of the world as one interconnected space rather than several disconnected power blocs.

These two simultaneous forces – rapid technological change and rapid political change – set the stage for the global economy that is evolving around us today. The proliferation of telecommunications technology and the development of the commercial Internet have opened new avenues of inexpensive real-time communication. Emerging nations like India, South Korea, and China have recognized the gift that has fallen in their lap, and are busy developing technology-based economies. These nations, together with Japan and the European Union, have serious plans aimed at competing with the United States in the innovation sector – the very sector where our research universities have staked out their future.

Some pundits argue that this is not a problem. After all, the U.S. consumer market is the largest in the world, and even though our economy may not be the fastest growing, it is still responsible for a larger share of global economic growth than any other country. Our total R&D is more than that of all other G-7 countries combined, the United States holds nearly 40 percent of the world's financial stock, and our innovation system is still the most robust. Within this view, the increase in sophistication in the innovation agenda of other nations and their upward trending indices are not to be feared, but considered in the vein of events in the natural order of things, with the United States continuing to hold the dominant position.

Then you have the other side of the coin – those pundits who argue that there are danger signs such as the fact that the EU nations, India, and China each now out-produce the U.S. in science and engineering graduates, with this gap expected to widen in the future. There is a downturn in numbers of technically talented international students and workers that come to the United States – a new phenomenon adding another turn of the screw to the workforce picture. Of the world's 25 most competitive IT companies, today only six are headquartered in the United States while fourteen are headquartered in Asia. Our federal R&D investment, while growing in dollar value, has declined from 2 percent of the GDP in the mid 1960s to about 1 percent

today. Within this context, concerns focus on a federal R&D investment that is not well balanced between fields, and some would argue is starting to short change long term research.

The litany continues, noting that high technology companies headquartered in the U.S. are now moving not only sophisticated manufacturing overseas, but also significant R&D operations. Scientific papers published by American authors have been flat for more than a decade, and the number of U.S. patents issued for inventions that were created abroad is on the rise. All of these things are also true.

So who is right about the importance of these trends? The answer is that no one knows for sure, but I would suggest our nation and our universities should be taking all of this very seriously because the risk of taking no action is very large. While the United States is still at least a 700-pound economic gorilla, the dynamics of economic power are beginning to change. Population demographics indicate that in 20 years from now, of every 100 people in the world, only 4 will live in the United States, while 56 – more than half – will live in Asia. As Thomas Friedman points out, even if only 10 percent of Chinese, Russians, and Indians become engaged in the global market, that is still 300 million people – more than the entire population of the United States. As the world becomes more interconnected and as the economic playing field becomes increasingly level, these circumstances will inevitably affect U.S. universities.

The growing global economy and the leveling of the playing field have changed the business landscape in significant ways. Over the past 30 years or so, the number of multi-national corporations has not only increased nine-fold, but the definition of a multi-national corporation has changed. We are used to thinking of multi-national corporations as big American companies with foreign branches or subsidiaries, but as business guru Peter Drucker recently pointed out, that is no longer true. U.S.-based companies are a small and shrinking fraction of the world's multi-national corporations. Of the 500 largest multi-nationals, only 185 – less than 40 percent – are headquartered in the United States. And they are growing much faster outside the U.S. Instead of generating products like Coca-Cola or cars, the largest multi-nationals are now service industries like banks, insurance companies, and financial service institutions.

A few weeks ago I had a conversation with Craig Mundie, senior vice president at Microsoft, who said he doesn't think of Microsoft as "multi-national," but rather as "global." What's the difference? A multi-national corporation has a home base in one country and does not adjust its business model or its products to fit local conditions. By contrast, in India Microsoft markets programs in 15 different dialects of Hindi, and one of Microsoft's fastest growing R&D facility is not in Seattle, but in Beijing. A truly global company takes a sophisticated approach that acknowledges nuances within a country and in many cases engages its citizens in all of its activities, including R&D.

