

“University Intellectual Capital”
Remarks by Dr. G. Wayne Clough
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It is an honor for me to welcome the Licensing Executive Society to Atlanta. I hope you have a chance to take in some of the sights while you are here, including the campus of Georgia Tech, which is right in the heart of the city along I-75/I-85 a few miles south of here.

Barry Rosenberg of Georgia Tech’s Office of Technology Licensing has been a member of this organization for 25 years now, which is the better part of its lifetime, and he has served as a trustee along the way, so we feel a sense of connection with all of you.

These days big debate from Washington to Wall Street is about the economy, which has once again impressed us with its speed, only this time it dropped like a stone. And that has raised a lot of questions. Are we destined for a recession? How big a tax cut do we need? Were dot-coms just a blip on the screen, and we are now returning to the way things were?

Actually, dot-coms were a blip on the screen in the sense that many of them were not economically productive. What they did was cool, but often it was not what people were willing to pay for. And venture capitalists got tired of artificially subsidizing the Internet.

But the dot-coms were only the first phase of the impact of the Internet on the economy. We are now moving into phase two, in which more traditional industries, which actually do things people will pay for, are using information technology to improve their productivity. Many of them invested heavily in information technology during the 90s, which helped to fuel our strong economic growth. Now, as the economy slows, they are focusing on how to get maximum benefit from their new technology by using it to cut costs. We are still early in that process, but last November the Brookings Institute released a report indicating that once it reaches its full potential, the Internet could save American businesses as much as \$200 billion a year.

Economics students at Georgia Tech will describe the ideal market as large numbers of buyers and sellers interacting with the advantage of total information. The Internet moves us closer to that description by making a lot more information easily accessible to a lot more people and broadening the reach of markets. In essence, Economics 101 has moved out of the college classroom and into the real world.

In the process, it is changing the way the economy works. The paradigm of the 1980s was to be competitive. Similar companies made similar products, and the winner was the one that consistently delivered the best quality at the lowest price. The watchwords were “faster, better, cheaper.”

Being a tough competitor is still important, but today’s winners are the companies that are also nimble and build alliances in the world of competing technologies. In the global Internet economy that is opening up around us, the market sets the price. With cut-throat competition squeezing down profit to virtually nothing, the only way to grow and make money is by creating a new product and getting it to market faster than anybody else. Even the biggest companies must now have an entrepreneurial mindset. It is now industry standard to produce three or four new computer models a year, and Hewlett Packard reports that 60 percent of their sales come from products developed in just the last two years.

Recent Treasury Secretary Lawrence H. Summers, who is an economist of distinction, described this New Economy by saying, “If there is one fundamental change at its heart, it must be the move from an economy based on the production of physical goods to an economy based on the production and application of knowledge.”

This new economy requires a strong cadre of scientists and engineers with advanced degrees who drive the research and development process, and it requires a broader pool of skilled workers who can make something, literally, of those ideas. Our most important economic resource is no longer labor, financial wealth, or land, but knowledge.

There is one more aspect to a knowledge economy that is worth noting. The Internet has made location irrelevant in many ways, but innovation is not one of them. I’m willing to bet that each of you can identify a handful of locations where innovation is concentrated for your industry. The lists will differ depending on the industry, but you will be able to pinpoint where innovation is taking place.

One of the best measures of innovation is new patents, and the locations where they are generated are remarkably focused. Economists call these locations “clusters.” It’s a term they borrowed from chemists, who use it to refer to a group of atoms that are highly interactive.

Clusters are fueled by innovation and become hotbeds of technology incubation and investment. They serve as engines of wealth creation for their regions, and by extension

for their nation. They generate start-up companies and provide the resources they need to thrive. They are places where the success of one company attracts another company to locate there.

The clustering of leading-edge industries at particular locations is determined by a number of factors, but the core of the cluster and its primary source is invariably one or more universities. During the course of my career I have lived and worked in Silicon Valley, the Research Triangle Park, and Seattle. All of these locations have vibrant high-tech economies, and while there are some differences in why they are successful, the common factor in each case is the presence of strong research universities that reach out to the community. The same is true here in Atlanta.

Universities are the source of research and innovation, and the producers of knowledge workers. And if we really want to assess the strength of the economy for the long haul, we need to look at how well we are doing in these two tasks – producing an educated workforce and conducting the research that will yield innovation. I want to talk briefly about the first, and then in more detail about the second.

