

REMARKS BY GEORGIA TECH PRESIDENT G. WAYNE CLOUGH  
Print Pak Corporate Meeting, September 13, 2004

It is a pleasure to be here with you this morning and to welcome you to the Georgia Tech Hotel. Dennis Love has been very generous in giving me an hour of your time. But I'm going to try to finish my talk in a little less than an hour so that you have an opportunity for comments and questions.

The Love family and Georgia Tech have had a special place in each other's hearts ever since J. Erskine Love first set foot on the campus as a 16-year-old boy from a small town in South Carolina. He immersed himself fully in campus life – pledging Delta Tau Delta and serving as president of the Ramblin' Wreck Club, a member of both the honor society ANAK and the Omicron Delta Kappa honorary fraternity, editor of the student newspaper *The Technique*, manager of the baseball team, and editor of the yearbook *Blueprint* in his senior year. And throughout his life, he often said that next to God and his family, there was nothing he loved more than Georgia Tech.

Erskine Love started Print Pak within eight years of graduating from Georgia Tech, and over the next three decades, he shepherded this company from two employees and one machine to 1,200 employees at eight manufacturing and 15 sales facilities.

But he still made time for Georgia Tech. He was a trustee, then president of the Georgia Tech Foundation and a member of the board of the Alumni Association. He was a charter member of the Thousand Club, and he was chairing the hugely successful Centennial Campaign on the Institute's 100<sup>th</sup> birthday, when he passed away unexpectedly in 1987 at the age of 58.

Today his family walks in his footsteps, carrying PrintPak forward to new milestones, and continuing to support the same institutions and organizations that Erskine loved, including Georgia Tech. Today the J. Erskine Love Manufacturing Building on the Tech campus pays tribute to his life, and an endowment created by the Love family supports education and research in manufacturing-related disciplines.

Ever since our earliest days, when students helped support the school by making equipment for Georgia industries, Georgia Tech has been integrally involved in manufacturing. We know that at its most fundamental level, the health of our economy depends on manufacturing. That is as true today as it was in 1885 when Tech was founded. It is manufacturing that actually creates wealth. The service sectors of the economy just move it around.

But what is also true today is that the nature of manufacturing is changing. The recent recession masked some fundamental shifts in the economy that were coming to fruition at the same time. First, technology has been improving productivity and reducing costs, and nowhere is that more obvious than in manufacturing. Computer power has revolutionized manufacturing processes and practices, creating a vast family of tools that offer unmatched precision, quality and efficiency – from CAD-CAM to “just in time” and “demand-pull” manufacturing. Real-time communication feeds information back into the process in time to reduce the margin of defects to virtually zero.

Salespeople with cell phones and laptop computers cover more territory in less time, and sophisticated logistics systems speed the products on their way.

Communication technology has helped industry overcome the constraints of time and place. The Boeing 777 aircraft, for example, has 132,000 uniquely engineered parts that were designed by hundreds of suppliers in a dozen different countries. Yet no model of the plane was ever assembled to make sure the parts fit together and worked. The plane was simply manufactured and flown. The design of its parts was coordinated across company lines and national boundaries using compatible software on networked computers. Parts and systems were pre-assembled and tested at computer work stations.

The Internet also gives companies an opportunity to speed up the pace without violating one of the most entrenched perks of skilled, professional jobs – the eight-to-five workday. Companies are increasingly using the capabilities of the Internet to in effect create a night shift and get the work done faster. At Bechtel, for example, an engineer in the United States who is finishing work for the day on the design of a power plant, sends his work over the Internet to a colleague in New Delhi, India, who is just arriving at the office to begin the workday and who picks up where the American engineer left off.

Technology has helped manufacturing to compete by enabling it to hold down costs and prices. While overall prices were increasing by 140 percent over the course of the past 25 years, the average price of manufactured goods increased by only 60 percent. What data like this reflect is higher productivity enabled by technology, which has allowed American manufacturing to offset a higher level of wages. Manufacturing productivity was strengthening from 2001 through 2003, even 1.3 million jobs disappeared during the same timeframe. The reason was because productivity gains outstripped the demand for goods, so that manufacturers could meet market demand with fewer employees. Contrary to prior experience and popular perception, these jobs did not go overseas. They disappeared entirely. A new catch phrase we are beginning to hear is “lights out” plants, which are so automated that there is nobody around who needs light to see what they are doing.