In this new economy, it would be unrealistic for the United States to think that we will continue to dominate the high-tech end of the economy as we have in the past. We, and this "we" includes U.S. universities, must learn to compete in an environment in which:

1. We produce only one of every four or five major inventions.
2. Our wages and the cost of health care systems are higher than those of our global competition.
3. The largest market for technology products are in Asia.
4. The largest technological workforce resides in other nations.

If we are to succeed in the future we need to reconcile ourselves to these new circumstances while there is time for us to build on our natural strengths. In October of 2003, I took a boat trip up the Columbia and Snake Rivers, retracing part of the route that Lewis and Clark took on their historic cross-country journey, and as I went I read their journal. That trip helped me understand what a rich heritage this nation has of exploration,

discovery, and risk-taking. Beginning with the earliest pioneers, Americans have always looked for new frontiers and imagined a better future. Today, the new frontiers are in the realm of ideas, a space that universities should help to lead.

As a nation, we have been known for entrepreneurship and finding ways to implement ideas and developments that are on the cutting edge, with much of this horsepower coming from our research universities. Put simply we have been the best at innovation, something we have largely learned by experience and something about which we still have much to learn. Innovation begins with the discovery and invention in science and technology, then adds to them the insight necessary to use those discoveries and inventions to solve problems, address the needs of society, meet market demands, and even create new markets. Innovation is a social activity that emerges from conversations and collaboration across the traditional academic disciplines, across the country, and around the world – collaborations that enable people to piece their ideas, knowledge and inventions together in unique ways.

For example, Mark Allen is an electrical engineering professor at Georgia Tech and a recognized expert in MEMS, which stands for micro-electro-mechanical systems. It is a technology that is often used to make tiny sensors. At the request of the Department of Defense, he developed a microscopic sensor to be placed inside the engine on a drone aerial vehicle to monitor air flow and turbulence and radio the readings to the controller, who was somewhere else on the ground. His technology helped make the successful use of drones possible in Afghanistan and Iraq.

Then Mark was called by a doctor at a hospital in Cleveland who was looking for a solution to a problem that cardiologists have with heart patients who need to be monitored because they have chronic heart congestion or have had a stent inserted somewhere in their circulatory system. The current monitoring technique is a CT-scan, which is not only expensive, but also requires the use of a dye that is toxic to the kidneys. And pretty soon these heart patients develop kidney problems that keep getting worse with each scan.

The result of this unusual collaboration between an electrical engineer and a cardiologist has been the development of microscopic sensors that are either built into a stent or sent through the blood stream to lodge in a lung. Instead of a CT-scan, the doctor simply waves a wand in front of the patient's body to pick up readings that are radioed from the sensor. In some cases, the patient does not even go to the doctor's office, but sends in the readings over a phone line. From this creative collaboration has come a company that employs thirty people and whose products are about to receive approval for use in medical practice. This is the kind of interdisciplinary collaboration that is at the heart of the innovation process, and it offers an exciting example as to how education, research, and the commercial marketplace can join together to make something remarkable happen.

During 2004, I was privileged to serve as co-chair, together with IBM CEO Sam Palmisano, of the National Innovation Initiative, sponsored by the U.S. Council on Competitiveness. We involved 400 of the nation's best minds from academia, industry, and government in developing an action agenda designed to help the United States compete in a world set on increasing market share in the innovation sector.

The National Innovation Initiative generated 30 recommendations that we grouped under three broad topics. The first is talent, which is the human dimension of innovation. The second is investment, which is the financial dimension of innovation. And the third is infrastructure, which provides the enabling framework for innovation. Research universities have interests at stake and an important role to play in each of these.

One of the most basic things we need to do is to replenish the pipeline of scientists and engineers who can discover the new ideas and invent the new technology that form the raw materials for innovation. I've already noted that we are being out-produced by other nations, but this is only part of the story. The United States lucked out in the 20th century, because, although we were doing little to encourage our own home grown talent to undertake studies in science and engineering, a disproportionate number of the world's brightest and best minds migrated here. What was the formula? We had the best universities, and our government was the most consistent and reliable funder of university R&D. So when circumstances in other nations drove the best and brightest to leave, they came here.