Georgia Tech's career services office is an incredibly busy place. Newly minted engineers are being snatched up before the ink is dry on their diplomas at starting salaries as much as twice those of typical liberal arts majors. And five years out of college, engineering is one of the top 10 professions for earnings. So, if the workforce marketplace operated in a purely rational fashion, you would expect high school graduates to be flocking in droves to engineering schools. But they're not.

The renowned MIT economist Lester Thurow does an annual survey of attitudes toward inventing called the Lemelson-MIT Invention Index. The results of his latest survey were released last month, and they are not encouraging. Teenagers recognize the importance of invention – 46 percent of them chose an inventor as the best person to be stranded with on a desert island. But they don't want to be inventors. Only journalists and politicians ranked lower than inventors on the list of careers that teens aspire to. They don't even want to know an inventor. Only 8 percent of teens would actually like to meet one – dead last among the career categories from which teens would like to meet an important person.

We're not doing very well on demographics either. Workforce growth was strong over the past decade, but the increase consisted largely of women and minorities, who do not tend to gravitate toward science and engineering. White males, who have shrunk to just 40 percent of the overall workforce, still comprise nearly 70 percent of the engineering, science, and technology workforce.

The fastest growing sector of the population is Hispanics, and they are the least likely to hold college degrees or to be proportionately represented among the nation's scientists and engineers. African-Americans are the second-fastest growing sector, and they are second least likely to hold college degrees or be proportionately represented among scientists and engineers. Women have become a major part of the workforce, and record numbers of them are earning liberal arts degrees. But the number who go into fields like engineering and computer science is stagnating at levels that are far too low, or even declining. The new economics are clearly out of sync with the new demographics.

The Department of Labor projects that new science, engineering and technical jobs will increase by 50 percent by 2008 – roughly four times faster than the national rate of job growth. But the science and engineering workforce has been shrinking and graying for the past 10 to 15 years as a result of declining enrollment in bachelor's degree programs. During the 90s, the percentage of growth-company CEOs who reported the lack of skilled workers as their top barrier to growth has increased from one-third to two-thirds.

In *Harvard Business Review*, Suzy Wetlaufer wrote, "Imagine the new economy's talent pool for a moment. Most executives would agree it's small to begin with. There may be a half-million engineers, analysts, and investment bankers swimming around, but truly only thousands of them qualify for the Olympics. Now, add the sharks – the countless companies that are desperately hungry for talent. Count to ten and all that's left is pulp."

If we can't get more young women and minorities in the door and through four years to a bachelor's degree in science or engineering, we certainly don't have much chance of getting them into graduate school and the research lab.

The National Science Foundation, which is a major supplier of federal research funds to universities, tracks the number of new applicants submitting their first grant proposal. They regard this measure as an important barometer of the production of new, young researchers. The NSF reported last May that the number of first-time applicants for research grants has declined by more than 20 percent since 1992.

I serve on the executive committee of the National Council on Competitiveness, and the same concern is reflected in our research data. The American workforce is growing, but the percentage engaged in research is shrinking. In 1985, the United States ranked first

in the world in the percentage of our workforce engaged in research. Today we are third, and another half-dozen nations are gaining on us.

Georgia Tech is the largest producer of engineers in the United States, graduating more than 2,000 of them every year, and we are bucking the national trend with increasing enrollments. At many research universities the lab is emphasized over the classroom, and undergraduates see research as diverting the attention of faculty away from them. At Georgia Tech we view research and undergraduate education as inter-related activities that can and ought to enrich each other. Our goal is to give students the best of both worlds – the attention to undergraduate education of a liberal arts college and the opportunity for exposure to a world-class research enterprise. Our faculty are engaged in break-through research, but they also teach, injecting the exciting dimension of leading-edge research into the classroom. And we give undergraduates opportunities for hands-on involvement in our research labs.

Research is a learning process, and our goal is to be a community of scholars, all engaged in the discovery of knowledge at some place on the continuum and all involved together in education, in research, and in reaching out beyond our campus. This approach helps us attract record numbers of applications from students of increasing caliber, making Georgia is one of the few states in the nation to actually increase its production of engineers over the course of the past decade.