The second trend that has had a significant impact on manufacturing is the opening of the international marketplace and the resulting increase in international competition. It has been caused by reduction of trade barriers and also by the end of the Cold War, which brought down the political barriers that had segmented the marketplace. Russia and China have now emerged from behind what was once the Iron Curtain to become global competitors.

In general, this is a move in the right direction, because it opens up new markets for American goods and services. But the process has been uneven and the impact on manufacturing has been problematic. Barriers in the trade of goods have come down more quickly than in other sectors. For example, over the past 20 years, trade in manufactured goods has increased almost twice as fast as trade in agricultural commodities. This has speeded up competition for manufacturers and left them very little time in which to adjust.

U.S. exports also face heavy tariffs in many places – heavier than goods coming into the United States. And the United States is much less likely to subsidize manufacturing directly the way

many of our competitors do. We also have stricter environmental rules and compliance issues for labor than much of the rest of the world. And while we are pretty adamant in our respect for intellectual property rights, other countries can be quick to disregard them.

So, policy both at home and abroad is lagging behind the reality of the global marketplace to the disadvantage of American manufacturers. In the long run, as countries develop economically, quality of life becomes a driving issue, and they invariably choose higher wages and higher environmental standards for themselves. But that can take a while, and in the meantime the disparities create problems for American manufacturers.

So far, virtually all of the market share gains made by China have come at the expense of Europe and Japan, while the United States actually slightly increased its share of the world market for manufactured goods between 1980 and 2001. But we are going to have to be proactive to hang on to our edge. Even with the productivity gains American manufacturers have made, they face a future in which nations like China, Russia, and India will be working to strengthen their positions.

We cannot fault other nations for wanting to make themselves more competitive in the global economy. In fact, if they succeed, they will become better markets for U.S. goods and services. To quote *Business Week's* chief economist Michael Mandel, "The biggest danger to U.S. workers isn't overseas competition. It's that we worry too much about other countries climbing up the ladder and not enough about finding the next higher rung for ourselves."

It is clear that we cannot compete in this economic climate by offering the same old solutions. If we do, we are likely to be out-manned in our workforce and disadvantaged by a higher cost structure. And decision makers will go elsewhere for their answers.

To quote my friend George Scalise of the Semiconductor Industry Association who also serves with me on the President's Council of Advisors on Science and Technology, "U.S. high-tech leadership is not guaranteed. That is all there is to it. We have it. We enjoy it. We have been here forever. But it is not guaranteed going forward."

To win in the competitive circumstances we face today, we must provide solutions that are creative and innovative. Our solutions must be cost effective not because they are cheap, but because they offer additional value to customers that makes them worth the money.

The advantage that America's global competitors have is at the end of the spectrum where processes and products are simpler or where they have been standardized and become routine. We need to accept the reality that we are not going to have a competitive advantage among those who provide what is needed at the low end of the economic spectrum. Our opportunity is at the high end of the spectrum, and our success will be based on our ability to compete with high-end products and services.

So, we need to redefine the traditional economic lingo, images, and perceptions that pertain to low-skill pursuits and refocus them on the high-level, leading edge of the economic spectrum. We have traditionally thought of factories as dusty, greasy, and full of rows of people operating

clanking machinery. And while manufacturing of that sort may still be needed to make some products, it will fall at the lower end of the economic spectrum, which we will cede to others to do. American manufacturing of the future will be focused on the highest-possible leading-edge precision technological work that it is not possible to do in other parts of the world. It involves sophisticated, complex equipment, and American manufacturers are starting to raise their qualifications for employees. For example, at the Timken Company, which is the world's leading manufacturer of roller bearings, technology and processes have become so sophisticated that they now looks for workers with bachelor's degrees for many of its entry level positions.

Our traditional economic lingo also connects the word "services" with low-skill jobs like the typing pool or the cleaning crew. While those tasks will still need to be done, we need to expand our concept of services to reflect the most sophisticated level of business operations. The letters in IBM, for example, stand for International Business Machines, and for many years all IBM did was manufacture office equipment. Today only one-third of IBM's business is in hardware. Two-thirds of it is providing the software and the ongoing business services that put the hardware into a context that enables its use to be maximized.

Companies can no longer simply manufacture goods and put them on the shelf. With the sophisticated products on which the United States needs to focus must come the added value of customer service. A competitive global economy puts the customer in the driver's seat, and the trend is toward products and services that can be customized to fit the customer's needs and provide maximum benefit. That calls for us to offer a higher level of detail engineering that meets the ever-tightening specs and consistency that customers want and need. And it calls for increased follow-up and feedback from customers. The key question is not merely how can we make a product better, but rather what can we make it do for our customers that will make life better for them.