The underlying principles that made that formula work are no longer dominant, as nations like India, China, and Russia upgrade their educational programs and increase R&D investment. At the same time, the United States has responded to the terror attacks of 9/11 by making it more difficult for students and academics to obtain visas and by handicapping the ones who do manage to get into the country by banning them from particular types of research activity through export control policies. International students are now heading to friendlier places like Europe and Australia or staying home to enroll in vastly improved educational programs. Applications to American graduate schools from international students are down 33 percent over the past two years. Of those who come, more and more are returning home after they graduate. Attracting talent from abroad played a large role in America's rise to technological leadership during the 20th century, but we are now losing that advantage.

The second broad area of the National Innovation Initiative recommendations is investment. Today we enjoy the benefits of a wide range of technologies – from the Internet to magnetic resonance imaging in medicine – that emerged as applications from fundamental, exploratory research begun decades ago. And it is critical to keep that research pipeline flowing. But over time, the federal R&D portfolio has lost its balance, with the lion's share of funding increases focused on health and life sciences, while funding for areas like engineering and the physical sciences languished.

However, the hotbeds of discovery and innovation are increasingly in the spaces between the traditional academic disciplines – in fields like nanotechnology, logistics, biotechnology, optics, and photonics. As the story of Mark Allen's heart sensors demonstrates, advances in biotechnology are based on research not just in biology, but also in chemistry, physics, electrical engineering, and mechanical engineering. This problem has been well documented by organizations like the President's Council of Advisors on Science and Technology, the National Research Council, the American Association for the Advancement of Science, and the Council on Competitiveness.

In response, Congress recently expressed its intent to correct the imbalance by expanding the budget of the National Science Foundation. Unfortunately, dealing with the federal budget deficit has thwarted that commitment. But even if Congress had provided the NSF funding, setting things to right is not that neat and tidy. Research in engineering and the physical sciences is spread across several federal agencies, and in some disciplines agencies like the Department of Energy provide more funding than NSF. As a result, we need to work strategically toward common goals that can garner broad-based support. If that does not happen, it will come back to haunt us. This will require a re-building of the coalition of trust between research universities, government, and corporations if we are to find the will needed to make the investments required.

The third topic of the National Innovation Initiative recommendations is infrastructure, which includes not only physical structures like highways and fiber-optic networks, but also what I would call "intangible" infrastructure – or the policies and the metrics that are needed to support innovation. They range from policies regarding intellectual capital to metrics that enable us to better value the human and intellectual assets that

increasingly enable corporations to maintain their competitive edge. While today we know intangible assets are as valuable as physical assets to our U.S. companies, we still do not have a policy framework to value them appropriately.

A number of cities and states are planning regional innovation summits to roll out the NII results and shape them for local conditions, and I hope many of you will have an opportunity to participate in discussing the recommendations and planning for their implementation. You can join us in Atlanta on October 31 on the Georgia Tech campus for one of these.

Talent, investment, infrastructure – research universities have an important role to play in all three. Now, such an agenda may sound to some ears as utilitarian, but I believe it is one of the frameworks we can use to help us better compete in this new global environment, to sharpen and clarify our role in support of the governments and people who fund our institutions, and to energize and broaden the educational opportunities we offer our students. In return we can expect to improve our own creditability with the public and our governmental institutions, which will aid us in our endeavors to seek support and influence policy in the future.

Too often we begin discussions about universities and their willingness to be responsive with the old aphorism that “universities are like big ships; they take a long time to change course.” I hope we can see the day when this phrase disappears from use. I have been fortunate to be at a university where I am sure this does not apply, and I have been in many meetings with my university colleagues, where I have heard of many exciting examples that illustrate how universities are steadily innovating in their educational offerings, research activities, outreach efforts, business practices and facilities developments. The quiet facade of our campuses often conceals from the public a sea change of activity. Innovation should not be a word that we shy away from, or a word that is only used in discussions about university research. We need to embrace it and see to it that others know what we are doing.

