Woodrow Wilson International Center for Scholars

Brazil Institute

Brazilian Congressional Study Mission on Innovation

Washington, D.C. and Cambridge, MA
April 18-20, 2011

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Institucional Support

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Foreword

The Wilson Center's Brazil Institute strives to improve the understanding of Brazilian realities for an American audience. The Institute focuses on issues relevant to the bilateral relations of the two largest democracies and economies in the Americas. This report is a perfect case in point. It includes the academic proceedings of the Brazilian Congressional Study Mission on Innovation to the United States, organized and led by the Wilson Center's Brazil Institute in April 2011. For three days, eighteen members of the Chamber of Deputies and the Federal Senate, representing the eight principal parties in Congress, took part in an intensive program held at the Wilson Center and the Department of State, in Washington, and the Massachusetts Institute of Technology in Cambridge, Massachusetts. The members of Congress, including two senators, heard from leading American and Brazilian experts on innovation. They engaged in substantive exchanges on different aspects of innovation policies, including intellectual property protection, relations between companies and scientists at public universities and research centers, and how regulatory frameworks impact research and the process of commercialization.

A seminar for journalists that specialize in the coverage of science and technology issues preceded the Congressional Mission in Cambridge Organized with the support of Interfarma, a member of the Brazil Institute Advisory Board, the Mission covered the full range of issues relevant to innovation policies in the United States. The delegation explored innovations in pharmaceutical sector but also the the information technology sector, whose interests and views are not necessarily convergent with those of the pharmaceutical industry represented by Interfarma. By bringing together the various dimensions of innovation, the Mission provided a balanced perspective on a topic made more relevant and complex by the

advancement of science and technology and its applications in the past quarter century.

Innovation has been at the core of the Brazil Institute's program since its creation. In 2008, working in collaboration with Prospectiva, an international consulting firm from São Paulo, the institute launched a series of six conferences on Innovation Policies and Business Strategies. The conferences were held in Washington and São Paulo and included presentations by leading Brazilian and American experts. Among them were Glauco Arbix, Carlos Henrique Brito Cruz and Carlos Americo Pacheco, Stephen Merrill and Kent Hughes. Arbix, Brito Cruz and Pacheco have since been named, respectively, president of the Brazilian innovation agency, Finep, scientific director at the São Paulo Science Foundation, FAPESP, and president of the Techonological Institute of the Air Force, ITA. Merrill is executive director of the National Academies' Board on Science, Technology, and Economic Policy (STEP) since its formation in 1991. A former president of the Council on Competitiveness and chief economist for a US Senate majority, Hughes is currently director of the Wilson Center Program on America in the Global Economy, PAGE. A lengthy bilingual report on the conference series written by Prospectiva's Ricardo Sennes was published in 2010 and is available online in Portuguese and English. [you might want to put the link here]

Following the first Brazilian Congressional Mission on Innovation, the Brazil Institute hosted in October 2011 a three-day conference on "Fifty Years of Science in Brazil and Challenges Ahead". The event, which marked the 50th anniversary of the São Paulo Science Foundation, FAPESP, was co-sponsored by the Ohio State University Medical Centerand the National Science Foundation,. It convened close to sixty researchers from Brazilian and American universities and research centers, in addition to executives from innovative companies. Most of the ten thematic panels were directly related to fields of applied scientific research.

As this report was being finalized, the Brazil Institute was busy working with its counterpart at King's College London in the program of the second Brazilian Congressional Mission on Innovation, scheduled to start in London in early April, with visits to companies in Manchester, Berlin, Basil and Paris. At the invitation of the Brazilian government, the Institute was also actively involved as partner in the planning of a major conference on the future of Brazil –United States relationsto take place in the the context of President Dilma Rousseff's visit to the White House

on April 9th 2012 The event will focus on trade, investment, energy and, particularly, on cooperative approaches to science and technology education and innovation. . One of the panels, organized with the Brazil Institute support, will featureon Science Without Borders, an ambitious education program initiated by Rousseff and funded mostly by the Brazilian federal government, with participation of Brazilian and American companies. The program intends to provide up to 100,000 scholarships for Brazilian undergraduate and graduate students to attend at least one year of school abroad on science, technology, engineering and mathematics.. Some 30,000 are expected to come to more than one hundred colleges and universities in the United States. Together with a new focus on the need to foster policies that will improve the international competitiveness of the Brazil's economy, Science Without Borders represents a major commitment to address the deficits in education and innovation the country faces as it emerges as one of the world's leading economies and a global political actor.

Paulo Sotero
Director of Brazil Institute, Woodrow Wilson International Center for Scholars

The future lies in innovation

Infrastructure, education and innovation. Three seemingly simple words that disguise a more complicated question: what more does Brazil have to do to be considered economically and socially developed, once and for all?

Brazil's Pharmaceutical Research and Manufacturers Association - Interfarma – whose 42 members dedicate themselves to health research, has sought to bridge the gap in relation to what the country lacks in terms of innovation, in a more objective manner.

Altogether, our companies have had a presence in Brazil for a combined 1,389 years. Year after year these companies provide millions of Brazilians the opportunity to live longer and better. But our drug innovations could play an even more important role.

Despite Brazil's fragile educational system, we are able to develop islands of excellence in the medical sciences.

Despite the shortcomings of our country university system, we have increased academic output measured by the numbers of PhDs, master's degrees and publications at a scale never before seen.

As a result, and given the country's size, political stability and the legal security we offer the ethnically diverse Brazilian people, along with continued demographic growth, we are often asked to take part in the world's most important clinical studies that seek to find new therapies and drugs. Unfortunately, however, it is at an alarming rate that we waste countless opportunities to move forward in this area.

We have an abundance of talent and opportunities, but lack clearly defined, ambitious and realistic public policies. What we spend on rhetoric could be put towards reducing the bureaucracy and fighting pre-conceived notions, all for the purpose of ensuring reasonable processes for developing innovation.

In short: Brazil talks more about innovation than it innovates.

Part of the solution will come from transforming the talk into objective policies, with an eye towards what is going on all around the world. Countries that are less developed than ours have already made innovation an absolute priority. Brazil could make innovation a national sport and be a real contender. The government has a defining role. Here, as elsewhere in the world, governments can indeed contribute to innovation by providing clear definitions, rational regulations, and sensible demands analyzed through processes that are at once efficient and transparent.

Interfarma has defended this agenda through a dialogue that has been both pluralistic and constructive, under the scrutiny of opinion makers and of those in Brazil's political leadership positions. As a way of contributing to the discussion on innovation, our initiatives over the past three years have included seminars, books, discussions with experts and authorities, and study missions abroad.

This report brings together the key instances from one of these events – the study mission that took 18 members of Brazil's Congress to the United States in 2011, organized by the Brazil Institute of the Woodrow Wilson International Center for Scholars, a renowned center for the study of public policy headquartered in Washington, DC.

The following pages describe successful public and private initiatives that have taken place in countries that engage in innovation, leading to the production of new knowledge and the benefits of the technologies developed and disseminated throughout the world.

It is in this world, both now and in the future, that Brazil can and must choose to take a more prominent position - as a truly innovative country.

Antônio Britto

CEO of Interfarma, Research-Based Pharmaceutical Manufacturers Association

Summary

Program

SUNDAY, 17TH

THE OCCIDENTAL RESTAURANT

7:00 to 9:30PM Reception and Inaugural Dinner

MONDAY, 18TH

WILSON CENTER 5th FLOOR CONFERENCE ROOM

9:00- 9:15 AM

Introductory Remarks

PAULO SOTERO, Director, Brazil Institute, Woodrow Wilson International Center for Scholars

ANTONIO BRITTO, President, Interfarma

9:15-10:45 AM

Innovation in the United States: the Interplay of History, Institutions and American Culture

KENT HUGHES, Director of the Program on America and the Global Economy

The Innovation Imperative – Perspectives from the Unites States and Brazil

CHARLES WESSNER, Director, Technology, Innovation and Entrepreneurship

10:30AM Coffee break

11:00- 12:45 PM

Synthetic Biology, the New Frontier for Innovation: from Fighting Malaria to Producing the Second Generation of Biofuels

TODD KUIKEN, Research Associate, Project on Emerging Nanotechnologies at the Woodrow Wilson International Center for Scholars

Synthetic Biology in Brazil

JOEL VELASCO, Senior Vice-President, Amyris

WILSON CENTER 6th FLOOR BOARD ROOM

1:00- 2:30 PM – Lunch

Welcome Remarks

Mike Van Dusen, Executive Vice President, Woodrow Wilson International Center for Scholars

Anthony Harrington, President and CEO, Albright Stonebridge Group

WILSON CENTER 5th CONFERENCE ROOM

2:30 – 3:45 PM

The Federal Communication Commission Broadband Deployment Plan

JOHN HORRIGAN, Vice President for Policy Research, Technet

International Information Technology Competitiveness and US Innovation Policies

STEPHEN EZELL, Senior Analyst, Information Technology and Innovation Foundation

3:45 PM Coffee break

4:00-5:30PM

The Patent Reform Debate

JAY THOMAS, Professor, Georgetown University Law Center

Brazil-US collaboration: a private sector perspective

CHAD EVANS, Senior Vice-President, Council on Competitiveness

6:30PM Reception at the Brazilian Embassy Residence

7:30PM (Departure for Nora Restaurant)

8:00 – 10 PM Dinner offered by Pharma

TUESDAY 19TH

9:45 AM – Departure from hotel by bus to U.S. Department of State

10:30 – 1PM

The Obama Administration Innovation Strategy and International Cooperation on Science and Technology

MARIA OTERO, Under-Secretary of State for Global Affairs

ARTURO VALENZUELA, Assistant Secretary of State for the Western Hemisphere

11:00 – 11:15 AM Coffee break

11:15 AM – 1:00 PM

ANDREW REYNOLDS, Deputy Adviser to the Secretary of State for Science and Technology
CARMINA LONDOÑO, National Science Foundation
MATTHEW J. GERDIN, Office of Technology Cooperation, Department of State
REBECCA S. TAYLOR, Senior Adviser, Innovation and Entrepreneurship, Department of State
NICHOLAS FARRELL, Science and Technology Advisor, Department of State

WILSON CENTER 6TH FLOOR DINNING ROOM

1:30–3:00 PM - Lunch

Challenges of Innovation in Brazil
RICARDO SENNES, Prospectiva Consultoria Internacional
NOELLA INVERNIZZI, Fellow, Woodrow Wilson Center, and Professor, Federal University of Paraná

WEDNESDAY 20TH

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

9:00-11:30AM

Welcoming Remarks
KARINA XAVIER, MIT Brazil Program

The MIT in Innovation in the US and in Brazil
LITA NELSEN, Director, MIT Technology Licensing Office
ANTHONY KNOPP, MIT Industrial Liaison Program

12:00 – 1:00PM – Lunch

GENZYME COPORORATE HEADQUARTERS

Biotechnology in Brazil: a Successful Story
ROGERIO VIVALDI, President, Renal & Endocrine Business Unit, Genzyme

1:15 – 2:30PM

Biomedical Innovation in Brazil
FABIO THIERS, Director of the Strategic Global Trials Research Program at the MIT Center for Biomedical Innovation

3:30-5PM VISIT TO NOVARTIS

Visit to laboratories and conversation with
ALEXANDER TRIEBNIGG, President of Novartis Brazil

Innovation in the United States: The Interplay of History, Institutions, and American Culture

KENT HUGHES
Director, Program on America and the Global Economy

I want to congratulate the members of the Brazilian Congressional Mission for your focus on innovation. If you look at the challenges that the world, Brazil and America, faces -- food security, energy security, flu pandemics, supply chains -- the answers to the key questions about the future require a good deal of innovation, technology, and science. I think you have picked a very important path to the future.

I would like to give a brief overview of the American innovation system and how it has evolved. It has evolved in terms of the basic structure of the American economy. It has responded to crises. Sometimes it has responded to opportunities. We never had a group that sat down and said, "Here's what the 21st century innovation system is going to look like." It evolved over time to be what remains one of the world's powerhouses of innovation. It's interesting to see how the approach to innovation did change as the American economy itself developed and became more outward looking and more globally competitive.

One of the striking features of the American Constitution is how little it says about the economy. But one of the few specific economic aspects of the Constitution deals, in fact, with innovation. If you look at Article I Section 8, you will find that Congress was explicitly given the power to

promote the progress of science and useful arts by securing, for a limited time, to authors and inventors the exclusive right to their respective writings and discoveries. In other words, the idea of patents and copyrights was actually embedded in the American Constitution. Most Americans don't know that the very first patent was issued by future President Thomas Jefferson, when he was our Secretary of State and also served as one of three commissioners of patents.

Abraham Lincoln was also a champion of innovation. He is often quoted as saying that patents "added the fuel of interest to the fire of genius." In the middle of the Civil War, Abraham Lincoln took a historic step of signing the Morrill Act, which established the land-grant colleges in the United States. Many of the very prominent universities that are top research universities today had their start as land-grant colleges; that is, the government gave federal lands to the states to establish universities.

From the start, they had a practical orientation. This is quite a distinction between the land-grant college and the European tradition. You see echoes of the focus on agriculture and mechanical in the names of some of today's top universities. One example is Texas A&M (Texas Agricultural and Mechanical), one of the two major university systems in the state of Texas. The American Civil War, a brutal civil war, drove many improvements in manufacturing. This pattern would be repeated as America entered into other wars, World War II,

In the first half of the 20th century, innovation, again, was partly opportunity, partly driven by a sense of necessity. You saw American innovation definitely influenced by World War I. In part, it was opportunistic that being at war with Germany, the United States confiscated the patents of the German pharmaceutical and chemical industries, which gave American industries a significant leg up in future competition.

The military also felt in World War I that the United States had lagged behind in terms of radio communications. The government stepped in, pulled together some of the key patents, which led to the founding of what became the Radio Corporation of America (RCA), which, for many years, was a very prominent electronics company in the United States. When RCA was founded, I believe, the U.S. Navy, held 30 plus percent of its stock. This was something that was not a long-term plan. It was driven by that exigency of World War I.

The United States was different from Europe, in that instead of founding a public post, a telegraph system, and telephone system, we created a regulated monopoly: the famous AT&T; the Bell system.

A&T founded the Bell Laboratories in 1925. If you talk to leaders in today's electronic world in the United States, you would find that Bell Labs played a very significant role in many aspects of the evolution of electronics. It wasn't exactly a public entity, but nor was it a typical private entity.

At the same time, we had an evolving system of public health. It started at the very end of the 19th century with a public health service that evolved over time in what is today the National Institute of Health. There were National Institutes of Health. There were several separate institutes that were founded along the way and then were put together under one broad heading. That has become a major source of funding for innovation, and, in many cases, of innovation itself.

World War II was another benchmark in terms of the evolution of the American innovation system. As President Roosevelt famously said, "Dr. New Deal gave way to Dr. Win the War." And then looking back at the winning of that war -- in which I want to recognize that Brazil was one of our allies and played an important role in the Italian invasion and liberation -- led to an understanding of how critical science and technology were, in terms of giving the Allies a real military edge. One of Roosevelt's science advisors became a prominent advisor to President Truman: Vannevar Bush, who wrote a seminal proposal under the title of "Science: The Endless Frontier." That thinking gave birth to what became the National Science Foundation, which then and today became a major source of funding for research in the physical sciences.

At the same time, there was an awareness that, as I said, that science and technology played a critical role in actually giving the Allies an edge. That led to the Department of Defense also being a major source of funding for research in the physical sciences.

Venture capital started to emerge as an institution shortly after the end of World War II. The first venture capital fund was founded in Massachusetts, but it has continued to spread and has been one of the sources, not always the most important source, but one of the sources for funding smaller startup innovative companies that have been a distinctive feature of America's innovation system.

Let me jump forward now to 1957. Most of you will remember Sputnik, the Soviet success in launching the first human satellite to circle the

Earth. This was quite a shock to the United States. It was viewed, in part, as a challenge to our national security, but it also was a major blow to American pride. The response to Sputnik was nationwide. It included not only the national government, but also local governments and local school boards all across the country. Every one of them thought it was critical that they emphasized mathematics, science, and foreign languages because they saw this as a global struggle with regard to the Soviet Union.

There were, of course, other changes at the federal level that had significant impact on the innovation system in the U.S. The institution that had been established to promote civilian air power switched to becoming the National Aeronautics and Space Administration, and it was that group that helped fulfill President Kennedy's commitment to have a man on the moon by the end of the 1960s.

Then, the administration established a new institution in the Department of Defense. It's now known as the Defense Advanced Research Projects Administration (DARPA). With an assignment to take chances on cutting-edge technologies that would support the national security mission of the United States, it has also had an enormous impact on our innovation system here and around the world. At one point, DARPA felt it was important to facilitate communication between military research laboratories. The National Science Foundation thought, "That's really a good idea. Let's see if we can't link civilian research authorities." At some point, this became a functioning institution better known today as the Internet. You see the enormous impact that has had here, in Brazil, Europe, China -- everywhere in the world. DARPA continues to do that kind of cutting-edge research with the distinction that their customer is well defined. Their customer is the Department of Defense, even though the impact of what it invents has had much wider applications.

Let me give you a recent example: Dean Kamen, a Manchester-based, New Hampshire-based inventor, was asked by DARPA to develop an artificial arm that would be of use to so many American soldiers who were coming home with having lost a limb. Dean was successful in developing an arm that has almost all the functions of a human arm: it is sensitive enough; and it could actually pick up a grape without crushing it. Although this was targeted at soldiers returning from the battlefields of Iraq or Afghanistan, clearly, it has enormous applications in the civilian world.