If we want to maintain our standard of living here in the United States, we need to lead the way at the high end of the economic spectrum, providing sophisticated manufacturing and services that are a step ahead of the rest of the world. To do that, we have to build an economy that is based on innovation. So, what, exactly, is innovation? You will hear the word innovation used interchangeably with "invention," but they are not the same thing. Invention can be done by the lone genius tinkering away in the garret or the garage. Innovation is a much more social activity that emerges at the intersection of technology with business and the marketplace. Innovation requires not only that we are the first to invent leading-edge technology, but also that we are the first to develop new ways to put that technology to work to address needs and solve problems. At its most literal economic level, innovation creates jobs, but it also functions on other levels to help us improve our quality of life in many ways.

In other words, innovation is a combination of novelty and utility, and the formula is invention plus insight. Innovation begins with targeted investment in fundamental research that is balanced across the science and engineering disciplines that are increasingly interacting to produce new knowledge. Then, innovation takes the new knowledge we discover and the new technology we invent and applies them in imaginative ways that create new solutions and new opportunities. Innovation happens at the point where supply meets demand, so the customer actually becomes a

collaborator, because innovation uses ideas and technology to do what the customer needs and wants in new and better ways.

Think back to the 19<sup>th</sup> century when Samuel Morse developed the telegraph, then Alexander Graham Bell invented the telephone. Those were inventions in the traditional sense of the word, but they were also innovations that spawned today's enormous telecommunications industry and changed the character of our lives and our work. If we use this as our model, we can identify five core characteristics of innovations:

1. They are global phenomena that are felt around the world.
2. They are multidisciplinary, arising at the intersection of different fields of research or spheres of activity.
3. They spark other innovations that play off each other, leading to rich, multi-dimensional systems of innovation.
4. They help to bring about emergence and openness; they are owned not by a single company, but generate products and services at many companies.
5. They are a transformational force that changes not just a particular industry or a particular market, but the way people live, work, and engage with each other.

If the United States is to lead the way at the high end of the economic spectrum, we need to create an environment that is fertile for this kind of innovation. We need to deliberately put ourselves in a position to drive change. Otherwise, somebody else will be doing the driving and we will be at their mercy.

This year I have the privilege of co-chairing with IBM CEO Sam Palmisano the National Innovation Initiative of the U.S. Council on Competitiveness. The NII was launched right here at Georgia Tech last February, and it brings together hundreds of leaders and scholars from universities, industries, government, and think tanks to work on the question of how to build an economy based on innovation.

A lot of people are talking about innovation these days, but the goal of the National Innovation Initiative is to actually do something – to move the nation from the talking phase into the action phase. The NII has seven working groups who are preparing for a National Innovation Summit on December 14. Their goal is to figure out how to harness the factors and dynamics that promote innovation. Their charge is to develop an action agenda of things the United States needs to do in order to create a fertile environment for the innovation that will drive our future prosperity.

We began that task by remembering our heritage. From the days of the earliest explorers and settlers, America has been about discovery and exploring new frontiers. We have always hoped for a better future and embraced change that we believed would make that dream a reality. So what we are undertaking here is a very American endeavor. It's just that the frontiers of the future are now in the realm of ideas. If America were a company, we would say that our core competencies are freedom and exploration, and that, essentially, defines innovation.

What will drive us forward is the exchange and interaction of ideas. This is the social part of innovation – developing and expanding what could be called “knowledge ecosystems.” This is a

concept that was actually identified and examined in an earlier initiative sponsored by the U.S. Council on Competitiveness in which I was also involved called the “Clusters of Innovation Initiative.” When you look at the national economy over the past century, you can see that certain communities developed as the heart and center of innovation for particular industries. Detroit developed into the heart of the automotive industry, for example. Napa Valley in California developed into the heart of the wine industry. Pittsburgh became the heart of the steel industry. So we studied several regional economies around the nation to see what the factors were that came together to make them a center of innovation for a particular industry.

And the answer was that they had a “knowledge ecosystem” for that industry. They had the full cast of actors they needed to mount a major production. They had universities educating the workforce, doing research, spinning off start-up companies and doing technology transfer. They had manufacturing companies, suppliers for the manufacturing companies, distribution systems for the products, and the services needed by all of these other players. All of these players were interacting with each other and building on each other’s knowledge and expertise. And they also worked together to overcome problems that stood in the way of their advancement. We came away from that study with the realization that any community could be a cluster of innovation for one or more particular industries if it identified its strengths, built up a full cast of the essential players, and created a climate in which they could interact and benefit from each other.