This should extend first and foremost to seeking how to better serve our students and provide them with a meaningful education. At the practical level, many of us have developed sophisticated electronic financial and service systems that allow students and parents to pay bills, learn about new services, be reminded of appointments with advisors, and sign up for courses, events, and parking without ever standing in a line or using a piece of paper. At Georgia Tech our students can even time the wait for campus trolleys and buses through a web based GIS tracking system.

Many of us have also improved education through technology as course materials are routinely web based, chat rooms are used to help students interact with faculty, and high speed Internet systems have staggeringly increased information access while also allowing creative interaction between students at different universities working on similar course projects. Access to what a university education represents is being dramatically changed by projects like MIT’s online OpenCourseWare, which is a free and open educational resource for students, faculty, and self-directed learners around the world.

But innovation in education is not confined to the revolutionary changes allowed by the power of computing and electronic delivery. Recognizing the imperative for our students to understand the creative process and to appreciate the changed global context, many of us have created new opportunities for undergraduate students to participate in research and study abroad. At Georgia Tech we have quadrupled the numbers of our students taking part in both of these activities in the past six years, and our goal is sight of having 50 percent of the student body involved in each before they graduate.

Innovation even extends to the degree options available to our students. There are a growing number of interdisciplinary degrees for our students to major in that build on the strengths of our disciplines. For example, on my campus our students can obtain MS and even PhD degrees in digital media, the human computer interface, computational finance, and bioinformatics and these are taught by faculty from different colleges and departments.

All of these activities taken together – better service, ease in negotiating the system, improved educational delivery, enhanced options to broaden the educational experience, and more relevant degree options – offer a new dimension of opportunity to our students, often times making me wish I were a student starting over again. They also improve our success rates in retention and graduation, and are effective in attracting women and minorities. At a university like Georgia Tech they add up to increased numbers of young men and women who fill our growing need for technological talent.

Responsive universities are also using innovative approaches to improve administrative services, and in the process to save money and enhance efficiency. For example, new information systems are streamlining faculty and staff payroll and business transactions. Secure websites where employees can update their personnel information and access their pay information, combined with the electronic transfer of their paycheck into their bank account, reduces the volume of paper, postage, and data entry in the payroll office. These are but a few of the ways we are innovating so we can as, our politicians often remind us, do more with less.

Innovation should extend even to the campus buildings and grounds and this is motivated by a variety of reasons. As nations like India, China, and Russia focus on the rapid development of their economies, the demand for conventional energy sources and construction materials have risen exponentially, and we feel the effects on our campuses. The cost of raw materials is up, and so are the costs of water and sewer services and power, and we have to seek ways to moderate them. At the same time, we are motivated by intellectual goals such as setting an example for a sustainable future and seeking ways to use facilities to enhance interdisciplinary teaching and research. In some instances these objectives can merge since doing the right thing in terms of how water is used can also lower costs. But to truly be innovative in this space calls for us to do something different – integrate our administrative and academic efforts in a way that has not been done before. This can be a bit risky, but at the same time it is exciting and makes life on a campus more fun.

I am truly encouraged by the trends that are emerging for sustainable construction on our nation's campuses. The U.S. Green Building Council rates construction projects for environmental sustainability, taking into account factors like the use of recycled materials in the building, the recycling of construction waste, energy efficiency, and proximity to public transportation. And as I prepared for this talk, I reviewed the list of buildings that have been certified by the Council for Leadership in Energy and Environmental Design, or LEED. The list included buildings on 30 campuses around the nation, from small colleges like Pima Community College in Tucson, Arizona, and Juniata College in Huntingdon, Pennsylvania, to major research institutions like Harvard University, the University of Michigan, the University of Washington, and Georgia Tech. But 30 institutions is just a tiny fraction of the thousands of colleges and universities in existence around the nation, so there is plenty of work to be done here.

As the story about Mark Allen's heart sensors demonstrates, another challenge facing research universities if we are to fulfill our role as drivers of innovation is to become interdisciplinary. We all talk the talk, but to walk the walk, we need to create a physical environment that in itself encourages faculty and students to converse and collaborate across disciplinary lines in the course of their daily activities.