The response to Sputnik also led to what may seem surprising now but was unprecedented at the time. As you may know, the U.S. has a very diffe-

rent kind of education system than most countries. We have some 16,000 local school boards that have a lot of influence on what is done and what isn't done. We have thousands of universities that set their own standards. The federal government really had not been involved in education at all up to Sputnik. But in the wake of Sputnik, they established the National Defense Education Act, which was targeted at scientists, engineers, and economists for graduate study. I benefited from that myself, so I think that was a good idea.

One of the things that also started to emerge -- and, again, there was a spin-off in some ways from the defense activity -- is innovative clusters, groupings of firms in Silicon Valley and in Route 128, in greater Boston. An element of this idea of clusters has been written about a good deal by Professor Michael Porter at the Harvard Business School. He has more recently looked at clusters of innovation and would certainly point to Austin, Texas, as one of those centers. Michigan has an Automation Alley. Oregon has Silicon Forest. There's a whole series of these innovation clusters that have emerged. What is different and interesting today is these clusters also have, in many cases, an international link as research and innovation becomes more and more of a global activity.

The next real evolution in America's innovation system came from the Japanese challenge in the 1980s that you may remember. Many popular books were highlighting Japan as number one. There was a sense that Japan was marching from one industry to the next. This led to a real look at some of the Japanese strengths. One was process. The Toyota lean production technique certainly gave a number of Japanese industries an edge. Process technology was adopted and adapted in the U.S. And there were a whole series of efforts to bring our research institutions, universities, and national laboratories closer to the market. A series of acts were adopted over the late 1970s and 1980s that allowed national laboratories or created incentives for universities to work more closely with business as a way of speeding innovations from the laboratory to the living room. In part, this was in response to Japan's success at rapid commercialization.

You can see this kind of collaboration still taking place at a state level, where most governors would view their Tier 1, or top research university, as very much part of their own growth, development, and employment strategy.

The Japanese success also triggered the beginning of a rethinking of America's education system. There was a famous publication that came

out in 1983 under Secretary Terrence Bell, President Reagan's Secretary of Education. It was called "A Nation at Risk." One of the famous quotes from that publication was: "Had a foreign power imposed America's education system on the United States, it would have been viewed as a hostile act." Despite the rhetoric and the national attention, nothing really much happened.

President George H. W. Bush, the first President Bush, wanted to be the education president. He pulled together all the governors. It was only the third time in U.S. history that a president had held a summit with the nation's governors, and the focus was education. The governors chose, a then-obscure governor from Arkansas to be their key representative in education. That young, obscure governor from Arkansas was Bill Clinton. He went on to be president of the United States. Clinton built on what George H. W. Bush had started. George W. Bush did the same and only now, after that long period of time since 1983, have we developed a system of national standards in mathematics. It's an example of how we responded to a challenge, but not necessarily in the kind of expeditious way that you would like.

The 1980s gave birth here to what I would call the "competitiveness movement." Part of that was the making research more available to the private sector that I mentioned. There were also some specifically public innovations: the Advanced Technology Program, manufacturing extension partnership -- something like our agricultural extension -- that has grown to the point where there is now a manufacturing extension facility within two hours of every small manufacturer in the United States.

There was a period where, I think, America was tempted to rest on its laurels. At the end of the 1990s, the Soviet Empire had disappeared and the Soviet Union itself collapsed. Germany had an initial struggle to absorb the German Democratic Republic. Japan was wrestling with the bursting of a double bubble, and there was a sense that this really was the American moment. Well, America has reawakened to see that, in fact, the world has changed dramatically.

One of the responses has been led by a bipartisan coalition in the U.S. Congress and by the private sector. A report done by the National Academies, "Rising Above the Gathering Storm," is now in its second edition. This led, eventually, to an America Competes Act that, again, focused on aspects of education, science, engineering, and mathematics, as well as emphasizing the importance of research in the physical sciences.

Before I conclude, let me just say a word about American culture. I think there is something different about America. In many ways, the difference here is similar to the difference in Brazil, in terms of the rest of the world. Both of us are major immigrant societies. When I lived in São Paulo, it would remind me of America in Chicago, where there were people from all over the world as well as internal immigrants who were building, industrializing, and creating.

In the U.S., we have always had an emphasis on the individual and a kind of self-reliance. And that continues to be a reality today. You heard an echo of how the frontier continues to be an element in our thinking when Vannevar Bush chose to say, "Science: The Endless Frontier," not the frontier that had closed because of land was exhausted, but the frontier that was always open to innovation.

The cowboy is still an icon in American thinking and he was a proxy for mobility here. For much of our history, we've been a very mobile and adaptable people. We started totally freed of any traditional, hereditary monarchy, and a cast of nobles. I think former Governor Huey Long of Louisiana expressed America's sensibility very well, when in the 1930s he said, "Every man, a king, but no man wears a crown." We have been open to talent from everywhere. We've had our own troubled past, with racism and clashes of ethnic groups and so forth. But by and large, we have been welcoming to talent and individuals from around the world, and that has paid enormous dividends.

AnnaLee Saxenian, who is something of a Boswell of Silicon Valley, has noted that about a third of the businesses in Silicon Valley had been started by Indian or Chinese immigrants. And that doesn't include immigrants from the rest of the world. Andy Grove, an immigrant from Hungary who headed Intel, is a fine example.

I think America, like Brazil, doesn't really define itself by a particular ethnicity. As I traveled around Brazil, I met Russians, Germans, Portuguese, of course, and a whole host of people from around the world. I think that will be an enduring strength of Brazil.

In the U.S., we have a particular attitude toward risk. You will often hear that Joe or Jane in Silicon Valley have earned their fortune in their seventh start-up. Failure, in some parts of the country, is defined as "not trying again." I think that has been a strength.

Finally, I want to point to the lemonade stand. I don't know if any of you have been here in the summer. If you drive through any American

neighborhood, you'll see small children selling lemonade. You'll see the parents proudly standing behind them. Neighbors come over and will say, "John" or "Jenny, this is terrific. You're on your way. You're going to be a great business success." So I think we're one of the few countries that, right from the start, emphasize not only democracy -- first grades will have election to get the president of the first grade -- but the sense that business is a good thing. Entrepreneurial activity is a good thing.

The Innovation Imperative — Perspectives from the Unites States and Brazil

CHARLES WESSNER
Director, Program on Technology, Innovation and Entrepreneurship

I'm very honored to have the privilege of speaking to such a distinguished group. I am, in fact, very encouraged that you're here because one of the themes of my talk is the importance of Brazilian and U.S. interaction. There's also another premise of my talk: we have things to learn from each other. I want to stress that we in the United States have things to learn.

I am speaking in a personal capacity, not on behalf of the Center or on behalf of the National Academies.

One of the things that we have a problem with in the United States is that your colleagues [American congressmen] are extremely complacent. I once asked a senior senator, when we were talking about innovation policy, what his colleagues thought. Where did they think our innovation strength came from? This is a very intelligent man. He paused and said, "Well, I think they think it's divinely ordained that we should have a lead in technology. And they've forgotten what their fathers did."

Now, your challenge, according to your colleagues, whom I have spoken with recently in Brasilia, is that you've got a really hard task here. Why is it hard? Well, it's because you're doing well. I was just in Ottawa a week ago, and the Canadians were saying, "We have a really tough task here. The more oil we export, the harder it gets to maintain a diversified, innovative economy." One of the questions the Canadians had was, "Are

we doing as well as Saudi Arabia?" Hear this: "Are we doing as well as Saudi Arabia in capturing the value of the whole chain from the petroleum industry?" Now, I think you guys do actually better than Canada on that. But the question is: how do you do well enough?

Another premise of my talk is that nobody has a lock. No one fully understands how innovation works. There is a distinguished professor, Richard Nelson, who calls innovation the "black box of economics." There's also a cartoon I wanted to put up, where they have a guy who does a whole series of equations, and then he has a passage where a miracle occurs. That somehow is often what we talk about for innovation policy. We don't really fully understand the creative genius.

Also, in Washington, many people don't pay much attention to the innovation ecosystem. We like to call it an "innovation ecosystem" because when you talk to my colleagues at the National Academy of Engineering, when you say an "innovation system," they think it's a series of pieces, like a bridge. Each piece goes there, and if you put it together, it works. Whereas a better analogy is a garden, where changing temperatures, changing sunlight, changing fertilizer, and watering gives you different options. It's a much more dynamic model. In fact, Brazil is a good illustration of a dynamic model.

I used to work at the Treasury; and we knew that you would fail with Embraer. Actually, we also knew that Airbus would fail. The fact that you have not failed with Embraer, I think, is a powerful statement of the importance of not necessarily listening to the advice of the conventional, orthodox Washington economists.

Yes, you subsidized, but, the last I checked, we sometimes subsidize Boeing a little bit. In fact, we have actually grown our economy by very close public-private interaction, particularly in the early stages.

Now, one of the good things about our system is we know when to let go. We're not running the Internet. We let entrepreneurs do those applications. But we're pretty good at doing some of the early work and then letting the private sector take it up.

There is also serious work by Vernon Ruttan, a leading economist who, alas, is no longer with us, who argues that there is no major export sector in the U.S. economy that has not had major government support. Now, that doesn't mean that every tiny-minded trade barrier makes sense for Brazil anymore than for us, but that the hand of the government is often there.

So let me get to my actual talk. I will talk about both U.S. and Brazilian innovation strategy, some of the myths that block our process, and some challenges we have with the "Valley of Death" – a concept that is very important to understand.

One reason we're glad you're here is because we have a lot in common; one of them is common global mega-challenges. If we're going to drive growth and employment -- which you all need to be reelected and you need for your people -- if we're going to have alternatives to oil, where you've already done very well, we need innovation. We need innovation to have a greener economy. And

we need innovation for global health and for national security. That is what we call the "innovation imperative." The best definition I've ever heard of innovation is that "research converts money into knowledge, and innovation converts knowledge back into money." This is something that we sometimes forget in the U.S. and is often forgotten within our universities.

We need innovation to grow in your competitive position in addressing these global challenges. Collaboration is a key part of that. One of my main messages to you when you're dealing with your institutions at home is it is very important not to lecture them. It is very important not to tell university professors to behave differently. You have to provide them incentives to behave differently. As many CEOs in the United States have pointed out, be careful what you measure because that's what people will do.

What are the leading nations around the world doing? One is high--level focus on innovation. Another is sustained support for R&D. Support for innovation, small, and medium-sized enterprises, and partnerships between the public and the private sector.

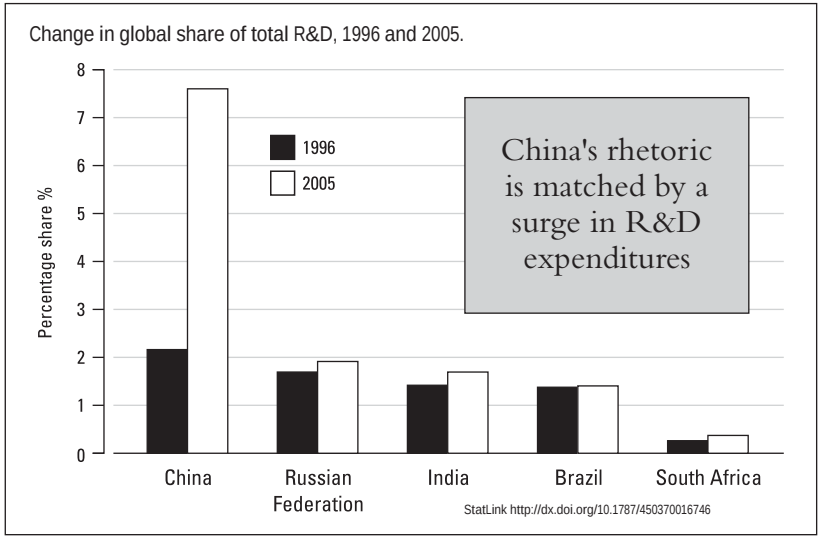
International cooperation is very real. You should also not lose sight of the fact that it's a tough world. There are many countries that are competing just as hard as they can with you. There's a great line in a wonderful play that someone says, "That's not fair." And the rejoinder throughout the whole play is, "Who said anything about fair?"

China gives us a lesson in many ways. I like to kid Americans that they seem to be cheating. How are they cheating? Well, they keep sending their children to school. They keep investing in universities. They keep building universities. They keep buying equipment for universities. And they keep training their kids as best they can. When I was out in Washington state, I suggested that they might set up a new university. I was with a distinguished group of leaders. They looked at me like I was out of my mind.

Yes, our fathers set up universities. Why would we set up universities? Our fathers built the innovation system that we have. Why do we do that? I mean, a case in point, we canceled a new tunnel into New York City. Why? Because it's too expensive and times are hard. When was the Holland Tunnel Built? That was during the Depression, when the economy was falling apart, the Nazis were running over Europe, and your other alternative was your friend's a Communist. You know, times were hard then, too. And so we built the Holland Tunnel. We built the Golden Gate Bridge.

Today, the countries that are going to win the future are focused, committed, and willing to spend. China is not just talking about it. Someone should show China's expenditure to the Parliamentarians from Brazil [see graph].

It's not just China. There is a huge surge from Asia collectively. By the way, it's a good thing. More money into research is a good thing. It's not clear that these inputs will necessarily give you innovation and inventions, but it does reflect their commitment to innovation, their commitment to investing in the future. How are you doing in the innovation imperative? Well, you have new investments, new institutions, and a new focus on science, technology, and innovation. On one level, I can only congratulate you. You have a strategy; you're consciously trying to work on your national innovation system. You are promoting innovation and enterprises. You are providing some incentives for startups. You have -- along with the rest



of the world -- been focusing on bio, nano, and health. And you recognize the major social benefits that are involved there.

When I was last in Rio, I was stunned by the growth of technology schools and the number of master's degrees. You're expanding out to the world intellectual stage in a very rapid fashion. This three-fold expansion is really quite impressive.

You also have -- and I think it's very important for you to understand -- a really high-quality innovation agency. I don't say this lightly; I don't know the new president of FINEP, but I can tell you that the last one had an international, global grasp of innovation policy. Having institutions like that is really important. Funding them is really important. And I was encouraged to hear that you have maintained the funding for FINEP. But remember: our Chinese colleagues are not just maintaining funding; they're increasing it. I'd like to talk a little bit about how you might do that. 20

The good news is the positive trend for your R&D investment, but there is also relatively bad news [see graph].

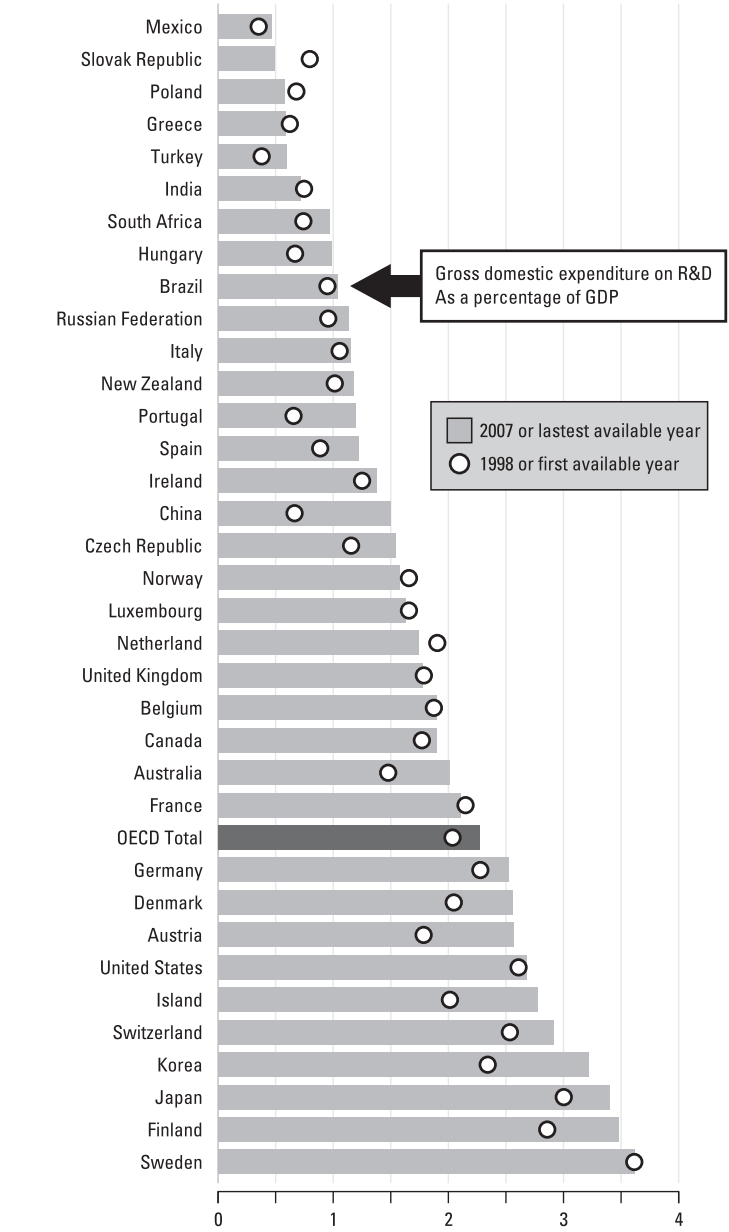
Brazil is not actually in the head of the pack. You're ahead of Mexico. But is that where you want to be? I think it's important to look at these things. And remember, these are just aggregate figures. This is not saying what are you getting out of it. I'm not saying that you should just distribute R&D all across all the universities throughout Brazil. One of the things our German colleagues and our French colleagues are wrestling with is: how do you concentrate resources to develop schools of excellence?

We have in the U.S. about 3,200 (3,600, depending how you want to count) institutions of higher learning. But only about 200 of those are really research universities. Probably only about 120 to 150 are top-quality schools. That push towards excellence is something that is worth discussing.