Beyond serving as a drawing card for students, the other practical result of involving undergraduates in research is that a significant number get hooked on it, and go on to pursue graduate degrees. And they succeed, because they come into graduate school already experienced in lab procedures and already capable of moving beyond the comfort of book knowledge and learned models to the creative pursuit of open-ended questions.

In addition to home-growing intellectual capital, research universities also put it to work in the discovery of new knowledge, and I would like to spend the rest of my time addressing this task.

The very first research university was Johns Hopkins, which was created as a research university. The rest of us began life as teaching institutions and sort of morphed into research universities along the way. That morphing process was accelerated when the federal government began to invest seriously in university R&D during and following World War II. Of course, much of the money the federal government put into research at this time went for defense. But many of the innovations it generated filtered out into

the broader economy and had a significant impact on important fields like electrical and computer engineering.

The strong economy we enjoyed in the 90s was not due to Alan Greenspan or Bill Clinton or even Bill Gates, but to that podium-thumping communist Nikita Krushchev, who challenged the United States to an arms race then a space race. Computer networks, for example, began as a defense tool. It was the Advanced Research Projects Agency, known as ARPA, and the National Science Foundation that provided the funding in the late 60s and 70s to create the Internet from which we have gained so much. Today's semiconductors go back to federally funded university research in quantum mechanics conducted during the 1940s.

Mapping the human genome and other life science achievements in the news today are based on fundamental break-throughs in physics and chemistry that happened 20 to 30 years ago. And the launch of Sputnik in 1957 triggered the education of a generation of scientist and engineers who developed this new technology.

In the heyday of defense research, the federal government was funding 70 percent of our national R&D portfolio. Today, the federal government supplies just over 30 percent. Today, federal funding for R&D has fallen below 1 percent of the Gross National Product, its lowest level since the 1950s.

Much of the slowing of federal support for R&D can be attributed to the end of the Cold War. Without an enemy to motivate us, the only sure thing was health problems, and the research budget for the National Institutes of Health has tripled over the past decade. But information technology has seen only a modest increase; mechanical engineering is starving; basic physics, chemistry and mathematics are all declining. This approach of favoring health research at the expense of other areas will not work in the long run, since NIH research is based on frontier research in science and engineering.

The decrease in federal funding for science and engineering research comes at a time when industry's demand for research is increasing, and that has enabled universities to maintain and even expand their research enterprise. But it is not a simple quid pro quo trade-off of public research dollars for private.

The federal government has traditionally funded fundamental frontier research, which is a highly speculative venture. It is hard to foresee what products it might generate down the road. Not only are the potential pay-offs in the distant future, but the benefits do not necessary accrue to those who do the research in the first place.

It is difficult for industry to justify the risks and the costs of frontier research when they must compete on a global economy that forces them to be very lean on the bottom line. Companies like Bell Labs that used to do basic research in-house don't do it anymore. Even when industry research is done at a university, it is still focused on the short-term development of marketable products, and it is usually based on federally funded research which explored the frontiers and laid down the foundation. Three quarters of the patent applications filed by private industry cite fundamental research funded by the federal government as the basis for their inventions.

We are clearly enjoying the harvest from the fundamental research of prior decades. But we are not fulfilling our responsibility to develop and plant the seed corn that the next generation will need to maintain economic strength. If we want to assure a continuing stream of technological break-throughs that fuel sustained prosperity, we must reverse the erosion of our research investments and our pool of research scientists and engineers. Barring the appearance of another Nikita Krushchev, we need a closer, better-coordinated partnership among research universities, private industry, and government.

Government is beginning to understand that the transfer of technology from university research labs into the private sector for marketing is an important economic goal. A three-way partnership among universities, government, and the private sector can help us to develop that process, and also enable us to achieve a better balance between the short-term research that generates new products and the long-term frontier research on which it is based.

This partnership is still evolving, and one of the thornier aspects of the growing relationships that we as universities are developing with corporations is defining and addressing conflicts of interest. The Bayh-Dole Act of 1980 allowed universities to receive and assign intellectual property ownership rights for inventions arising from federally funded research. And in the years since then, university-based patenting and licensing activities have steadily increased.

The primary purpose of university technology licensing offices is to seek the timely dissemination of technology to further the public good. The emphasis is not on maximizing the financial return, but on maximizing the social benefit of new technology. This is the primary difference between technology licensing and patenting in the university and the private sector, and as universities and industries work more closely, the potential increases for those two motivations to come into conflict.