Although regional economies are really the building blocks of our economy, there are some things that have to happen at the national level, or at least be coordinated from the national level – things like research funding, public policies that offer incentives, investment strategies, an education system that produces the workforce we need, and trade compacts that provide a level playing field in the global market place. These are the issues we are addressing in the National Innovation Initiative. And we will present our proposals for action in December.

Now, let me talk a little more specifically about innovation from the perspective of higher education in general and Georgia Tech in particular. Innovation begins with research to discover new ideas and develop new technology in new interdisciplinary fields like nanotechnology, logistics and biotechnology. Right now industry is doing about 70 percent of the research that is conducted in the United States, but most of what industry does is applications and developments that are based on fundamental, frontier research funded by the federal government and performed at universities.

It is easy to understand why this is true. Frontier research is where science meets the unknown. It is difficult to know when and where new discoveries will appear and what they might be. Even when new discoveries have appeared, it can take a long time before they are put to practical use. Research in nanotechnology, for example, began in the late 1950s, and we are just now beginning to see the most rudimentary products on the commercial market more than 40 years later. The research that resulted in the Internet was begun decades before it became possible to buy something from Amazon-dot-com.

What’s more, the practical, profit-making uses of fundamental research may turn out to be in a completely place from where the original research started out. When this happens with industry research, the patents just sit on the shelf. In the dog-eat-dog competition of today’s global

marketplace, it is difficult for private industry to justify spending on frontier research when the bottom-line profit is likely to be some years away and may turn out to benefit somebody else.

So, if federally funded frontier research is what drives industry applications and developments, then an innovation economy calls for us to be strategic about how federal research funds are invested. I have been a member of the President's Council of Advisors on Science and Technology for the past several years, and one of our primary concerns is the fact that the nation's research portfolio has gotten out of balance. For five years beginning in the late 1990s, Congress was focused on doubling the budget of the National Institutes of Health, which fund research in the life sciences. To do that, they stopped increasing funds for the physical sciences and engineering, and in some cases even cut back existing funds for these other disciplines. The problem with that approach is that research has grown increasingly interdisciplinary. Hot new fields like the ones I named – biotechnology, nanotechnology, and logistics – are a combination of disciplines. And they can only achieve their potential if all of the disciplines feeding them move forward together.

Mapping the human genome, for example, was an achievement in the life sciences. But it was based on fundamental break-throughs in chemistry and physics, which are physical sciences that have now been shortchanged in the federal research portfolio. Chemical engineering and mechanical engineering are also providing insights into the operation of living systems, which are driving innovations in the life sciences. Yet they, too, have been ignored in the distribution of research funds. Increasing research in the life sciences is good, but if we do not fund commensurate increases in other disciplines which help to drive innovation, we will hamstring ourselves.

Achieving balance in the portfolio is not easy, because responsibility for research appropriations is divided up among about 10 different committees in Congress and the research funding goes to a number of different federal agencies, each of which is focused on its own internal mission rather than on coordinating with each other according to a common national agenda. But we need to do a better job of it if we are to be the ones driving change.

However, even if we can bring our research portfolio into perfect alignment, it won't matter if we don't have an educated workforce that can make something of those discoveries and inventions. India and China are emerging as economic powers in part because they have done what our nation is not doing – steadfastly investing in building world-class education systems that produce skilled technology workers like engineers.

*BusinessWeek* recently reported that India's schools are pumping out 260,000 engineers a year who will work for salaries much lower than in this country. China is graduating more engineers than any other country in the world – more than twice as many as the United States – and Russia has a large number of high quality engineers who are welcoming U.S. companies to open shop there.

In stark contrast on the home front, the number of American students earning engineering degrees has been declining since the early 1980s. And I have to insert a caveat here on behalf of my own institution to say that Georgia Tech is one of the few universities that has bucked this

trend, increasing its engineering enrollment while others declined. For a while, the United States was fortunate to be able to offset that decline by attracting outstanding foreign students to fill our classrooms, and many of them stayed to take jobs in our workforce. However, this trend line has now turned downward, as other nations improve the quality of their education programs. And those international students who still come are much more likely to return home, because good jobs are now waiting for them in their own countries.

We are now seeing some white-collar American jobs in customer service and technology moving overseas to take advantage of those educated workforces. In India, where the average per capita income is only \$460 a year, top engineering graduates from Indian Institutes of Technology consider themselves well paid at \$10,000 a year. But this is obviously only a fraction of the pay scale for their counterparts in the United States and Europe.