During our trip to Brazil we visited Minas Gerais, and we were very impressed with the system that they have in that state, impressed enough to invite State Secretary Portugal to come up here and talk to a major National Academies meeting.

What do you need to do? You've got to continue to work on strengthening the policy framework. A point that is very important is some of the cultural attitudes. We are more tolerant of risk; we're more tolerant of failure with a small company, but it's not in the genes. There's an old joke, but a good one: Do you know the secret to Silicon Valley? It's German capital, French engineers, and British managers.

The (Relatively) bad news. Brazil's position in the OECD R&D comparison.



OECD Factbook 2009: Economic, Environmental and Social Statistics

But the real secret is what we have in the sand. Some of what we have in the sand of Silicon Valley is the network of legal firms, patent offices, and universities that make that dense cluster. The secret is also policy. If you have a company in Silicon Valley and it fails, when the entrepreneur goes home, she tells her husband that she tried really hard, but it just didn't work. And he says, "I know you tried hard. Let's go out and have dinner, and we'll talk about what you'll do next."

In Finland, when the entrepreneur comes home and says the company has failed, his wife bursts into tears, drops the dishes, and cries, "My God! Where are we going to live? How will we ever pay the debts?" What is that difference? That difference is the bankruptcy laws. If you can't start a company quickly, and you can't end a company quickly, then don't expect to have an entrepreneurial environment. Yet, I know labor laws are tough to reform. It depends a little bit how much you care about your country.

In Italy, it takes six years to close down an enterprise. So what happens? You get lots of black market enterprise because the administrative load is too heavy. I would leave that as a challenge to you. How can you reform constructively those labor laws? How can you make it easy for a firm to stop when it's not working and reallocate the capital, and the spirit, and the entrepreneurship? That's what Chapter 11 [bankruptcy law] does in the United States.

So what are we doing here? Well, we are benefiting from some of the best leadership in innovation that we've had in a long time. One of the reasons that you should be here and think about collaborating with us is the U.S. share of global R&D. You are quite literally where the money is. It's an open system. It's a cooperative system. We're not here to help poor-rich Brazil because you're not poor. You've got great academic strengths. You've got great research strengths. The trick is to have a twin-pillar approach where you're providing funds -- we're providing funds-- where you can train people that can collaborate here.

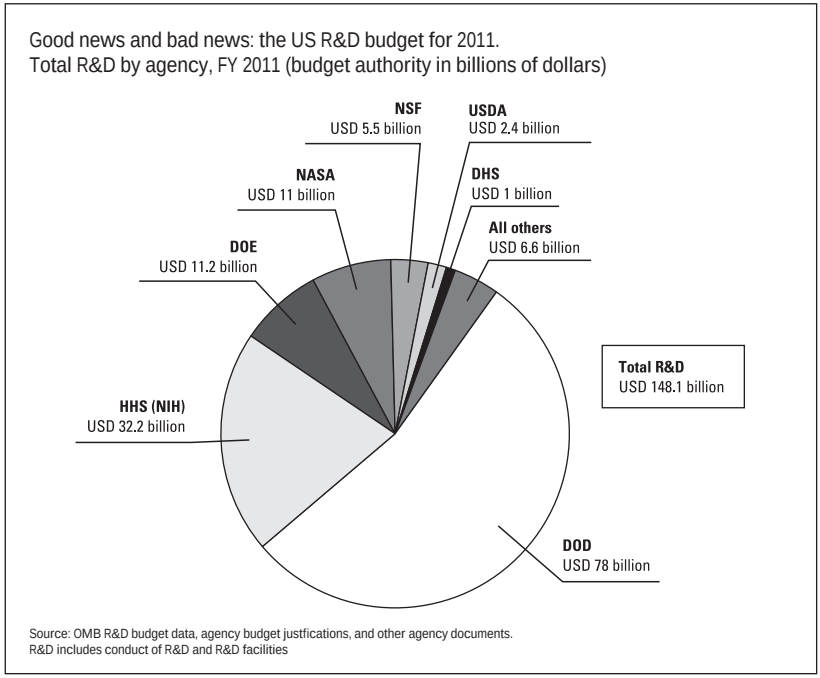
I would commend to you the Canadian Academic Chairs Program. They basically set up a whole series of well-paid positions across the country. It's actually kind of funny when you think about it. Canada complained for years and years about the brain drain, and then they finally figured out that maybe there was a brain drain because they could earn more money in the U.S. than they could in Canada. So they started paying them better, and surprise, surprise, they came back. Not only did the Canadians come back,

but also U.S. professors went up, which encourages this type of productive interaction, what the OECD calls "highly-mobile human capital."

So, there's a good reason to be here [in the United States]. But there's good news and bad news. We have the world's largest investment in health research, about $32 billion a year, not counting $5 billion in supplemental funds (so $37 billion). But non-defense, basic, and applied research is a problem that our Senate doesn't understand. Look how big that is [see graph]. That's in health research. That's the National Science Foundation.

This development is on the defense side, and there's a reason for that. We're trying to solve roadside bombs; we're trying to make sure that a new fighter jet works right the first time, every time; you have to make sure it works. You don't want an experimental submarine. On the other hand, we are seriously overstating to ourselves how much we're spending in research. We spend less than we pretend.

Now, the Obama administration should be an inspiration to the world. In the last three weeks I've been in Slovakia, the Czech Republic, and Germany, having high-level meetings with our German colleagues, and, as I mentioned, in Canada. The president's innovation strategy is really one of



the most comprehensive that we've seen at any time. Going back 40 years, it's clearly the best; the commitment to more research, a focus on skilled work force. We have a terrible problem with our immigration policies. We are, collectively, idiots. We bring in some of the best and brightest; we spend $150,000 to $200,000 to educate them up to the Ph.D. level, and then we kick them out, often back to the very countries that want to compete with us. This is profoundly stupid, and unfortunately, it's tied up with problems on the Mexican border.

We're focused on infrastructure. This is something we share with Brazil. I was very impressed to read that you're constructing three new superhighways around the state of Rio. We're beginning to work on a high-speed rail network in the country. It's only taken us 30 years, but we're beginning. The French -- whom, for some reason, the Americans love to hate -- put up a sign in Dulles Airport not long ago. You know, our trains are known for not being the fastest, and we celebrate our fast food. So the sign said, "Come to France, the land of slow food and fast trains." I'm not sure it encouraged tourism, but it was funny.

We're investing in clean energy innovation. We are a private sector, free market economy. Great! So, when we wanted a battery industry, what did we do? The president allocated $2.5 billion to help start the battery industry in this country, to help bring back American technology from China and Korea.

We've developed some new institutions. We now have ARPA-E. We have the Startup America initiative, which is going to help supplement our venture capital industry. We're working on improving patent, and, of course, we have an endless task of trying to improve our elementary and high school education.

This is quite an agenda. It's the most comprehensive, well-thought innovation policy we've ever seen. I think that's indisputable. Unfortunately, it took the administration the first two years, when they controlled the Congress, to come up with this idea. Now that they've come up with the idea, they no longer control Congress. Will these programs be funded? Will they work? That would be a complicated discussion, but we could do that by sector. There's also the question we all focus on, which is how do we get these into the market?

This is one of the things we struggle with here. In our country, we often have this statement: "If it's a good idea, the market will fund it." The reality is, and as several Nobel Prize economists demonstrate, that is not

the case. New ideas suffer from a real problem: they're new. I would like to point out the case of two young guys in Silicon Valley who were trying to raise money to start their company about 10 years ago, and they had a very hard time. They were turned down by almost all major venture firms. The two young guys were Larry Page and Sergey Brin, who founded Google. It's not always obvious.

One of the things that we all wrestle with is this: We spend about $150 billion on research, but as I mentioned, these new ideas can't get support. So how do you get across to where you can start to grow a product? Many good ideas end up dead in this Valley of Death. A challenge for you, working with FINEP, but I think also some other programs, is how do you help your firms, your academic entrepreneurs get across this valley? It's a core policy challenge all over the world.

Many people say, "Well, you can't have this problem here." When I was in the Senate doing some testimony not long ago, the first response was, "What about venture capital? If you've got a good idea, the venture guys will fund you." Well, no. Actually, the venture market is constrained. Only about $1.7 billion is in early-stage deals. It is also subject to fashion. One year, they're doing bio. The next year, they're doing nano. The next year, they're doing solar. They tend to herd together. It's also limited. It's only $21 billion in a $14 trillion economy. It's down from about $28 billion in 2008. It was $17 billion in 2009. Now it's back up, but it's a model that is under strain.

Let me quickly talk about one proven path across the Valley of Death. We call it SPIR. It's a great program because it takes a percentage of the research budget and applies it to national needs. The fact that it's an allocation means that it's budget neutral. If we had to vote for this in this country every year, we wouldn't have the program. It's also large scale. It's $2.5 billion a year. And because it's a large scale and it's been around for a while, we get what we call a "portfolio effect"-- that is, a whole series of investments. Some of them will work, some won't. It's also decentralized and adaptive. It's administered by a whole series of different agencies in different ways.

This is what I'd like to commend to you. FINEP is great, but what about having your Ministry of Health also encourage innovation? What about having your Ministry of Transport encourage innovation? Why do I suggest that? The truth is, in most countries around the world, there is an oligopoly supply system for major ministries. And this is a way of breaking

through that. It's a very competitive program here; only about 20 percent of the companies get to Phase I. Only about half of them make it to Phase II, where they can pick up a million dollars. We don't ask for the money back. These are not loans. There's no recoupment. They're either research contracts or outright grants.

It's a second chance program. If you don't make Phase I to Phase II, you can get another Phase I. We like to compare it to a basketball game or soccer, to put it, perhaps, more in the Brazilian context. You take a lot of shots, you don't always score. But there's only one way to win a soccer game and that's scoring. Taking those shots is incredible, and this helps that. It provides that first money, which is the hardest money to get. The entrepreneurs control the company. They don't lose control to venture capitalists.

We did a major assessment of this. We spent $5 million for me to be able to tell you what we're saying here. We brought together 20 researchers in the field. We had 20-person oversight committee. Many of the companies were created because of the awards. The research was initiated because of the awards. They partner with universities. If I asked you, "Do your universities work enough with industry?" I would bet your answer would be, "No." So how do we get them to do that? This is one way. It creates jobs, it creates innovations; it solves problems for the government.

I understand that São Paulo has initiated a program like this, which is a good thing. It should be a demonstration to others. Can you encourage programs like this? Can you modify what FINEP is doing? But above all, can you spread the innovation process across the different ministries?

Now, let me just say a few words about the 21st century university. You want a university that teaches the next generation, does research, but also that works on commercialization and generates market-ready students. I talked to one of the major corporate leaders from a U.S. multinational in India and I asked him about the quality of his students. He said the ones from the Indian institutes of technology are the best in the world. But, below that, they have three problems: they're not used to working on teams; they don't speak really good English, which makes it hard to integrate in the global economy; and they can't do PowerPoint. So it's hard to figure out what they know and what they don't know.

Universities should not be seen as a place where there are guys in white coats. They are centers of regional development and growth, the same way an airport is. Linking airports and universities is a very powerful combination. You need new leadership; you need people to actually be responsible

for their university. You need to give them authority and funds, and you need to hold them accountable.

Let me give you a personal view. Do you know what the great danger is to innovation around the world? It's the Ministries of Education. They know everything. They change nothing. Every centralized Ministry of Education -- whether it's in Sweden, China, or India -- is a threat to change. They're a threat to innovation. They're a threat to the growth of knowledge. Getting them to change is really hard. Outside programs can help.

My conclusion is if innovation is key, then it needs your focus. You've made really good investments in research and in FINEP. Is it enough? I would respectfully submit to you, ladies and gentlemen, it is not enough. You need to up the game. When you have a winning soccer team, do you stop buying new players? Do you stop bringing in new coaches? No, you up the game. And I think that's exactly analogous. Brazil has to up the game because now you're competing in the big leagues.

We would like to make sure that innovation policy is not a hobby. It's not something you do when everything else is done. Resource inputs are essential, but they're not sufficient. You've got to get the incentives right. You have to drive changes across the economy.

Now we have a common challenge of how we're going to deal with this rapidly changing global economy. We need to get our incentives in place. We need to learn from each other and to work together. It's a privilege to be here with you to encourage that dialogue.

Synthetic Biology, The New Frontier for Innovation: From Fighting Malaria to Producing the Second Generation of Biofuels

TODD KUIKEN
Research Associate, Project on Emerging Nanotechnologies

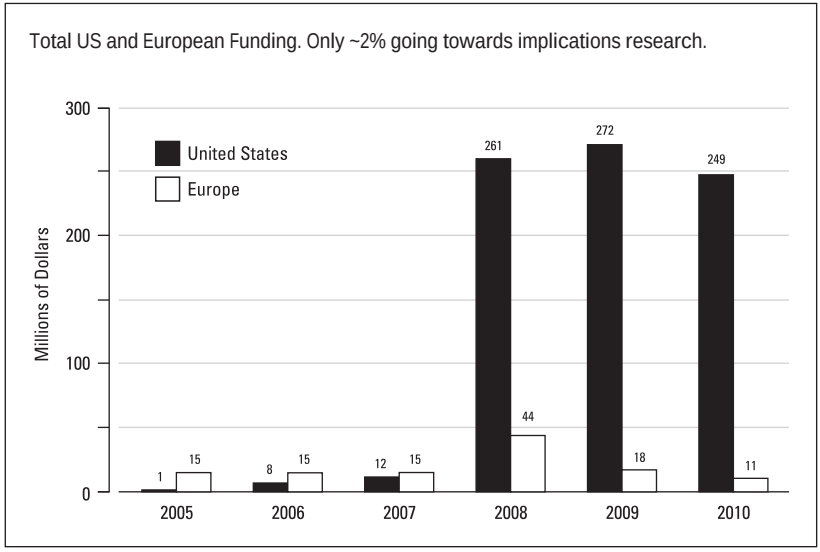
What is "synthetic biology"? That's an emerging form of bioengineering, the design and construction of new biological parts, devices, or systems. You can think of synthetic biology as an outgrowth of genetic engineering, where you're able now to create synthetically DNA strands, take different components of DNA strands, and put them together in different ways to do certain things within a living cell. The basic tenet is that it combines science and engineering in order to design and build novel biological functions and systems. This grew out of the engineering field. A lot of the first pioneers in this field weren't biologists; they were actually computer engineers that looked at the biological systems and said, "Wow, this really operates pretty much like a computer system, and we think we can redesign these things based on those ideas."

Jay Keasling, one of the leading pioneers in the field of synthetic biology, gives a good explanation of what they're doing. He said, "My idea of synthetic biology is that it's the industrialization of biotechnology. It's doing for biology and biotechnology what other engineering disciplines have done for other fields: the development of standardized components

that are well characterized, that can be assembled and put together to make a device that will accomplish some particular task… Biotechnology, as it's been practiced, has been a series of one-offs. If you look at every kind of new project that comes up in synthetic biology, they tend to be one-offs in that. We don't have standardized components that come out of that, that can be used for the next project. As a result, biotechnology is still a very expensive discipline to work in. It takes a lot of person power to do biotechnology. We have to navigate the patent landscape because biotechnology grew out of primarily the pharmaceutical industry where you patent, hold those patents exclusively, and don't share them; that isn't necessarily conducive to the kinds of sharing that we want to have. Even some of the smallest most trivial but most useful components are patented, which means that they can't be used in important applications like producing a low-cost biofuel or a low-cost drug for the developing world."

Last year, we wanted to see how much the U.S. government was actually spending from a research standpoint in the field of synthetic biology [see graph].

We went back through 2005. In 2008 the numbers jumped up pretty rapidly. Those are up to about $260 million a year that they were spending on R&D. Most of that money was actually coming from our Department of Energy, and the money was going directly into biofuels research. What



was interesting, however, was that a small portion of that and only about two percent of the total was actually going into "implications research" --- the environmental implications of what could potentially happen using these technologies and the social implications of what these new emerging technologies would produce.

My work at the Synthetic Biology Project at the Wilson Center involves tracking industries, universities, and other actors, such as companies that have also ventured into this field. You could say they fall into a few different categories. One of the majority ones is biofuels; the other is in DNA sequencing, which is what enabled synthetic biology to emerge, so as the costs of sequencing DNA has dropped rapidly. Another interesting note is that Monsanto, which is an agriculture company, has recently provided funding into this field as well, looking into whether or not their fertilizers and seeds can be developed using this technique.

In May 2010, Craig Venter's lab announced that they had made a bacterium that has an artificial genome, basically creating a living creature with no ancestor. This story was on the cover of The Economist, which pointed out that computers and humans are now representing God. The question is not whether or not they actually created new life; most people would say they didn't. What they did was absolutely extraordinary. For the first time, they synthetically created an entire DNA sequence. They took that sequence and inserted it into a bacterial cell. That cell then took in the new code from that DNA and started to replicate itself. So you can almost think of this as a artificial insemination, where they took the code of life, inserted it into a house and then that bacterial cell took that new DNA, started replicating, and created the new form that they had sequenced. It's an extraordinary feat. It's going to have major implications to the field.

I think the press and others were confused by the idea that they created a brand new life form, which is not exactly what they did. Based on that, the U.S. president created a bioethics commission that looks at a vast array of ethical issues. When Venter had made his announcement, he formed his bioethics commission to look directly at synthetic biology. They had about a six-month time span to come up with recommendations for the president on this new emerging field of synthetic biology. I want to focus on a few of these: risk assessment review and field release gap analysis, monitoring containment, and risk assessments. These are important because we're starting to deal with biological entities. They may be synthetically

created, but figuring out what happens to these once they're put out into the environment is going to be an important aspect as this field develops.