Critics of close relationships between universities and private companies paint bleak pictures of unscrupulous researchers being paid in shares of stock to compromise their research results in the interests of the company that funds the research. But making it difficult or cumbersome for university knowledge to go through technology transfer into the private sector clearly doesn't serve the public interest, either.

We enjoy a long list of benefits – from computers, to pacemakers, to space-based weather forecasting – that were generated by university research then transferred to private companies. The real challenge is to create relationships that balance the integrity of the academy and the transfer of the technology.

In Georgia, we have been working on building relationships between private industry, government and research universities. Twenty-four percent of Georgia Tech's research portfolio is now sponsored by private industry, second highest in the nation. And in a recent national survey of economic development experts, practitioners and researchers, Georgia Tech was voted first in the nation in technology transfer. So we have experienced some success in this endeavor, and I want to tell you a little from personal experience about how it works.

Herb Lehman is on the program later this morning to tell you about our newest partnership, the Yamacraw initiative, so I will focus on our largest and oldest partnership. The Georgia Research Alliance was created a decade ago, and it includes Georgia's six research universities, both public and private, state government, and three high-tech industries – advanced communications, biotechnology, and environmental science and technology.

The goal of the Georgia Research Alliance is to make Georgia a cluster location of innovation in these three industries by funding, promoting, and coordinating research and technology transfer. To date the Research Alliance represents an investment of about a billion dollars. Some \$300 million has come from state government, which is used as seed money to attract federal and corporate investment. The state puts up the first half of the money to create endowments for research chairs at the six universities, providing leverage to raise matching private funds.

State funding also provides equipment and even labs and buildings, which help to attract internationally known scholars to hold the endowed chairs. In turn, the scholars attract research funding, top-quality graduate students, and high-tech companies, as well as spinning off new start-up companies.

The Alliance practices coordination and collaboration in very literal and practical ways. One of the ground rules for research projects is that each one must involve collaboration between at least two member universities. There are also ground rules for sharing intellectual property rights for any discoveries that may result.

This collaborative approach has made the Alliance attractive for research investments from both the federal government and private industry. Because it embraces the research capabilities of six universities, funding proposals can be more complete and more carefully tailored, offering federal agencies an opportunity to target their investments for maximum value.

At the same time, the collaborative nature of the Research Alliance offers industry a cost-effective opportunity to invest in frontier research. Several companies can join together in sharing the cost of fundamental research from which they all benefit, and each company can then apply that research in its own direction in the development of new products.

Opportunities exist for exclusive arrangements between individual universities and corporations to do particular applications of research. But they happen within a larger context and a longer continuum, which helps to minimize the opportunity for conflict of interest problems to develop.

As Georgia Tech shapes our ongoing relationships with private industry, both within the Georgia Research Alliance and outside of it, we have been working on several aspects of intellectual capital management. First, we make a deliberate effort to start at the top. Our goal is for top management at Georgia Tech and the company in question to address the major issues in a master agreement that provides one large umbrella contract and sets up the parameters for sub-agreements on individual research projects.

When there is no overarching master agreement, we often end up with dozens of faculty negotiating dozens of different individual agreements. This scatter-shot approach not only eats up a lot of time and labor, but also makes the broader relationship unfocused and opens the door for digressions that are not optimal either for the university or the company.

An overarching master agreement makes it clear what the university president and the corporate CEO want to achieve in the relationship, and it sets the focus and simplifies the process for sub-contracts on individual research projects.

To streamline the contracting process even more, we have established a group in our Office of Technology Licensing that focuses specifically on industry interactions and contract negotiations. These folks are specialists who know the issues, anticipate potential problems, and help faculty and industry negotiate sound contracts with a minimum of fuss.

Another intellectual property challenge that is different for universities than companies is this: What happens when research generates an idea for a marketable product? In a corporate setting, the whole point of the research is to generate new products, so it is clear what happens next. But the path to commercialization is more difficult at a university.

There are two basic routes: 1) “Throw it over the fence,” which is to say licensing the technology to a big company that is already engaged in that particular business. This approach is the least risky for a university and often brings us immediate revenues. But the long-term benefits may be small, and it may not fulfill our goal of maximizing the benefit of technology for society. Big companies are often slow to get innovations to market, and they are prone to shelving perfectly good ideas if they do not fit in with the company’s plans and direction.