At Georgia Tech we take this very seriously and believe that the way we plan and design our physical campus can make a significant contribution to creating an interdisciplinary environment. Over the past decade we have built or renovated over five million square feet of space and we have used this as an opportunity to deliberately design clusters of academic buildings around themes rather than disciplines. We are now completing the fourth building that makes up our Biotechnology Complex where we have brought together engineers, scientists, and policy makers through office and laboratory design as well as by the strategic positioning of our Starbucks and dining facilities. This complex also includes a first for us in one of the buildings – an incubator floor with wet lab capability. The incubator is run by our high tech business incubator, the Advanced Technology Development Center and is designed to promote early commercialization of research ideas. Other themes that are driving building clusters on our campus include nanotechnology, information technology, manufacturing, and computing. Given that the amount of research funding on our campus devoted to interdisciplinary activities has rapidly increased in the past five years, we believe this approach is succeeding as we had hoped it would.

Innovation is also increasingly showing up in university activities through multiple university collaborations. In some cases this can be driven by federal funding but it is also a function of higher motivations. Locally in Atlanta, Emory University and Georgia Tech used Emory's lack of an engineering program and Tech's lack of a medical school to advantage by creating a unique partnership to form what is now one of the nation's top five biomedical engineering departments. This program is jointly governed by the respective boards of trustees of the two universities.

But collaboration can extend well beyond local partnerships. For example, the Organization for Tropical Studies, which is headquartered at Duke University is a collaborative effort of 63 universities in the United States, Latin America, and Australia that offers graduate education, conducts research, and engages in conservation activities around the world.

Another exciting example is formation of the National LambdaRail, Inc. which represents a concerted effort by a group of universities, including Georgia Tech, to create the next generation network needed for the advanced research of the future. The earliest expression of this fiber-optic network is now live, and when it is fully implemented, it will have 40 times the capacity of Internet2. But more than this, it allows for universities to use as much of this power as needed for concentrated periods of time rather than waiting for space on a limited, shared network. The universities that decided to create the NLR did soon their own, striking while the fiber was available and developing the protocols for its use without having to compromise on operational objectives. This is a great example of an innovative approach that involved risk, but risk supported by the level of reward.

In the time I have with you, I am able to illustrate only a few of the ways in which universities are demonstrating their ability to innovate. There are more I could cite – for example, initiatives to create educational systems that will take on global dimensions and new approaches to economic development to speed the delivery of the ideas from our research labs to the marketplace where society can use them to improve the world. In spite of the challenges we all face in terms of limited resources, political forces that are attempting to set our agenda for us, a growing public skepticism about rising costs of education, rising expectations, and the need to improve access, there has never been a more important time for universities to innovate. We have examples before us that demonstrate the power of this idea.

In closing, I want to return to a theme I left hanging earlier in my remarks. I noted in comments about the Engineer of 2020 that we attempted to predict the future, by using a scenario based approach to planning. What did we conclude? Well, I am not going to give it all away and instead recommend that you refer to the

publication that can be obtained from the website of the National Academy of Engineering. The bottom line is that we believe that we are on the verge of one of the greatest periods of technological change in our history, riding on the wave of coming developments in areas like nanotechnology, and biotechnology. However, we also believe that socio-political factors will have a significant effect on how, and if, the new technology will be implemented.

There is no one specific future we can foresee, but universities can be the proverbial tipping element if they have the will to be adaptable, to anticipate change, and to be responsive to new conditions. In sum, I believe universities will have to learn to be innovative to their very core and they will have to accept becoming risk takers, including the downside that can come with this territory. As business consultant and entrepreneur Harold R. McAlindon put it, “The world leaders in innovation and creativity will also be world leaders in everything else.” We need to work together to seek to innovation if we are to continue as world leaders in higher education, and in doing so, we can help our nation respond to the hopes and dreams of future generations of our fellow citizens.