Some of the other issues that the commission recommended was that there be an international coordination and dialogue as this field grows. Ethics education, which we're looking at as well, is an interesting issue. One of the things that we're doing is trying to figure out how you change the curriculum in an engineering discipline to start thinking about the ethical issues involved in synthetic biology if you actually are creating or redesigning living organisms. The engineering field itself has an ethics course, but it doesn't really involve anything associated with the issues associated with biology.

Two years ago, we put out a report looking at the ethical issues of synthetic biology and concluded that there definitely will be some ethical concerns that arise with synthetic biology. They can be divided into two categories: physical harms and nonphysical harms. Physical harms are your environmental harms, health safety harms, and security harms; and the nonphysical harms are your moral and social concerns -- within that you can take a precautionary approach or the precautionary principle approach, however you want to define that, or a more proactionary approach, in whether you go after these issues beforehand or as the technology is developing.

What do we mean with these nonphysical harms? We asked a few questions that we think get raised in this issue, and one is: How do you distribute the tools that are needed to do synthetic biology? Do you need to distribute the technology across the world to countries that may not have the resources to do this technology right away? How do you distribute the benefits? Who's going to get the benefits of some of these technologies as they develop? Do you take a model, as Amyris did, where they're in a sense giving away the technology in the form of malarial drugs to the developing world, or do you patent everything so you can keep all of the money within the country or the company that developed the actual technology?

What's the appropriate attitude to adopt from us and to the rest of the world? What are the benefits that I get from this technology, and what are the benefits to the larger society? We run a bunch of focus groups looking at the issues of synthetic biology, and we ask people what's their reaction to these technologies. What's interesting is when you ask them if they are comfortable with this technology in general, they're a little reluctant. But when you dive a little deeper and ask, "How would you feel if I told you

that this technology had the potential to cure a specific disease such as cancer?" They become a lot more comfortable with the technology.

This gets into this issue of "what's the benefit to me, and what's the benefit to the rest of the natural world?" Then you have moral and religious concerns. When we start talking about creating new life or redesigning what's already out there, it definitely raises some of these moral and religious concerns. What I found interesting from the Craig Venter announcement was that the religious community in a sense took a very passive role on it and didn't find that many objections to it. Now that may change as more of this develops and you actually start seeing more synthetic life forms being created, but we're going to have to wait and see how that develops.

Some of the physical harms are largely safety and security questions, regarding the environmental health of what happens with synthetic organisms and their interactions with the natural environment. What's the [effect of this on] human health? What's the exposure to humans to these new synthetic organisms that are out there? Then you have biosecurity concerns that this technology could get into a rogue hand and they could recreate, say, an Ebola virus synthetically, or they could recreate an anthrax virus. These are all concerns that have to be addressed as the technology is developing.

I want to go a little bit deeper into the environmental implications. I'm an environmental scientist by training, so that's my area of concern mostly. One of the things we've found is that the ecological risk assessments are lacking from the synthetic biology standpoint. What do I mean by an ecological risk assessment? What are the implications of what will happen if these organisms are intentionally released or they're accidentally released? The applications of synthetic biology are far and wide, so you have to assume that a lot of these organisms are going to escape. What does that mean when they get out into the natural environment? Are they going to interact with the natural organisms that they're loosely based on? Will those organisms uptake the new DNA sequences that have been inserted into these organisms? What you hear a lot from some of the practitioners is that they've designed in what they call "kill switches." This means that the organism has been designed to basically self-destruct once it's out of the environment that it was specifically created to live in.

This was done for two reasons. One was for the environmental implications so these things would self-destruct if they got out into the natural

environment. The other is from an actual intellectual property standpoint. If you're thinking about biofuels, for instance, and you're growing up these algae in a tank; then someone just comes in, and scoops out a cup of it. They can bring it back and grow it out themselves. In essence, these are supposed to kill themselves if that were to happen. There's some concern with that because synthetic biology is different from an environmental standpoint. If you look at it from a synthetic chemistry standpoint, where we've had fertilizers and pesticides, when chemicals get out or there's a chemical spill, you can get that back because there's something you can actually take out of the water or take out of the air. What we're talking about now are actual biological organisms, and what I think history has shown us is that biological organisms tend to try to live on. They don't really want to die. Despite our best efforts to control or kill them, we're not very good at it. So it's something that has to be looked at pretty closely when you're talking about a biological organism that has the potential to escape, then enter into the natural world, and interact with other organisms.

There are a lot of ideas out there on synthetic biology, and they're not all positive. I will mention two reports: "Synthetic Solutions to the Climate Crisis: The Dangers of Synthetics Biology for Biofuels Production" from Friends of the Earth, and "The New Biomassters: Synthetic Biology and the Next Assault on Biodiversity and Livelihoods" from the Et Cetera Group. While these tend to be some of the more radical environmental groups, they actually raise some interesting ideas and concerns about synthetic biology, particularly in the realm of biofuels and using synthetic biology techniques to develop new medicines. They're concerned about land grab issues. What does it mean if we're now going to move from big oil to big agriculture? Are you going to displace farmers using these new techniques? Are you going to put other people out of work using this new technology? I wanted to put this out there so people are aware that there are other ideas and they're not all positive, and that these groups can tend to have a lot of traction.

They can derail an entire industry, an entire technology, if the public rejects it. If you look back at what happened with the genetically modified organisms debate, GMO foods and crops, a lot of that had to do with these two organizations that convinced the public, particularly in Europe, to reject the technology. It had a huge economic impact to the U.S. farmers because they can't sell their crops in Europe, for instance. So the public and society have a big part in these new emerging technologies in whether or

not they accept them. A technology can have great potential benefits, but if the public rejects it, it's worthless.

I want to move into the DIYbio movement because it's an interesting phenomenon that is growing at the same time that synthetic biology has. This is a group that was founded about two or three years ago to help organize the efforts of amateur biologists, citizen scientists, and other non-traditional practitioners of biology worldwide. On their website, you can see a map of some of the various groups. Basically they're beginning to adopt different practices like genome sequencing and biological engineering that were once only accessible in an institutional setting. A lot of this has to do with the drop in price of DNA sequencing, which has enabled people other than Ph.D. students to enter into this field. For instance, in 2008 there were two members, the two founders of this group. Two years later, there are over 2,000 people that are on their lists, calling themselves amateur or citizen scientists. There's 20 various regional groups. These are all across the world. I believe there are two located in Brazil.

Another phenomenon that's developed out of this are what are called community laboratories. The first one, a fully functioning biotechnology laboratory called Genspace, recently opened in Brooklyn in December. You can think of this almost as a gym membership where you pay a monthly fee, and you can go to this space that has various different lab equipment and run your own experiments outside of a traditional university or corporate laboratory. A woman in Boston basically sequenced her own DNA in her closet in her house to figure out if she had this promoter that was going to express this potential disease that ran in her family. You have other people that are working on engineering yogurt bacteria to tell you if you have a contaminant in your yogurt. And there is a startup company created by two Ph.D. students at the University of Michigan. They've raised money on a site called KickStarter, which is basically a crowdsourcing technique of raising money, and now send out biotechnology kits to high schools that don't have that curriculum in their high school to get them more inspired to work into this field.

As you can imagine, there's some pretty significant biosafety and biosecurity concerns with this movement. At the Wilson Center, we are partnered up with DIYbio to try to put together information and set some standards for this movement so they can do these things safely. A lot of the people that are involved in this aren't trained biologists; they're not trai-

ned in lab practice; and they may not know what it is that they're actually making or throwing out when they're finished with it.

I want to end my presentation with the iGEM competition, which is the International Genetically Engineered Machine competition. This started at MIT in 2004, I believe, and basically these are undergraduate student teams that are given a kit of biological parts at the beginning of the summer. The biological parts are those pieces of DNA that we were talking about before that you can put together in different ways to make things do things, or make them do different things. They work at their schools over the summer and design new parts to build biological systems, then operate these within living cells. In 2004 there were five teams from five schools, and it was only located in the U.S. Six years later, there was 130 teams that were represented on all the continents across the globe. I'm a judge at iGEM. I judge the environmental health and safety aspects of all of the teams' projects.

The 2009 Brazil team that was there won a gold award for their project. It's important for them to be able to get funding because you're growing your future scientists in this new field of synthetic biology. Already from this competition, there has been at least two companies that have formed directly as a result of these undergraduate teams' work. They do all of the work themselves over about a three-month period. So I just wanted to leave you with that. This was in 2009. They didn't have a team in 2010, but this year they do, Brazil does have another team from the same university. They've actually partnered with a university in France. It will be interesting to see what develops out of two different countries from two different parts of the world. This competition is a way that you can grow from your own countries new scientists that can then go back into industries or into the university system and teach science again. It's something that you can look at. It's an easy thing to fund. These projects don't cost that much money, and I think have enormous returns in the future.

The leading edge of synthetic biology in Brazil

JOEL VELASCO
Senior Vice-President, Amyris

Amyris is a renewable products company that is applying its industrial synthetic biology technology platform to provide alternatives to select petroleum-sourced products used in specialty chemical and transportation fuel markets worldwide. We engineer microorganisms, primarily yeast, and use them as living factories in established fermentation processes to convert plant-sourced sugars into potentially thousands of molecules. Put it simply, we engineered the same yeast used to convert sugarcane into ethanol in Brazil to produce more value-add hydrocarbon molecules.

ADDRESSING MALARIA

While Amyris commercial focus is to develop renewable fuels and chemicals, its first breakthrough of innovation came in 2005 through the development of a technology to produce Artemisinic Acid, a precursor of Artemisinin, an anti-malarial therapeutic. Artemisinin is part of a highly effective treatment for malaria patients. Patients take the artemisinin-based combination therapy, or ACTs, after they have been infected with malaria. Malaria is a preventable, curable disease that claims the lives of more than a million people a year. In Africa alone, malaria causes 20% of all childhood deaths, killing 2,000 children every day.

Unlike a vaccine that is possibly years away, artemisinin is available today albeit not in quantities needed. The uncertainty in supplies of artemisi-

nin, which until now has been derived from a plant-based source, artemisia annua, creates a significant public health crisis as millions are infected with malaria every year.

Recognizing this challenge, the Bill & Melinda Gates Foundation provided Amyris with a grant to leverage synthetic biology to convert plant--sugars, like those found in sugarcane, into a semi-synthetic version of artemisinin that could alleviate ACT manufacturers dependency on plant material and exposure to the associated vagaries of the growing season. In 2008, with the technology proven to work in the lab, Amyris entered into an agreement to license our artemisinic acid-producing yeast strains to Sanofi-Aventis on a royalty free basis for the purpose of manufacturing and commercializing artemisinin-based drugs for the treatment of malaria.

With the technology proven and our shared commitment with our partners to ensure that the malaria drug will be available to all who need it, Amyris had turned its focus to the production of renewable chemicals and fuels. Amyris is now applying inspired science to reduce the world's dependency on fossil fuels.

SUSTAINABILITY = PERFORMANCE

Before Amyris, choosing a sustainable product required customers to make tradeoffs. More often than not, they compromised on performance. Levering its industrial synthetic biology platform, Amyris is optimized to deliver high performance solutions to those who seek sustainable alternatives to petroleum sources fuels and chemicals.

Amyris's first commercial focus has been in the production of farnesene. Why farnesene? Because farnesene is a 15 carbon molecule that, with minor modifications, can be flexibly adapted to serve as an alternative to fossil fuel-derived products across a number of markets. Biofene®, Amyris--brand of renewable farnesene, can be used as-is or modified to provide other renewable ingredients for the six markets upon which the Company is focusing: cosmetics, flavors and fragrances, industrial lubricants, plastics and polymers, consumer product goods and transportation fuels like diesel and jet.

Another attractive aspect of Amyris' renewable farnesene is that we can use sugarcane as a feedstock. While Amyris's platform can work with a variety of plant-sugars, the Company is focused on Brazilian sugarcane for our production efforts because of its abundance, low cost and relatively

price stability. Sugarcane is the most photosynthetic efficient plant to convert sunlight, carbon and water into stored energy in the form of sugars. And finally, of course, renewable hydrocarbons provide a number of compelling advantages when compared with fossil fuels. It's biodegradable. It doesn't yield sulfur and it has significantly lower emissions than petroleum. Best of all, unlike the world's finite supply of fossil fuels, we are making renewable products from sustainable produced feedstock.

MAKING IT HAPPEN

Amyris produces renewable hydrocarbons by applying its proprietary industrial synthetic biology platform to genetically modify microorganism – primarily yeast – to function as living factories. After the sugar source is extracted from the sugarcane at a traditional mill, Amyris employs fermentation process that used the engineered yeast strain to convert the sugar into the target molecules – currently farnesene but eventually other hydrocarbons like isoprene.

Over the last few years, Amyris has made remarkable progress both in terms of technologies to address some of the world's challenges. The Company is currently producing at three sites in three continents. Two industrial scale sites are currently under construction in Brazil, where about a quarter of Amyris's staff and its state-of-the-art demonstration plant is located. In the coming years, the Company expects to continue its accelerated growth and innovation both in the United States and Brazil.

In a world of finite resources, we need to solve problems with solutions that are both renewable and sustainable. Amyris is committed to that challenge with solutions that don't compromise on performance, affordability and availability.

The Federal Communication Commission Broadband Deployment Plan

JOHN HORRIGAN
Vice President, Policy Research, TechNet

The National Broadband Plan was mandated by the stimulus legislation that Congress passed shortly after President Obama was inaugurated. It directed the FCC to produce, within a year, the National Broadband Plan. We asked for a one-month extension so it was not delivered on the one-year anniversary of the stimulus legislation but rather on March 17, 2010.

Why do a National Broadband Plan? First, there's been a sense in this country that the United States trails other countries in broadband. According to the Organization for Economic Cooperation and Development (OECD), we ranked fourth in broadband penetration per hundred people in the population in the year 2001-2002. About a decade ago, the U.S. was ranked near the top by that metric of broadband progress, and it's been a steady downhill story since. Today, we're ranked at about 14th in the world in terms of broadband penetration per hundred population. In terms of network quality, there's a study done by Cisco and the Oxford Business School that puts the U.S. 15th in speed of network. So there's a sense that the U.S. is not doing as well as it should in broadband and that was one strong motivation for developing the plan.

Other motivation is the general belief that better broadband is better for the economy. That can have two effects: one is a direct economic benefit. If there is public investment in broadband, that's an opportunity for job

creation given that people will be hired to run infrastructure and provide service. An indirect benefit, and arguably a bigger benefit, is with better broadband you have a better innovation platform in your country. Faster speeds, more ubiquitous deployment, higher rates of adoption, it is hoped, will stimulate people's entrepreneurial instincts, create new businesses, and also enable existing businesses to deliver services more effectively and efficiently.

The third important pillar of developing the broadband plan was the notion that broadband is a tool for addressing key societal challenges such as healthcare and the delivery of education. In developing the Broadband Plan, we were always clear in saying that better broadband is not going to solve the healthcare problem in the United States. Better broadband in itself will not improve educational outcomes in the United States. But as comprehensive solutions are developed in those and other areas, broadband can be a very useful part of the solution.

Let's talk about what the plan found and recommended. First, how do we go about tackling the problem when we actually did the plan at the FCC? A phrase that was repeated often in the plans development was "data driven." The National Broadband Plan itself, which is a document of about 376 pages, is very data driven, heavy in providing information that supported the various recommendations made.

At a high level, we set out a broad goal that we call the "100 by 100" goal, which is to say by 2020 the plan ambitiously forecasts and hopes that there will be 100 megabit connections to 100 million homes in the United States. That 100 million homes comes to about 90 percent of all households in the U.S. From a level today of about 65 or 67 percent of people with broadband at home in the United States, the goal is to not only increase broadband adoption to 90 percent but to dramatically increase the speed of infrastructure going to people's homes to 100 megabits from the typical speed today of about six megabits per second.

What can you do at 100 megabits per second that you can't do today? Often times when that question is asked, particularly of broadband carriers in the United States, the response will be "consumer demand is not that far along yet." The typical use case for the typical consumer requires about six megabits per second today -- meaning that the typical Internet surfer in the United States is someone doing e-mail, Facebook, some video, and some uploading of content. Uploading speeds are typically about half the rate of download speeds.

The notion that there's a huge demand for 100 megabits today is not supported when you look at the typical use cases for Americans. The response you might get from an engineer, somebody who has long history in the internet business, is that it's historically been the case that when you provide greater speeds you will get innovators at the high end, having their imaginations quickened by this extra speed to develop more innovative applications. So it's this aspirational notion that more speed will spark innovators to do more things that will help draw demand toward uses that take advantage of 100 megabits per second. And you will find people in the United States that find that the 100 megabits per second is a conservative goal. They call it a conservative ambitious goal. Some people think we should get to one gigabit per second to people's homes. And, just as an aside, Google is pledging to do that for Kansas City with the Google fiber-to-the-home competition that Google recently concluded.

We set out this ambitious goal and tried to characterize where we are today across three dimensions: the deployment of infrastructure; the adoption of broadband among consumers; and how broadband can be used for these national purposes that I've alluded to already. So let's talk about infrastructure. What did we find in trying to benchmark where infrastructure is today in the United States? We found that approximately 95 percent of U.S. households have at least one wireline broadband provider to their home. In most cases that would be either DSL or cable modem service. We found 80 percent have access to two wireline providers; again, that's going to be DSL or cable.

In the United States, the company Verizon provides FIOS, a fiber-to-the-home service. That probably only reaches 2 or 3 percent of American broadband users. About two or three percent will not all be Verizon, but the incidence of fiber-to-the-home to the U.S. is fairly small. Our analysis showed that if you wanted to wire the final 5 percent of the geographic land mass of the U.S. -- or the final 5 percent of households, I should say -- it will cost about $24 billion to reach what are typically remote, rural areas, where there is not presently wireline broadband access. That would cost, we estimated in the broadband plan, $24 billion. In terms of what happens in other environments, in terms of broadband infrastructure, the stimulus bill funded $7.2 billion of infrastructure. How does that compare with private sector infrastructure investment in broadband? About $30 billion annually is invested in broadband in the United States by the private sector. That's the story on wireline infrastructure.