Route number 2 is to license the innovation to a start-up company. This is riskier, but it can pay off in the long run, both in serving the public good and in generating a return. It also allows the faculty inventor to stay involved in getting the technology to market, which studies have suggested is important.

At Georgia Tech, we have a very open policy for faculty to commercialize technology through the start-up route. We even have one faculty member who has two start-up companies underway simultaneously. This process is assisted by our Advanced Technology Development Center, which we call ATDC for short.

The ATDC was created 20 years ago as the nation’s first university-based business incubator, and today it is widely recognized as one of the nation’s best. It helps researchers harden their ideas into marketable products, assists with management and marketing, and incubates start-up companies in its facilities. The companies “graduate” when they have reached certain benchmarks in earnings and size, or have been acquired by another company which takes over the job of guiding them.

This process makes it easier for start-ups to procure venture capital, because investors know that ATDC has kicked the tires and looked under the hood to make sure that the

company's idea has real-world market potential. They also know the company will get the assistance it needs to succeed.

Since its creation in 1980, ATDC has incubated more than 110 companies and graduated more than 70. Last spring we recognized a record 19 new graduates, which together attracted more than \$300 million in investment from venture capital, mergers and acquisitions.

Some 40 percent of the companies nurtured by ATDC have been founded by Georgia Tech faculty – some even by students. Faculty seldom possess the full range of business skills required to bring a start-up company to fruition. They also usually want to continue their research careers, rather than devote their days to managing flow charts and personnel issues.

So we encourage them to define their own role in a research capacity and bring in outside business staff to handle the day-to-day management. That way they can remain on the Georgia Tech faculty, and their involvement with the company they founded fits under our faculty consulting policies.

We also encourage them to think ahead and incorporate an exit strategy for themselves into the business plan they develop when they start the company. When tech stocks were hot, an IPO was one possible exit strategy. These days, however, it is more likely to be a merger or acquisition. And in a few cases, the founder doesn't expect the business to grow rapidly and is happy to continue consulting with a small niche company for a longer time.

Universities have always valued intellectual capital as their primary asset, but the business world is just beginning to think about it. Company balance sheets list the cash value of computer hardware and software, but that is no reflection of their real value, which lies in the information the computers store and the ways in which people use both the computers and the information to be more productive.

We have not yet come to grips with an economy that is driven by intellectual capital. Business guru Peter Drucker says we are straddling the fence – living in an economy driven by knowledge, but still using the traditional industrial model in which financial capital is the key resource, and the person with the money is the boss. We are maintaining the old model by bribing knowledge workers with bonuses and stock options, but that only works to the extent that the stock market is booming and money is an issue for individual workers.

Drucker foresees the time when it will become counterproductive to run a business with short-term "shareholder value" as the primary goal and justification. He says, "Increasingly, performance in these new knowledge-based industries will come to depend on running the institution so as to attract, hold, and motivate knowledge workers. When this can no longer be done by satisfying knowledge workers' greed, as we are now trying to do, it will have to be done by satisfying their values," and by turning them "from employees, however well paid, into partners."

John Patterson, vice president for talent at Priceline.com says that to keep elite performers, he has to keep re-creating for them the conditions that attracted them to a start-up in the first place – the opportunity to create smart new products and to launch new initiatives.

The brightest minds at universities are not there for the money – they invariably could make more in industry. But they are attracted to the university by the value we place on intellectual capital itself – the freedom to pursue answers to questions, and the opportunity to try new things and create new technology. And that is one respect in which business will need to learn to become more like universities even as we learn from you in other respects.

The most valuable economic development tools we can have in the 21st century are a platform for research and innovation that will drive leading-edge technology, and a skilled workforce. Universities are the source of both of these tools. But to develop and use them well, a closer and more complex relationship is essential among universities, government and the private sector.

For universities, these relationships provide a wonderful opportunity to be more fully engaged with the entrepreneurial business world, and to be more practice-oriented in the experiences we offer our students, so that we teach the skills that industry needs. It is an opportunity to participate in the discovery of knowledge and innovations, and to participate in putting those ideas to work.

And if we step forward to fully engage in these partnership opportunities, we will be achieving our own goal to help create a stronger, more prosperous society.