Large corporations have responded to skilled labor at such bargain prices. We see reports that Microsoft is investing \$400 million in facilities in India and \$750 million in facilities in China. Boeing is laying off engineers in the United States while expanding the engineering workforce at its Moscow Design Center. By some estimates there are now more IT engineers in Bangalore, India, than in Silicon Valley. By 2008, McKinsey forecasts that back-office jobs in India will have increased five-fold, employing 4 million people and accounting for 7 percent of India's gross domestic product.

Building your economy on innovation requires superior education systems that produce both a cadre of talented researchers in science and engineering and a world-class workforce with up-to-date knowledge and skills. So you can see we have some work to do if we are going to produce a national workforce that can turn the gear wheels of an economy based on innovation.

Now, how does all of this relate to Georgia Tech, and how are we as an Institute helping to create that innovation-friendly environment? First, we are engaged with the world in ways that are unique in higher education. Universities have traditionally been somewhat monastic in nature – cozy and comfortable within the confines of their own campuses. While major corporations have been international entities for years, major universities have remained focused on one campus at one location, and their international activities have tended to consist of study abroad programs and offering advice to other universities.

At Georgia Tech, we have moved beyond that model. Our goal is to become one of the world's few truly international universities, with full-fledged physical platforms at strategic international locations where we engage in education, research, and economic development in partnership with other universities, government, and industry in those places.

Georgia Tech now has four campuses on three continents. In addition to this one in Atlanta, we also have campuses in Savannah, Georgia; Metz, France; and Singapore. These are not merely study abroad facilities; they offer full academic and research platforms and grant Georgia Tech degrees to students who never set foot in Atlanta.

Georgia Tech-Lorraine in Metz, France, is the oldest of our international campuses. It has been offering graduate degree programs for more than ten years and now offers an undergraduate degree program as well. It began strictly as an engineering operation, but is now branching into other disciplines to provide that critical interdisciplinary mix. It has well-established research programs in collaboration with industry, and has begun to spin off new companies. Georgia Tech-Lorraine gives us a physical base from which to build partnerships with European corporations and universities, such as the Technical University of Munich, with which we are developing a joint degree program, and Imperial College in London.

Singapore, of course, is the world's hub for logistics, which is a field in which Georgia Tech has ranked first in the nation for many years. So logistics is the focus of our research and education programs there, which represent a partnership with the National University of Singapore. But we will be expanding into other areas as well.

We are also growing our research enterprise, especially in those leading-edge fields I mentioned – nanotechnology, logistics, and biotechnology. Within the past few years we have opened two new biotechnology facilities, and we have funding commitments from the state and a private donor to build a Nanotechnology Research Center that will put us at the forefront of this sweeping new field.

We are also working to smooth out the often-bumpy path from the research lab to the commercial marketplace. We created VentureLab, which keeps an eye on the research underway in Georgia Tech's many laboratories, helping to identify discoveries with commercial potential and then guiding their development to the point where new companies are ready for incubation at ATDC – our Advanced Technology Development Center – which is one of the nation's most respect technology business incubators.

ATDC is located right across the Fifth Street from here in this new Georgia Tech development we call Technology Square. Technology Square is a literal expression of what we do at Georgia Tech on many levels. It is designed to be an intersection of innovation – a place where ideas and expertise come together and interact, generating innovation. In addition to ATDC, Technology Square is the new home of our Management programs, which offer expertise in innovation and the management of change. It also houses the Economic Development Institute and the Technology Square Research Building, which is home to the Georgia Electronic Design Center and several Georgia Tech computing programs.

These entities now have a wonderful presence right on the edge of the campus, where they are surrounded by Atlanta's growing high-tech business community. Our goal is to incorporate our faculty, staff, and students into the economic pulse of the city and the state, and to collaborate in multiple but coordinated ways in promoting the development of a signature high-tech business corridor for Atlanta.

At the same time, Technology Square also provides an international intersection of innovation through the sophisticated communication and teleconferencing capabilities of the Global Learning and Conference Center, linking Georgia Tech's far-flung campuses and opening the door to exchanging ideas with the rest of the world.

So, we are pleased to welcome you to Georgia Tech and to Technology Square. This new complex is a tangible expression of our dedication to helping create an innovation-based economy that not only assures our own position as a world leader, but also helps to create more wealth for the benefit of everyone.