In terms of spectrum, the National Broadband Plan spends a good deal of time talking about what we saw as the looming spectrum crisis. There is increasing demand for spectrum in the U.S. that is driven largely by the devices that many of us have in our pockets or in front of us right at this moment, smart phones, which take up a lot more band width than traditional cell phones. Do we have very many I-Pad users in the audience? Those people with I-Pads are even heavier users of data services using the spectrum and there's an upward trend in adoption of tablets, whether I--Pads or other products these days. Wireless data traffic is projected to grow 35 times by the year 2014 so this huge projected increase in demand for wireless data is the basis for the claim in the National Broadband Plan that we have to do more to get more spectrum into the market place over the next 10 years. The Broadband Plan calls for 500 megahertz of spectrum to be made available in the market within the next 10 years.

The key mechanism to do that is something called incentive auctions, which is a fairly hot topic of debate in the U.S. in telecom policy circles. So what are incentive auctions? In the United States television broadcasters have been granted spectrum to broadcast their television programs. The broadcasters were granted a lot of spectrum years ago when it did require lots of spectrum to broadcast television signals. Advances in technology has made it possible for TV broadcasts to be made with a fraction of the spectrum that broadcasters were granted and other licensed by the FCC many years ago.

The National Broadband Plan said that as much as 120 megahertz of spectrum could be freed up if we could reclaim some of that spectrum from broadcasters. The idea is to get some of that spectrum back from broadcasters without really harming their ability to broadcast their existing programming. The trouble is broadcasters aren't a big fan of this idea. They have the spectrum; they would like to keep it. The idea behind incentive options is to say to a broadcaster: if you choose to put your broadcast back into the public domain, we, the U.S. government, will sell the spectrum at auction to the private sector and some of the proceeds from that spectrum will go back to you, the broadcaster. That's the incentive for the broadcasters to participate in the auction. When the spectrum is eventually sold in the commercial marketplace, they get a cut of the proceeds from that. As I said, that is a subject of controversy. It requires Congress to pass legislation authorizing the FCC to conduct these kinds of auctions. The FCC is, in

fact, in favor of this approach; yet it can't move without congressional authorization and that's pending before Congress in the United States.

Let's talk a little bit about adoption. I said that 95 percent of homes in the United States have access to at least one wireline broadband provider. This means that 95 percent of homes could get broadband service if they choose to. The question is, how many choose to get broadband service at home? The answer is from surveys conducted by the FCC, the U.S. Department of Commerce, under my guidance when I was at the Pew Internet Project: about two-thirds of Americans have broadband at home. That data nugget is often a head scratcher in some of the audiences I talk to. People say, "You mean people have the infrastructure coming to their home, yet they choose not to have broadband?" And the answer is yes. Around that 28-percentage point gap represents a sizeable slice of the American population who, for whatever reason, chooses not to get broadband service where they live.

In the Broadband Plan, we were charged with trying to figure out why Americans without broadband do not have broadband, and we conducted a survey that found that there are several different barriers that people face to broadband adoption.

Americans pay about $40 per month for broadband. Among non-broadband adopters, 15 percent are saying that that typical price of $40 is too much for them. Another 10 percent of non-adopters say the computer is too expensive so they can't afford the hardware to get online. But then you get about 22 percent of non-adopters saying they lack computer skills. You can see, in the first instance cost, whether it's the monthly fee or the cost of a computer, looms large; but people have other challenges to getting online. Lack of computer skills is one and the final bullet is lack of awareness of broadband's utility. People just say, "It's not for me, I don't understand what I would do with broadband if I were to have it."

The other key point is when you ask people why they don't have broadband, these several different reasons I've listed here for not having broadband tend to travel in groups. If you're somebody who says it costs too much, you're also very likely to cite the fact that you don't have computer skills. So to readdress the broadband adoption gap, you're not going to employ one policy lever such as simply subsidies to lower the cost; you're going to have to give people a comprehensive approach: training, subsidy, as well as some good old-fashioned marketing as to why broadband is a nifty and useful thing to them. The last third of adopters are the hardest set

of customers to get and the private sector finds it very expensive and time consuming to go after those customers.

What are the solutions that have been proposed to try to close this broadband adoption gap? If you can partner with the public sector, with existing non-profit efforts that are aimed already at promoting broadband adoption for the private sector, it can effectively reduce your cost of acquiring those hard to reach customers. One idea is to create a digital literacy corp. Basically, hire people to go out and train those who don't have broadband on how to use it. Mobilize young people looking for a job opportunity to go train people who don't have the skills to use broadband. Secondly, develop public-private partnerships to train non-users on how to use computers and the Internet. This idea came about through discussions with members of the private sector when we were developing the Broadband Plan. We held 40 public workshops in the process of developing the National Broadband Plan, where we got input from members of non-profit organizations, the private sector, and other actors. The public workshop as a mechanism to gather private sector support as well as support from other sectors of society was key.

Comcast is one good example of a company that has devised what is called an A Plus program to try to give subsidies to eligible school children to have computers in the home and cut-rate broadband service. Then third, share best practices on adoption promotion programs around the country. In scanning the landscape in the United States of initiatives to close the broadband adoption gap, we found a lot of unevenness around the country. There are some places where the community has gotten behind developing training programs to train people to use broadband. Other places are behind the curve looking for a way to accelerate their programs to close the broadband adoption gap. If there were a forum by which best practice could be shared, we felt that this would be a useful mechanism to close the broadband adoption gap. Comcast had some difficulty getting a hardware company to participate in the program to give a sufficient cut rate on computer hardware to get online. But if they can clear that hurdle, Comcast pledged, I think, to provide broadband service to eligible homes. Eligible homes typically mean school-age children eligible for benefits programs like school lunch programs. I think the figure would be $15 per month for broadband -- well below that average number that I quoted of $40 per month.

However, in terms of priority, do you want broadband reaching the widest number of subscribers or do you want to upgrade the network in strategic areas in such a way that might spur innovation and economic growth? Unfortunately, the U.S. Congress did not provide us guidance on that because they basically recommended that we look for ways to promote universal adoption of broadband. From my perspective, if I had to prioritize, I would say it's important for overall welfare and economic growth to invest strategically in network speed, so you get very high speeds to the areas where you're going to grow the most entrepreneurs and have the most job creating potential. One could spend a lot of money to get the highest speeds to rural America, yet there are relatively few entrepreneurs in rural America waiting to get higher network speeds to invent the next job creating business. They tend to be in urban areas, clusters of talent around universities and so forth.

With respect to national purposes, the areas that Congress directed the FCC to look into as to how broadband could improve are: energy and the environment, government performance, healthcare, education, economic opportunity, and public safety. What the Broadband Plan did was to highlight good examples from around the nation, where broadband was being used to help people manage their energy usage at home, for instance, or for the delivery of healthcare.

After about a year, how is Broadband Plan doing and what has been done? In terms of infrastructure, these are some initiatives that have come about since the release of the Broadband Plan that were either highlighted in the Broadband Plan or given more momentum because of the Broadband Plan. In a State of the Union Address, the president set this goal of covering 98 percent of the country with fourth generation high-speed wireless infrastructure within five years. That ambitious goal set forth by the president has a number of components to it. One is freeing up 500 megahertz of spectrum, something pulled directly from the Broadband Plan incentive auctions, which I did touch upon as to what they are.

The Office of Management and Budget estimates that incentive auctions could bring $28 billion in revenue into the treasury if implemented correctly. The president's plan actually has some ideas for spending some of that $28 billion but also giving back the money to the treasury. Three billion dollars is proposed for a wireless innovation fund to develop mobile applications aimed mostly at some of those national purposes that I listed; $5 billion for a 'one dime' spending for rural high-speed infrastructure;

and $10 billion for a public safety network. That involves giving a very valuable section of the electromagnetic spectrum -- the so-called D Block in the 700-megahertz portion of the spectrum -- to public safety agencies around the country. Then, they will be able to build a national interoperable public safety network, so that firefighters in one part of your city could easily not only talk to but also communicate with video or data. It would cost $10 billion to build that infrastructure to put up the towers and develop the hardware to make that work. That leaves, if I'm doing the math correctly, close to $10 billion that would go to the Federal Treasury.

Then comes from the stimulus bill, the $7.2 billion in grants for infrastructure. A lot of that from the Commerce Department is for the so-called middle mile of fiber optic networks. The middle mile is the portion of the fiber optic network that takes traffic from your neighborhood to the high--speed trunk lines that distribute data traffic around the world. The Commerce Department identified that as an infrastructure gap in the United States. Typically, there's a decent wireline broadband infrastructure in even rural areas, in a reasonably densely populated rural area. The trouble is getting that traffic from that rural spot of density to the main portion of the broadband infrastructure. That's the so-called middle mile. So the ARRA grants have helped deal with that.

But the president's wireless initiative is a goal. To attain that goal, those specific elements -- the wireless innovation fund and the $5 billion for rural high speed -- are things that have to happen.

On how to increase broadband adoption, there's been somewhat less action in the ensuing year. There are programs under the stimulus program within the Commerce Department. They are on the order of $500 billion collectively that go toward sustainable broadband initiatives that fund community groups who are all about training people who don't have broadband on how to use them. There's $250 million for public computing centers to help libraries and anchor institutions like police or fire departments to provide public access to people who don't have broadband. And there have been some nascent efforts to develop the public and private partnerships that I mentioned before.

The FCC has just begun a proceeding in reforming the universal service fund to try to channel some funds from the U.S. Universal Service Fund -- which is a $9 billion per year fund aimed at both infrastructure and adoption, but mostly aimed at old-line telephone infrastructure and adoption of telephone service. It's not oriented towards high-speed uses.

Reforming that $9 billion fund and letting some of those funds be used to promote either broadband adoption or infrastructure development is underway and in the early stages at the FCC. So the adoption issue has probably gotten less traction in the ensuing year since the Broadband Plan than some other issues. Other people will actually probably say that some of the issues on spectrum have gone entirely too slowly as well. People's mileage may vary.

On national purposes, this is an instance where the Broadband Plan laid out some goals for different corners of government to take action. Since the Broadband Plan was delivered, some efforts have gotten underway around different departments. In the Education Department, for instance, there's been the development of a national educational technology plan on how to use information technology more effectively in schools. The National Institutes of Standards and Technology in the United States (NIST) is working on standards for smart grid developments, so that the energy grid in the United States can be managed more effectively and consumers have an opportunity to manage their energy consumption at home. With public safety, I mentioned this issue of the D-Block auction of spectrum to help develop a public safety broadband network. That is slowly getting underway but again; the wheels of government often turn slowly.

Let me just conclude with some ideas on the question of will the Broadband Plan deliver. On the one hand, it's a fairly weighty government document of nearly 400 pages that lays out a lot of detail. I've just given you a flavor for how some of those specific recommendations are being implemented over the past year. But the final chapter of the Broadband Plan starts out with that sentence, "This plan is in beta and always will be." Meaning the plan itself has to be constantly under review, scrutiny, and revision if necessary, as technology changes and as other things change in the climate. You have to update your goals and your processes for meeting those goals as situation changes in the world economy. I would just recommend that you set up a process by which the bar can be moved to higher goals if you need to as the situation changes.

Will it deliver? Well, there has to be better metrics to measure progress. One thing that we ran in to again and again in the Broadband Plan is the dearth of metrics on how to measure phenomenon in the broadband space. As U.S. government statistical collection practices are by and large still anchored in the industrial age, we have to do more to try to understand how to measure things in a broadband age. Secondly, institutional change:

there has been an incredible interest among state and local officials in the United States on how to use broadband. I think that has been in part, not exclusively, but in part a result of the National Broadband Plan.

I spoke at several events in the aftermath of the delivery of the Broadband Plan, where there would be city officials, state officials, coming up afterwards and being really excited on how to use broadband to run their governments more efficiently and promote economic development. Lots of cities have task forces in the U.S. trying to better use broadband and better understand broadband infrastructure. That kind of institutional change has to take place in order for the broadband plan to become real. At least, I have witnessed some of that in its early stages in the immediate aftermath of the Broadband Plan, but more has to be done to sustain that.

You undertake a National Broadband Plan so that you have a robust platform for innovation. How to measure outcomes in innovation from inputs in broadband is another challenge that we have to understand better. It's something that we have to have an ongoing discussion about. Then finally, if the Broadband Plan is to have a real impact, you want to see accelerated outcomes in terms of learning for school kids and entrepreneurship at the state and regional level. Those are important indicators. It's not something you're going to measure well a year after the Broadband Plan is delivered, but it's something to keep in mind as we go forward.

I would add that too many countries in this world believe that the core focal area of their growth should be their export-traded sectors of their economy. The message of my presentation is that while that's important, raising the productivity of domestic, non-traded sectors of your economy is equally, if not more important.

International Information Technology Competiveness and U.S. Innovation Policies

STEPHEN EZELL
Senior Analyst, Information Technology and Innovation Foundation

General Purpose Technologies (GPT's) drive transformations and economic growth. Most innovations come incrementally with modest changes and improvements in products, processes and business models. But, approximately every half century, a new technology system emerges that changes everything. In the history of the human race, we've had about 35 of these General Purpose Technologies. The wheel, the printing press, the three-masted sailing ship, steam power, the railroad, steel, electricity, and, today, information and communications technology. The point about GPT's is that they impact and change virtually everything: what and how we produce it; how we organize and manage production in our society; the location of productive activity; the infrastructure needed to support it; and fundamentally the laws and regulations needed to support the General Purpose Technology.

GPT's also have three main characteristics. First they become pervasive and all encompassing. That means they become a part of almost all industries, products, and functions. They enable innovation in products, processes, business models and models of business organization. Finally they undergo rapid price declines and performance improvements. Take, for instance, the little thumb drive, a two-gigabit thumb drive. This is part of our everyday lives today, right? In 1995, how much would five gigabytes worth of storage capacity have cost? Five gigabytes cost $5,500 in 1995. So

we have incredibly steep declines in price, while we have incredibly steep improvements in performance at the same time. Of course, this is simply for storage capacity. I imagine we'll find the same thing for processing power of computers.

I'm sure you're familiar with Moore's Law, which of course says that the number of transistors that can be fit onto a microchip doubles every two years. In fact, when we look at the cost of one million computer operating instructions per second, that's how we measure the speed of microprocessors. In 1960, the cost of asking a computer to do one million instructions per second was $1.1 trillion; today it is 13 cents.

To illustrate that point, I have my wife's birthday coming up, so I picked up a greeting card for her. It's a nice little greeting card with an embedded microprocessor inside that plays "Unchained Melody" by the Righteous Brothers, a classic American tune. I bought this card for $4.99. Now imagine how much I would have had to pay in 1946 to buy my wife this greeting card. This would have cost me $4.6 billion in 1946. The very first computer was the ENIAC Computer created at the Pennsylvania University in Philadelphia. The ENIAC computer was developed at a cost of $5.5 million at that time. This little greeting card is 800 times more powerful than the very first ENIAC computer. This greeting card has more computing power than existed in all the world in 1955, and we're just getting started.

We see similar trends in the increases in Internet connectivity speeds. We can look back to 1992, 1996, and, for those of us who were online then, we were dealing with very slow dial-up modems. By the early 2000s, we started to get into DSL lines, Digital Subscriber Lines in the United States, 1.28 megabytes per second. Maybe by the mid 2000s, we were up to 2.5 megabytes per second. Today, we are at about to 6 megabytes per second, but we expect to go to 100 megabytes per second by 2020. In fact, Verizon and Comcast are now starting to roll out 40 and 50 megabyte per second offerings. This means that, over the past three decades, the average speed of Internet connectivity to the home has increased by 117,000 times. The speed of the network backbone has increased by 18 million times. This means that the world is becoming alive and bathed in real time access to information in all times and in all places.

By the end of 2013, it's estimated that there will be 5.5 billion devices or sensors around the world connected to the Internet. Every oil rig, oil platform every air plane, every piece of livestock will be connected to

a real time Web of information, and we'll know everything we need to know about it instantly. That will enable the creation of new business models never before conceived in human history. Think about what firms like Match.com or eHarmony have done for dating or Priceline or Orbitz, for the airline industry. We can now simultaneously aggregate supply and demand for any product or service on a global basis in real time and price it. Information and Communications Technology is super capital that drives the productivity and growth of an economy.

A study from Nathan Associates found that IT capital has seven times the impact on GDP and productivity than non-IT capital in nations with low levels of IT usage, and around three times more in developed nations. We also find very clearly that the application of information technology within enterprises drives their productivity growth and therefore the profitability. Another study found that in large U.S. firms every dollar of IT capital is associated with $25 of market value. However, every dollar of non-IT capital, buildings, cars, forklifts, is associated with only one dollar of value. In fact, in a study that analyzed 80,000 U.S. firms between 1987 and 2006, each additional IT worker in a U.S. large corporation contributed about $338,000 of total value to the firm. Moreover, a study found that the doubling of IT capital stock within U.S. firms is associated with a 4 percent increase in their productivity growth. So the application of ICT is driving productivity growth and profitability in U.S. companies. We find this for the economy at large.

In March 2010, ITIF released a report called "The Internet Economy after 25 Years." It was on March 15, 1985 that the very first commercial Internet website ever came into being. We've only been on the commercial Internet for 25 years. But how much do you think in those 25 short years that the commercial Internet adds annually to the global economy? The commercial Internet adds $1.5 trillion each year to the global economy. Because of the IT revolution the U.S. economy is $2 trillion larger than it would be otherwise each year. In fact, a 2008 study by Eric Bergelson found that it was ICT that contributed one-third to one-half of overall U.S. productivity growth, which increased the U.S. economy by $150 billion in 2008 alone.

What are the implications of this from an economic perspective? Ultimately, we know that economies grow by increasing their productivity. How do economies increase their productivity? There are two ways. The first is by what we call "across the board productivity growth." This means

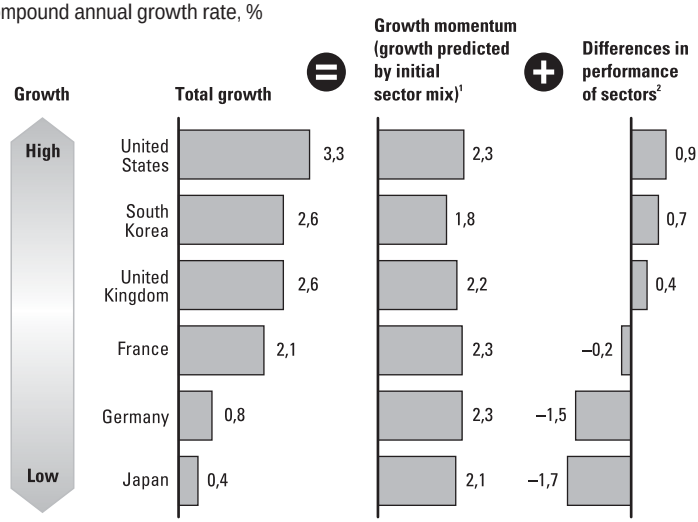
raising the productivity of all the firms in all the industries within an economy. All your banks, retail establishments, hotels, hospitals, traded sector, manufacturing, autos, and airplanes; raising all of their productivity. The second way economies can grow is by changing the composition of your economy: the shift effect. This is by replacing lower value-added industries, like call centers, with higher value-added industries like semi-conductors or a pharmaceutical center. Both are important to driving growth. However, when McKinsey looked at this question, he found that the sector performance matters much more than the mix of sectors within an economy.

In his report, called "How to Compete and Grow," McKinsey looked at six developed countries [U.S., South Korea, UK, France, Germany and Japan,] and their economic growth -- their increase in GDP between 1995 and 2005 [see below].

If we took the average growth rate for all the sectors across those six developed countries in 1995, what would their expected growth improvement have been? If the productivity levels of all U.S. industries grew at the average of the developing world's, what would we expect their increase

Sector performance has mattered more than the mix of sectors for overall GDP growth in developed countries

Contribution to total value added, 1995-2005
Compound annual growth rate, %



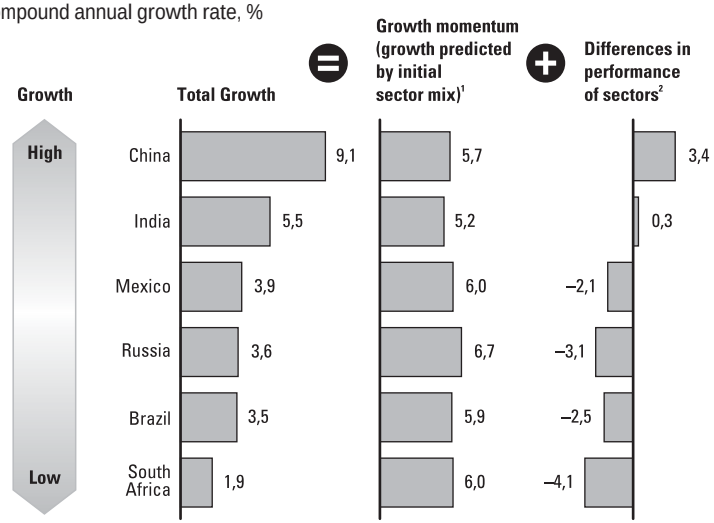
1 Country growth rate calculated as if all sectors would have grown with sector-specific growth rate average across all developed countries.
2 Actual country growth minus growth momentum of initial sector mix.
Source: Global Insight; McKinsey Global Institute analysis.

in GDP growth to be over a 10-year period? For the U.S., the expected increase in GDP was 2.3 percent a year. But U.S. growth ended up being 3.3 percent per year; while Japan expected 2.1 GDP increase over 10 years, but they actually gained .4 percent annualized. Essentially, the reason why was because the U.S. did a far better job than its competitors of raising the productivity of all sectors of its economy across the board than its competitors did.

McKinsey found that the exact same trends held for developing countries as well [see below].

When they looked at China, India, Russia, Brazil and South Africa, they said, "If all the sectors of Brazil's economy grow at the average rates of these other developing nations, then we would expect between 1995 and 2005, Brazil's economy to have grown at a 5.9 percent annualized rate." In the end, Brazil grew but only at a 3.5 annualized rate -- in fact, 2.5 percent less than the sectoral composition of your economy in 1995 would have suggested. What accounts for this kind of underperformance of expected growth? The answer that the McKinsey study finds is that Brazil has not done as good a job as some other countries at raising the productivity of

Sector performance matters more than sector mix in developing countries as well.
Contribution to total value added, 1995-2005
Compound annual growth rate, %



1 Country growth rate calculated as if all sectors would have grown with sector-specific growth rate average across all developed countries.
2 Actual country growth minus growth momentum of initial sector mix.
Source: Global Insight; McKinsey Global Institute analysis.

all your sectors across the board. This is the real way that economies should be focused on growing.

What are the insights on economic growth from ICT? First, that across the board productivity growth is more important than changing the sectoral mix of your economy. So Brazil's moves to grow your aerospace, airplane, pharmaceutical, and biotech industry, your machine tolls; that's all great. You're doing the right things. You need that. But you also have to be focusing on leveraging information and communications technology to raise the productivity of all your firms across your entire economy. Because the fact is that when you look at where the value of information technology comes from, you find that 80 percent of the benefit of ICT comes from its usage and only 20 percent of the benefit of ICT comes from its production. Therefore, the real power of ICT is using it to boost the productivity of all your sectors in your economy and, in particular, its usage of ICT by enterprises that matters.

ITIF did a study that looked at rates of productivity growth between the United States and Europe from 1945 to 2010. We found that in the post-war period from 1945 to 1995, European productivity and improvements were superior to the United States. But after 1995 the U.S. accelerated ahead of Europe in productivity improvements by about 1 percent a year. The difference was 85 percent explained by how much more effectively U.S. enterprises were using ICT than European ones. It should be clear from this analysis that barriers to ICT flows can only damage an economy.

The economists Kaushik and Singh did a study of the impacts of India's IC tariffs on its economy from 1970 to 1995. What they found was that for every dollar in tariffs that India applied on its ICT industry, the economy suffered a loss of one dollar and 30 cents. Why? In India's attempts to develop a domestic, indigenous ICT industry by imposing tariffs on imports of foreign ICT products, firms throughout the rest of the Indian economy were left to use inferior ICT products. So their banks, insurance companies, and airlines didn't have the benefit of world leading information and communications technologies, and their economy suffered.

Your neighbors in Argentina have placed a 33 percent tariff on imports of assembled computers in an attempt to spur the creation of an indigenous Argentinean computer industry. Essentially, they place a 33 percent tariff on assembled computers, but there are very small tariffs on the imports of computer components like the hard-disk drives and the circuit

boards, et cetera. But what that's meant is that 33 percent of computers sold in Argentina are assembled by hand to get around these tariffs on imports of assembled computers. What does this leave Argentine consumers and firms with? Inferior IT products that inhibit their ability to use ICT to drive innovation throughout the rest of their economy. So, the message is that tariffs on ICT products and equipment are bad for an economy.

A few thoughts on ICT and innovation policy: ITIF has done a lot of work trying to explain international leadership across critical information technology application areas, such as health IT, e-government, intelligent transportation systems, and mobile payments. We have released a series of four reports on explaining international IT leadership in intelligence transportation systems, health IT, mobile payments, and e-government. Intelligent transportation systems is bringing real time information to your traffic system, having cars being able to communicate with the infrastructure, bringing real time traffic flow information into the vehicle. Health IT is, of course, electronic health records; and mobile payments means using your mobile phone to do financial transfers, mobile banking, and e-government.

We find the same set of countries keep coming up as world leaders: in intelligent transportation systems, Japan, South Korea, and Singapore; the same for mobile payments; in e-government, South Korea, Denmark; and the Netherlands; health IT leaders are Denmark, Finland, and Sweden. Who are these leaders that we find across these different IT application areas, and what do they all have in common? The answer is they've had national IT strategies or National Broadband Plans that go back about a decade. Japan introduced its e-Japan Strategy One in 2000, updated it with e-Japan Strategy Two in 2003, and came out with a new IT Reform Strategy in 2007. South Korea had a ubiquitous society kind of master plan for information technology. The point is that these countries have national strategies to think about how information technology can be applied for the transformation of their society and their economy across different industry verticals. I think we are coming to this discovery now in the United States that we need to do this. But we're maybe a little bit behind the curve, and that explains why we aren't finding ourselves as the world leaders in some of these IT application areas, like this set of countries.

We find that a number of countries around the world have increasingly made the recognition that innovation-based economic growth is the path forward. The UK, for example, has made a conscientious decision to place

innovation at the center of their nation's economic growth strategy. In the past decade, three-dozen countries have introduced National Innovation Plans and National Innovation Strategies to guide innovation in the transformation of their economy. Countries that wish to lead the world in innovation-based economic growth must think about it strategically and must develop the institutional capability to understand how innovation drives their economy through different verticals like healthcare, education, government, transportation, et cetera.

The Patent Reform Debate

JAY THOMAS
Professor, Georgetown University Law Center

It's been a tumultuous time for Brazil in terms of patents. When Brazil entered the World Trade Organization, it adopted a stance of going to pharmaceutical patents immediately; the controversial topic of revalidation patents came up as well. Let me tell you more about what's going on in the States in patent reform and take a look at what that means potentially for Brazil and its practices.

I've heard a lot about great inventions coming every 50 years and long waves and infrastructure and universities and a bit about financial markets. But from the perspective of the private sector, the number one government intervention that leads to innovation is patents. I'm not talking about inventions that come out every 50 years; I'm talking about new medicines, new telecommunications techniques, new devices that come out every week. The patent system is the primary mechanism that supports that kind of continuous investment in R&D. The patent system is a centuries old technique. Brazil has been a long investor in the patent system. There are patent laws that date back into 1809, and Brazil was an original signatory of the leading international agreement about patents, the Paris Convention in the 19th century. It costs the government very little to run as compared to a prize system. Essentially, you just administer it into intellectual property office. It promotes investment in R&D, which leads to innovation. It leads to disclosure of technologies. Alternatively, companies might keep their products and processes secret. Through the patent system, the patent instrument is published, and anyone's able to make use of it. The one thing I have to do before I go to Rio every time is stop at the Apple Store, and

others are obviously doing the same. Intellectual property is also seen as benefiting commercialization technology. Finally, patents only last a limited period of time. When they expire, that technology goes into the public domain and everyone can use it.

Now the popularity of the U.S. patent system is evident. You've seen some impressive statistics about increases in technology; so it is for patents. The rate of filings in the United States in 2010 exceeded 500,000 applications. It's a remarkable growth of confidence of industry in the patent system in the United States. The year 2010 is the first time in the history of this country we've had more applications from foreigners than U.S. citizens. We're supporting the inventive efforts of our foreign colleagues, and we're seeing more growth from foreign system.

Now having said all of that, the last significant update to U.S. patent law was in 1952. Technologies change and the laws can adapt to grow with them. Significant reports, both by our Federal Trade Commission and by our National Academies of Science, suggested reforms to adapt the U.S. patent system to modern conditions. Serious discussion began in our legislature in 2005 and the Bill has changed; the potential reforms have moved and shifted, but we seem to be near the end of the line. The America Invents Act passed the Senate by pretty wide margin. If you follow news about Washington recently it's pretty hard to get a vote of 95 to five on just about anything, and it's also moved out of our lower tribunal of the House of Representatives with a solid vote so far.

What are the goals specifically? To modernize the patent system. Technology has changed; it's continuing to change, but the patent system has remained relatively static. The notion is it needs to be modernized. We need to improve an environment for innovation and keep United States industrial competitiveness as high. The last time we really thought about some changes to our patent system was in the late 1970s. That's an era when the United States was extremely concerned about its industrial competitiveness, particularly in respect to Germany and Japan. Those changes were made. It seems time to try it one more time. We're looking to adapt best practices from pure patent systems. Actually, U.S. law is going to look a little bit more like Brazilian Patent Law -- a little bit more like European practices that the U.S. has examined and conceded to adopt for itself. Some of what that we would do is move to a first inventor priority system.

As you know, it's amazing who invented the airplane. We think it's the Wright Brothers; other countries have their own inventors. It's just common that some people invent the same technology at about the same time. In most countries, including Brazil, it's the first person to file -- the first to get to the office -- who succeeds in getting the patent. The U.S. currently undergoes a much more laborious, intensive inquiry as to who is the first to invent. We've decided to move to the global norm. That will impact the practices of our companies, which will find it easier to file in Brazil and vice versa: Brazilian firms will find it easier to approach the U.S. office. Our foreign trading partners were concerned that this first--to-invent system was a form of discrimination against them because U.S. companies were more facile and skillful at using the system. That appears now to be gone.

We're also talking about improving the patent office. These are some lessons, sadly, I could convey to your own intellectual property office in Rio. The USPTO faces extraordinary challenges. You can't have that much of an upscale in number of applications filed without encountering a serious backlog. The bill would allow the U.S. patent office a greater flexibility of practice to reduce its backlog, to have more interaction with affected industry, and also to set up satellite offices. Right now, as with the Brazilian office in Rio, the U.S. office is concentrated in Washington. Not everyone wants to live here, so we're thinking about offices that are high technology centers. This would allow interaction between the technological community and the government at an increased level. It would also allow our examiners not necessarily have to work in one particular city. They could telecommute and move, checking in once in a while at the office. We're also thinking about decreasing our litigation costs. As a common law system that features a jury, we have often very expensive and time-consuming litigations. They take a lot of time; they cost a lot of money; and they involve a lot of principals that aren't found in the patent systems of other jurisdictions like Brazil. So we're getting rid of them -- we're cleaning out our system to make them more compatible with global norms. These are all things for Brazil to think about, as the U.S. has looked inward to try to improve its patent system.

What are the implications for Brazil? Right now, your intellectual property office has a tremendous backlog. The term of patent protection in Brazil is 20 years from the date of filing. What that means is you don't get any rights until that patent is actually approved. Every day at the office is a

lost day in term. The average pendency for patent applications in Brazil is about 10 years. The U.S. thinks we have a crisis with a three-and-a-half-year delay. There simply isn't any way that electronic companies are going to file a patent application, and 10 years later that patent will actually be effective on the market. In 10 years technologies completely change. Similarly, what is the worth in getting a patent in other areas like life sciences with such a delay? Remember, 10 years is the average. The more complex biotechnologies, vaccines, and medicines are on the bad side of that average.

The Brazilian patent office has the honor of being a patent cooperation treaty office, so you can accept applications under a certain treaty. Not so many offices get that. But try to figure out where a Brazilian patent is, who has it, and the location of its publication – that information just isn't available. In our modern era where technology is supposed to be disclosed in shares, you're missing that big benefit. You're missing the benefit of technology disclosure. You're paying the price in terms of government fees for medications, but you're not getting the benefit. That's something I think that ought to change.

Experience with revalidation patents has proven to be a constant battle for pharmaceutical companies. It seems every mechanism available to the government has been used to challenge these patents, such as a rather feisty patent office and the Attorney General. It has been a real struggle for companies that are trying to market innovative medicines in Brazil.

Pharmaceutical data package protection is our last issue that's fallen under scrutiny as the U.S. has reviewed its patent system and tried to clean house. Once that's done, it's going to start looking abroad. Pharmaceutical data packages consist of the clinical data, the trials that are done to approve medicines. Right now, that can be used without any consequences in Brazil. You simply fill out the application at your food and drug administration and use it without any kind of review. That's arguably inconsistent with the TRIPS agreement and the WTO. Counterfeit medicines remain a big problem in Brazil. But perhaps even worse are similar medications. Ones with a close bioavailability and absorption rate, even though they have the same active ingredient. Those two have been a big problem in terms of proprietary rights. These are all things for Brazil to think about, as the U.S. has looked inward to try to improve its patent system.

Surely, the relations between our countries have not been improved by different attitudes toward compulsory license and patents, with the U.S. bringing its concerns to the World Trade Organization, leading to reprisal

arguments that the U.S. Patent Law is discriminatory. From the perspective of the U.S. and European pharmaceutical innovators, the compulsory licenses that are granted will delay the introduction of the most advance medicine in Brazil. They are worried that they'll simply be copied once a marketing approval is obtained. Now we were talking about the Food and Drug Administration and all the different points of contact. But the Brazilian food and drug administration doesn't have a point of contact with the patent office. In the U.S., when there's a Food and Drug Administration approval of a generic, the patent owner is notified. In Brazilian law, there is no linkage provision. That leads pharmaceutical innovators to have to police the streets themselves to look for similars, compounding pharmacies, and generics.

The USTR sees the WTO and the TRIPS agreement as a very hard won concession. They will be loath to retreat from that. They have retreated. There is only one WTO agreement that has ever been amended since the WTO was formed, and that's TRIPS agreement. After the Doha Round, the United States and other developed countries yielded and added a new ability to declare compulsory licenses to patents. So there's a sense we've already had some slippage over the original deal. The TRIPS agreement gives Brazil and other WTO members very substantial ability to declare compulsory licenses.

Brazil-US Collaboration: A Private Sector Perspective

CHAD EVANS
Senior Vice President, Council on Competitiveness

The Council on Competitiveness has a fairly long-standing relationship with Brazil with a couple of key partners that I'll talk about. We're a non-profit, non-partisan think tank in Washington, D.C. Our mission is very simple: the advocacy of policies and activities that promotes growth in U.S. productivity, growth in the standard of living for the average American, and the success of U.S. goods and services in the global market place.

In 2004 we were visited by Jorge Gerdau, founding chairman of a very similar organization to our own Competitiveness Council. He challenged us to think about how we could partner with MBC (Movimento Brasil Competitivo) in developing a series of engagements. The purpose of those engagements would be to deepen the bilateral innovation relationship between the two countries. In 2005 and 2006, we began a deep collaboration, participating in MBC's annual meetings. In 2007 we hosted, not only with MBC but also with ABDI (Agência Brasileira de Desenvolvimento Industrial), the world's first U.S.-Brazil Innovation Summit, which took place in Brasília. We brought a delegation of around 50 U.S. CEO's and university presidents to an event that Gerdau hosted. For all intents and purposes, it was a success from our perspective in raising the visibility of the important role that innovation plays in both of our societies. That first summit also led to a call to action that was endorsed by then Presidents Lula and Bush. That supported our contention that we needed another innovation

summit, hosted by President Jack DeGioia at Georgetown University this past September. Between those two summits, we wanted to create a more engaging conversation and dialogue among innovation stakeholders. We decided to create something new: the Innovation Learning Laboratories.

Innovation Learning Laboratories are multi-day workshops that take place both in Brazil and the United States. The purpose of which is two--fold: first of all, to focus on policy alignment between the innovation economies in both of our countries. More importantly, the second purpose is we, along with MBC and ABDI, are trying to catalyze concrete world partnerships between businesses in both countries; between universities; between businesses and universities; public and private. That has been our goal between 2008 and 2011. We've actually hosted 11 of these learning laboratories in both countries.

I want to describe the process of the Innovation Learning Lab. We kicked off in Washington, D.C. in 2008 and in Brasília in August of 2008. From there, we moved to Porto Alegre in 2009, Chicago, Research Triangle Park in North Carolina, São Paulo, Silicon Valley, Rio de Janeiro, and Golden, Colorado. We've just held our last Innovation Learning Lab in Phoenix at Arizona State University this past February. Each of these 11 Innovation Learning Labs is a multi-day workshop involving 30 to 50 people from both economies. Its purpose is to spend time together in a moderated conversation, to drive towards catalyzing these new partnerships. I just want to give you a sense of the scale of the conversation because it is about increasing innovation: we're dealing with issues, the entire spectrum of innovation from the actual innovative thought and idea, the ideation, through the development of technology, the development of product and processes. How do you get that innovation into the market place? And how do you scale that innovation into large, viable, sustainable businesses?

In dealing with all of those issues, we're looking at research and development; the role that intellectual property plays in driving entrepreneurial innovative activity; the policy environment; the regulatory environment; the administrative environment that is necessary for an innovation ecosystem to function. Out of these laboratories and these sets of issues, a series of concrete deliverables have come out. There are so many business-to--business opportunities that have developed, but also some larger systemic partnerships that I want to give some attention to.

One of the initial ideas that came out in early 2009 led by CEMIG, the utility company in Belo Horizonte, was the desire to create a sister

city demonstration product in Smart Grid technology. We're very close to identifying the community in the United States that will be the sister city project. I think it will be Richland, Washington. What we've done with CEMIG is to identify a community of about 40 to 50,000 people in Brazil-- outside of Belo Horizonte -- a similar size community in the United States. The Sister City Smart Grid Demonstration Project is all about co-investment between the two sister city projects. It's about research exchange, people exchange, and it's about multi-sector. We're looking to not only bring in the utilities but universities and startup companies that want to be involved in this. The MBC, the Council on Competitiveness, and ABDI play a catalyst role, to try to trigger these sorts of partnerships.

Another example that's taking place in Porto Alegre is that of co-incubation. This is an effort to drive entrepreneurial innovative business development in both countries. The incubator in Porto Alegre will attract, mentor, and help small and medium size U.S. entrepreneurs who want to create a business in Brazil and vice versa. Arizona State is going to attract 10 to 12 Brazilian startup companies that want to launch in the United States but need help with business plan development and marketing. This is what we like to think of as a win-win situation for both economies. We're looking to expand that global co-incubation model to other universities in both countries.

There have been a couple other ideas that have come out: a clean-tech open concept where we would think about how you can acknowledge and reward startup entrepreneurial innovative companies in the clean tech, energy space. There are many more of these opportunities. I think what is interesting about all of the work from the two summits -- and the 11 laboratories that have spanned between the two summits -- is that we've really tried to engage a series of leaders on five mega opportunities. The first of which is this nexus of energy and water. We've posed a very simple question to all of our laboratory participants. How will our two countries together innovate to meet the growing demand for global energy? We know that in the next two decades global energy demand will increase by 50 percent. Of that growth and demand, 80 percent will take place in non-OECD countries. Brazil and the United States have a leading role to play in addressing that demand.

The second big question that we've asked all of our stakeholders and our network in both countries to address is that of food. Our two countries alone will have to help solve the issue of feeding the world when global

food demand doubles in 50 years. How will we do that? There are no two countries that are better poised to help solve that global grand challenge.

A third issue that we're all addressing together in this larger network is how our two countries will build the smartest, the most resilient, the most sustainable infrastructures for a 21st century innovation economy. The panel that was before us talked about one of those types of infrastructures in IT and cellular communications. But it's more than just physical infrastructure; this is also policy infrastructure. How do we ensure that we have the most agile, flexible, responsive innovation ecosystem that will attract and mentor and help innovators prosper?

A fourth question is how will our leaders come together to ensure that we have a culture of creativity, collaboration, mutual innovation, and entrepreneurship. Then, finally, the fifth major opportunity where we're working is this nexus of manufacturing and services: that coming together of the manufactured product and the ecosystem of services that adds value to that product, which will lead to new industry growth and new jobs in the 21st century. How can our countries understand that?

This leads me to where we are going from here. Our next lab will be November 18, 2011 in Porto Alegre. What will be particularly special about this event is we will be inviting the competitiveness councils from 40 other countries to come to Porto Alegre at the same time. It will be a real opportunity for the MBC, ABDI, and Council on Competitiveness partnership to shine. It will also be an opportunity to expose innovators from around the world to the capabilities that Brazil has in this innovation economy. Also, I'm hoping to have some best practices or guidelines on intellectual property. One of our goals this year is to do a series of global case studies that would point out best practices that could be shared and adopted in multiple countries.

On the patenting and the globalization of benefits from innovative technologies, I would note that from the perspective of the members of the Council on Competitiveness, the crown jewel for the innovative activity is the patent. Without that patent, you will not see the type of investment that is necessary to develop and scale that innovation for a large market size. Patent breaking tends to completely take away the incentive to invest in that sort of scaling. You wouldn't actually see any global sharing of the best products or the best service. I think that's a very serious concern that I know many of our members have, and this is a very frank ongoing conversation that we've had in Brazil. We hosted our first U.S.-Brazil summit

in June of 2007. Merck's HIV drug patent was broken in Brazil in May that year. The initial co-chair for our U.S. side for the Innovation Summit was the CEO of Merck. He did not come to the summit in June. Obviously, it was one month after that happened, so there was friction. But we made the decision to continue with the Innovation Summit.

It's also important to put this in a global context. Obviously, I think the United States and Brazil are the most important, but let's look at a country like China, which, five years ago, anyone would have said is a most egregious violator of intellectual property rights, which is probably still true today. But we are seeing a massive transformation take place in China with the emergence of innovative firms that are demanding respect for intellectual property, which will be driving global markets going forward. So the U.S.-Brazil debate is important, but the U.S.-Brazil debate has to take place in a global reality. We can both be left behind very quickly by China, Indonesia, Vietnam, or South Africa. In 1986 when our Council started, it was the U.S. response to Japan. There are now dozens of global competitors to the United States, or to Brazil.

Finally, we will have more summits. We were particularly gratified when President Obama met with President Rousseff just a month ago. In their final joint statement, they recognized the power of the innovation summits. They explicitly called out for more. We're hoping -- and we will be working with both administrations -- to plan for the next innovation summit in Brazil in 2012 with Gerdau, MBC, and ABDI.

BRAZILIAN CONGRESSIONAL
STUDY MISSION ON INNOVATION

PowerPoint Presentations

Addressing the Innovation Imperative

And the Challenge of Early Stage Finance

The Woodrow Wilson Center
Washington DC
April 18, 2011

Charles W. Wessner, PhD.
Director, Technology, Innovation, and Entrepreneurship
The National Academies

Today's Presentation

- Addressing Global Challenges with Innovation
  - Brazil's Innovation Strategy
  - The United States' Innovation Strategy
- The Role of Innovative Small Businesses
  - Innovation Myths and Policy Obstacles
  - The Early Stage Funding Valley of Death
  - The Role of the SBIR Program
- Our Common Innovation Challenge
- Today's presentation reflects my personal views

Current Global Mega-Challenges

- Fostering Economic Growth through Innovation
  - Driving domestic Growth and Employment
- Developing New Sources of Energy
  - Commercializing renewable alternatives to oil
- Addressing Climate Change
  - Growing a Green Economy; A major Growth opportunity
- Delivering Global Health
  - Transforming large investments in research to affordable and personalized treatment and care
- Improving Security
- Innovation is key to addressing these Global Challenges

What is Innovation?

- Innovation is the successful transformation of new ideas or known ideas into new products, services, or improvements in organization or process.
- Innovation encompasses a series of cooperative scientific, technological, organizational, financial and commercial activities.
  - Research is only one of these activities and may be carried out at different phases of the innovation process.
- Innovation translates knowledge into economic growth and social well-being

The Global Innovation Imperative

- Key Points
  - Innovation is Key to Growing a Country's Competitive Position and Addressing Global Challenges.
  - Collaboration among Small and Large Businesses and Universities is Essential to Capitalize on Investments in Education and Research
  - New Incentives are needed to foster innovation and collaboration

How are Leading Nations Responding to the Innovation Imperative?

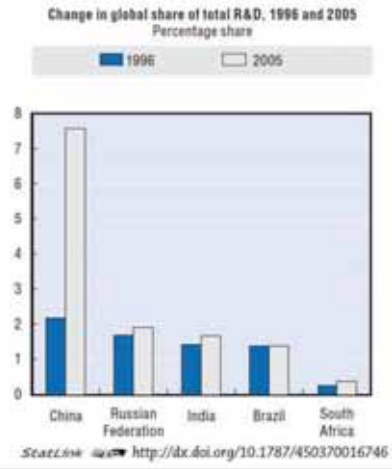
- They are providing four things:
  - High-level Focus
  - Sustained Support for R&D: Leveraging Public and Private Funds
  - Support for Innovative SMEs
  - New Innovation Partnerships to bring new products and services to market
- Many countries are investing very substantial resources to create, attract and retain industries in a variety of sectors—
  - They see it as a national imperative!

China's Drive for Innovation

- Government with strong sense of national purpose
  - Strong investments in education and training
  - Strategy to move rapidly up value chain
  - Effective requirements for training and tech transfer
  - Critical mass in R&D is beginning to be deployed to generate autonomous sources of innovation & growth
- Government goal is to acquire technological capabilities both to grow and to maintain national autonomy.
- Focused, Committed, and Willing to Spend

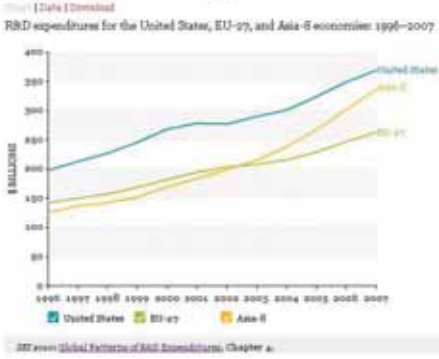
Modified from C. Dahlman, Georgetown University

China's rhetoric is matched by a surge in R&D Expenditures



Asia's Surge

Global R&D: Measuring Commitment to Innovation



The rapidly growing R&D expenditures of the Asia-8 economies (China, India, Japan, Malaysia, Singapore, South Korea, Taiwan, Thailand) surpassed those of the EU-27 in 2003.

Source: NSF 2010 S&E Indicators

How is Brazil is Addressing the Innovation Imperative?

New Investments and Institutions Underscore New Focus on Science, Technology and Innovation

Brazil's Innovation Strategy

- Strengthen the National Innovation System
  - Reinforce National S&T institutions
  - Invest in a skilled workforce
  - Support S&T infrastructure
- Promote innovation in enterprises
  - Financial and Technical support for innovative firms
  - Provide incentives to start-ups
- Increase R&D in strategic areas
  - Bio, Nano, Health, Biofuels, Space, and Nuclear
- Use S&T and Innovation for social development

Source: Secretary Francelino Grando, Presentation at February 2010 National Academies Symposium on "Clustering for 21st Century Prosperity."

Brazil's Growing Achievements

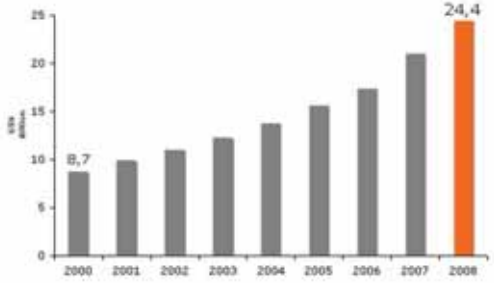
A growing knowledge workforce
  - The number of master's degrees awarded annually has doubled, to 36,014 between 2000 and 2008
  - Growth of technology schools from 140 to 366 between 2002 to 2010
- More knowledge created
  - From 10,521 scientific articles in 2003 to 30,415 in 2008
- More R&D Expenditure
  - Public and private R&D investment has soared from $8.7 billion in 2000 to $24.4 billion in 2008
  - **This is Good!**

Source: Secretary Francelino Grando, Presentation at February 2010 National Academies Symposium on "Clustering for 21st Century Prosperity."

Best Practice in Financing Innovation: FINEP

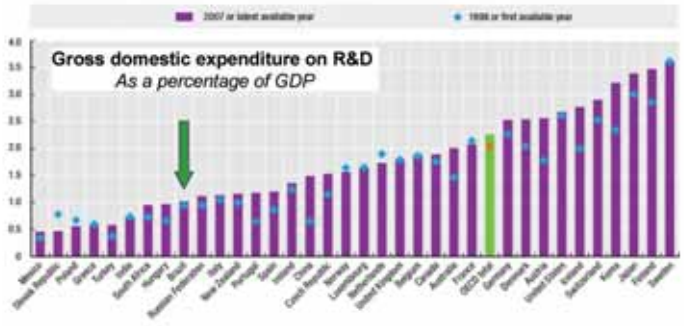
- 2010 Budget US$2.42 billion, from $87 million in 2000
  - Combination of direct grants, loans, and venture
- Provides:
  - Grants to non-profit R&D institutions and private firms
  - Loans to private firms for R&D
- Broad range of programs to provide funds to industry, from start-up to mature firms
- Targeted sectoral funds in 15 areas, including aeronautics, energy, biotechnology, telecom, transport, and oil

The Good News: Brazil's Growing R&D Investment



Source: Francelino Grando, Presentation at February 25, 2010 National Academies Symposium on "Clustering for 21st Century Prosperity."

The (Relatively) Bad News
Brazil's Position in the OECD R&D Comparison



OECD Factbook 2009: Economic, Environmental and Social Statistics

Minas Gerais: Global Best Practice

- Sistema Mineiro de Inovação is consolidating pools of excellence to create "critical mass"
  - Promoting science parks, incubators, and training programs
  - Establishing linkages among government programs, local efforts, and investors
  - Connecting researchers and entrepreneurs
  - Recruiting more PhDs and training workers and entrepreneurs
  - Drawing in corporate investment from multinationals
- Our program at the NAS is focused on describing "Best Practice" policy in these areas

Source: Alberto Duque Portugal, Minas Gerais Secretariat for Science, Technology and Higher Education. National Academies Symposium on "Clustering for 21st Century Prosperity." February, 2010

Brazil's Key Challenges

- Strengthen the Policy Framework
  - Improve conditions for creation and termination of firms and employment –a key roadblock!
  - The establishment of the National Institute of Metrology, Standardization and Industrial Quality (INMETRO) is a key step
- Create and sustain new innovative companies
  - Help SME's access financing
- Foster cooperation between Universities and Enterprises—with real incentives

Source: Glauco Arbix, University of São Paulo, 2009

Innovation in the United States

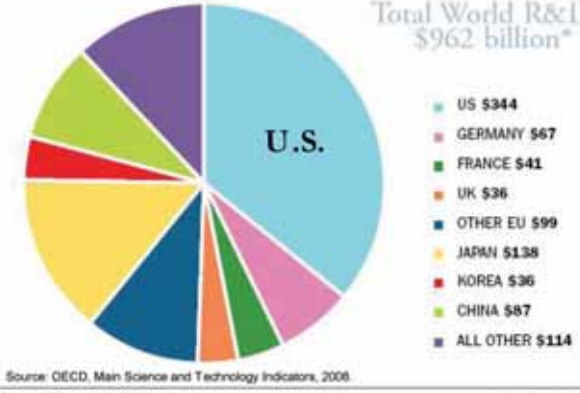
A Renewed Commitment to Innovation

President Obama Understands Innovation

- "The first step in winning the future is encouraging American innovation."

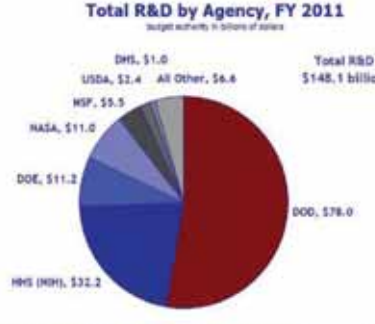
– President Obama, January 25, State of the Union Message

National Shares of Global R&D



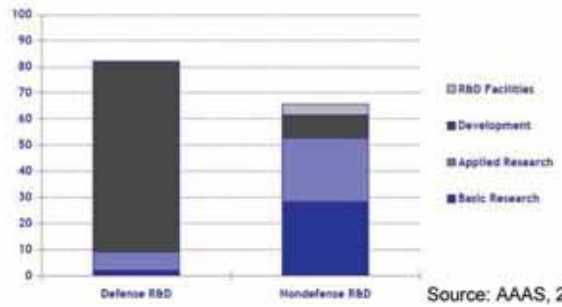
Source: OECD, Main Science and Technology Indicators, 2006.

Good News and Bad News: The U.S. R&D Budget for 2011



Source: AAAS, 2010

~90% of Defense R&D Spending is for Weapons Systems Development



Source: AAAS, 2010

The Obama Administration has launched a comprehensive Innovation Strategy

Full spectrum of investments in Research, Technology Development, and Commercialization

The President's Innovation Strategy

- **Invest more in research**
  - One time $18.3 billion in Stimulus funds for R&D
  - Doubling the R&D budget of key science agencies
  - Target of investing three percent of GDP in R&D
  - Make the R&E tax credit permanent
- **Grow and Attract a Skilled Workforce**
  - $200 billion over the next decade for scholarships and tax credits for students
  - Race to the Top to incentivize K-12 school performance
  - American Graduation Initiative to produce 5 million more community college graduates by 2020
  - Improve the processing of high-tech visas

Source: "A Strategy for American Innovation"
White House NEC, OSTP, February 2011

The President's Innovation Strategy

- **Invest in Innovation Infrastructure**
  - Modernize the Electric Grid
  - Build a high-speed rail network of 100-600 mile intercity corridors
  - Support the creation of regional innovation clusters with $50 million in EDA matching grants
- **Invest in Clean Energy Innovation**
  - Support American manufacturing of advanced vehicle technologies with $25 billion in loans
  - Provide grants to catalyze private sector investment to build a globally competitive domestic battery and electric drive component industry
  - Proposed 10 year, $150 billion investment in the research, development and demonstration of clean energy technologies

Source: "A Strategy for American Innovation, White House NEC, OSTP, February 2011

President Obama's New Innovation Initiatives

- **New Institutions to Drive Clean Energy Technologies**
  - Fund frontier research with ARPA-E
  - Create new Energy Innovation Hubs
- **Startup America Initiative**
  - Creates two $1billion initiatives for impact investing and early-stage seed financing
- **Wireless Initiative**
  - Plans to connect 98% of Americans within 5 years
- **Patent Reform**
  - Patent fees to fund faster processing of patents
- **Improve K-12 Education**
  - Advanced Projects Agency for Education (ARPA-Ed) to support breakthrough technologies to support learning

Source: "A Strategy for American Innovation, White House NEC, OSTP, February 2011

Quite an Agenda!

- Arguably the most comprehensive and well though-out Innovation Policy the U.S. has ever seen
- Key Questions Remain:
  - Will the President's programs be funded?
  - Will they work? And as always,
  - How do we translate investments in knowledge into products for the market?

The U.S. Myth of Perfect Markets

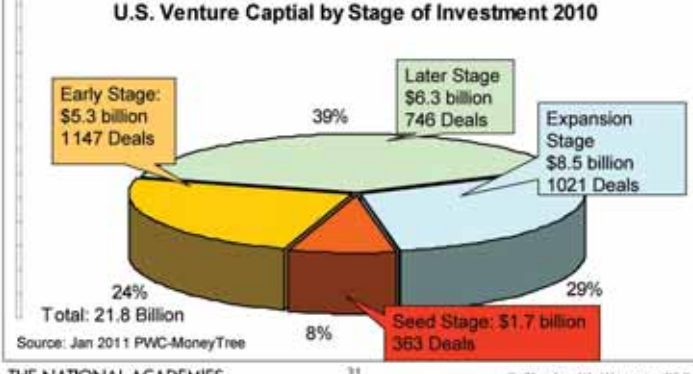
- Strong U.S. Myth: "If it is a good idea, the market will fund it."
- Reality:
  - Potential Investors have less than perfect knowledge, especially about innovative new ideas
  - "Asymmetric Information" leads to suboptimal investments
    - George Akerlof, Michael Spence and Joseph Stiglitz received the Nobel Prize in 2001, "for their analyses of markets with asymmetric information"

The Myth of Perfect Venture Capital Markets

- Myth: "U.S. VC Markets are broad & deep, thus there is no role for government awards"
- Reality: Venture Capitalists have
  - Limited information on new firms
  - Prone to herding tendencies
  - VC investments have moved towards later, less risky stages of technology development
  - Limited investments in the seed stage of investment—only $1.7billion (363 deals) in 2010

THE NATIONAL ACADEMIES
30
© Charles W. Wessner PhD.

Allocation of U.S. Venture Investments in 2010



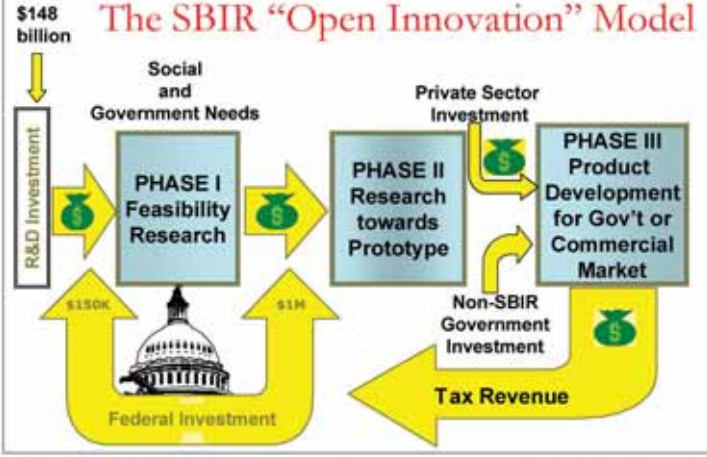
Crossing the Valley of Death is a Major Challenge

One Proven Path Across the Valley of Death is the U.S. the Small Business Innovation Research Program (SBIR)

SBIR's Best Practice Features

- **Focus on Valley of Death**: Funds Proof of Concept and Prototype: "The first money & the hardest"
- **Stable Program**: Long reauthorizations
- **Secure Budget**: 2.5% allocation of Agency R&D budgets for small business awards & contracts
- **Large Scale**: Largest U.S. Innovation Partnership Program: Currently a ~$2.5 billion per year
- **Portfolio Effect**: Substantial sums invested in new companies over a long period increase success
- **Decentralized & Adaptive**: Each Agency uses its funds to support research by small companies to meet its unique mission needs

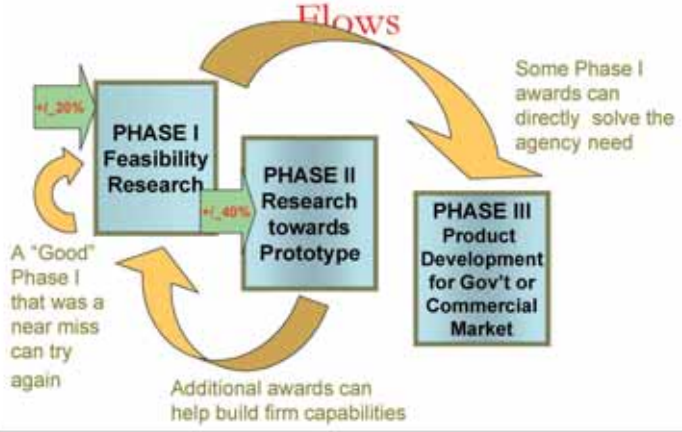
The SBIR "Open Innovation" Model



Advantages of the SBIR Concept

- Double-gated Competition
  - Phase I: Many limited exploratory investments
  - Phase II: Added funding to push promising ideas to prototype
- Recoupment is through the tax system
  - Grants lower risk faced by prospective entrepreneurs
- A Flexible, Second Chance Program
  - A "Good" Phase I that was a "near miss" can try again
  - Additional awards can help build firm capabilities

SBIR is Flexible: Alternative Flows



SBIR "Jump Starts" Entrepreneurs

- Provides 'first money'
  - Helps get new projects started
  - Academics can apply even without a company
- No dilution of ownership; owners retain control
- No repayment is required
  - Government recoupment is through the tax system
- SBIR recipients retain intellectual property developed using the SBIR award
  - No royalties owed to the government, though government retains royalty-free use for a limited period
- Certification effect draws in additional investment
  - Signal to private investors of technological validity and commercial promise of the innovation

National Academies Assessment finds that
SBIR Awards Have a Substantial Impact on Participating Companies

- **Company Creation**: 20% of responding companies said they were founded as a result of a prospective SBIR award—25% at Defense
- **Research Initiation**: SBIR awards played a key role in the decision to pursue a research project (70% claimed as cause)
- **Company Growth**: Significant part of firm growth resulted from award
- **Partnering**: SBIR funding is often used to bring in Academic Consultants & to partner with other firms

SBIR Success takes Many Forms

- Employment Success
  - SBIR helps new Start-ups grow, creating the high quality jobs of the future
- Innovation Success
  - New products, patents, licenses, and publications
- Government Mission Success
  - Acquisition and Procurement
  - NASA uses SBIR-funded Lithium-ion batteries to power the Mars Rover
  - DOD uses SBIR developed armor to shield against IEDs
- NASDAQ Success
  - SBIR investments contributed to the success of companies like Qualcomm, ATMI, Martek, Luna

Other Nations are Adapting SBIR

- Finland has adopted a 3-Phase SBIR Program
- Sweden has created a small but successful SBIR type program
- Russia has adopted an SBIR-Type program
- UK SIRI program is similar in concept; now being upgraded
- The Netherlands government has recently adopted SBIR, following a pilot program
- Japan, Korea, & Taiwan have adopted SBIR concept
- India has launched an SBIR Initiative for the biotechnology sector
- Singapore is implementing a program
- Poland is considering adopting an SBIR type program
- The European Union is considering an SBIR type procurement program
- Brazil has a major program underway in São Paulo

Innovation Awards in Brazil?

- Should there be a national program or should every state adopt one?
- Are current innovation programs at FINEP or elsewhere sufficiently scaled, i.e., awards of successively larger size?
- Is government procurement being used to help drive innovation?

SBIR is not "the" Solution to National Innovation Challenges

It is a very important mechanism, one that works best with 21st Century Universities

From the "Ivory Tower" to the Marketplace

- "Pure" Research is not the only University Role
- Research Related to Industry Helps Generate Training and Skills Necessary for Productive Lives
  - (and the tax dollars for Research)
- Industry's Needs and Questions can Drive Research and be a Source of Relevant

Roles of the 21st Century University

- **Teach the next generation**
  - With up-to-date laboratories on real market questions
  - Focus on science needed to address current and future questions (e.g., climate change, nuclear waste, stem cell research, genetically modified food)
- **Conduct Research**
  - "Curiosity-driven Research"
  - But also on Social Problems and Industry Needs
- **Commercialize**
  - New Science-led solutions to societal problems
  - New Products, Processes
- **Generate Market-ready students**
  - Create a cadre of creative and curious team players able to go and work in industry

Today, Industry (and Regions) Need University Research to Create Future Growth

- **University research** draws ideas from commercial trends—feedback loops from industry to universities are sources of Quality Research
- **Regional economies** rely on research universities for jobs, branding, growth, & entrepreneurship
- **University innovation** + early government funding are key to the growth of many successful technology companies
- **A Supportive University Culture** & Real Incentives make it happen

Encouraging Universities to serve as a Nexus of Growth…

- …Requires Real Changes in
  - **Culture and Values**: This requires new leadership and new incentives
  - **Status of Professors**: permissive environment to encourage innovations, collaboration with industry, and pursuit of innovation awards and wealth
  - **Institutional Practices**: Parallel research institutes with self-select mechanism
- Strong local Leadership & Local Autonomy are required

Conclusions

Innovation is Key to the Future of Brazil and the United States

Mutual Learning and Cooperation are Essential for our Common Future

"Innovation" is the Key to how Nations Compete and Grow in the 21st Century

- Innovation Policy cannot be a "Hobby"
- Innovation is key to growth, prosperity, and security
- Resource Inputs are Essential, but are not Sufficient
- Incentives are Required for Innovation and this involves Institutional Change
  - Innovation Partnerships help structure the incentives for successful collaboration

Our Common Challenge

- The Challenge for Brazil and the United States is to Adjust to the new Globalization Dynamic— and to help shape it
- This involves initiating change through competitive incentives:
  - Incentives for entrepreneurial activity for Small Firms, Large Firms, and Universities
- Mutual Learning and Cooperation are Essential for our Common Future
- Lets work together!

Synthetic Biology

The Next Frontier?

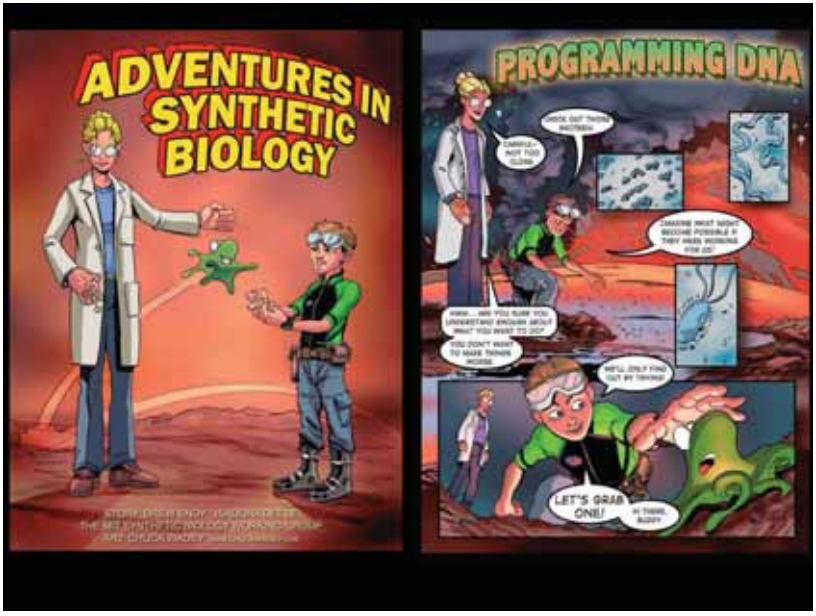
Story Line

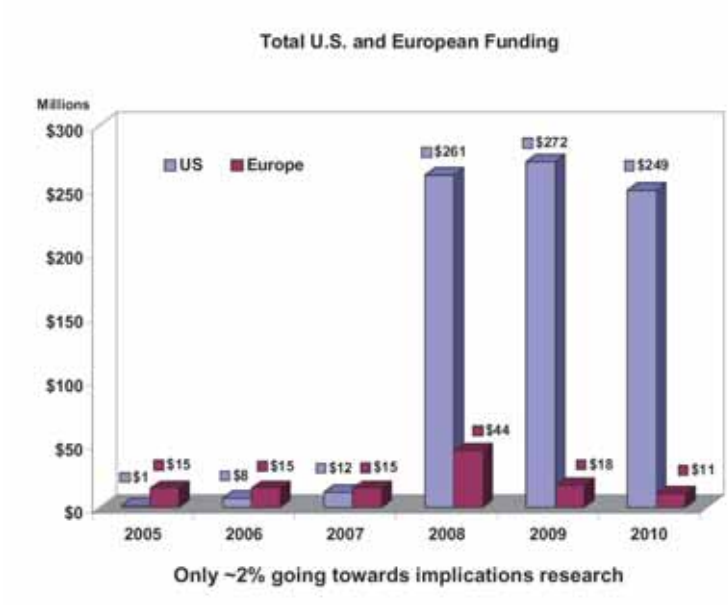
- What is Synthetic Biology
- What's being spent
- Ethical and Environmental Concerns
- DIYBIO
- iGEM

What is synthetic Biology?

- Synthetic biology is an emerging form of bioengineering
  - the design and construction of new biological parts, devices and systems
  - the re-design of existing natural biological systems for useful purposes
- It combines science and engineering in order to design and build novel biological functions and systems

http://ars-synthetica.net/primer


ADVENTURES IN SYNTHETIC BIOLOGY
PROGRAMMING DNA
LET'S GRAB ONE!


Total U.S. and European Funding
Millions
$300
$250
$200
$150
$100
$50
$0
US
Europe
$1
$15
$8
$15
$12
$15
$261
$44
$272
$18
$249
$11
2005
2006
2007
2008
2009
2010
Only ~2% going towards implications research

Venter and Smith Create New Life?

- In May 2010 JCVI announced they had made a bacterium that has an artificial genome—creating a living creature with no ancestor

Cover of The Economist May 2010

President's Bioethics Commission

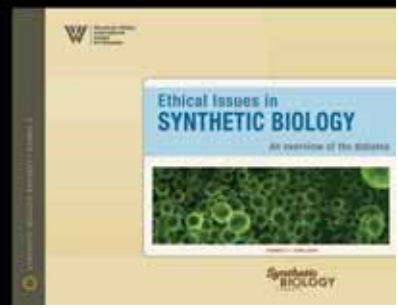
1. Public Funding Review and Disclosure
2. Support for Promising Research
3. Innovation Through Sharing
4. Coordinated Approach to Synthetic Biology
5. Risk Assessment Review and Field Release Gap Analysis
6. Monitoring, Containment, and Control
7. Risk Assessment Prior to Release

President's Bioethics Commission

8. International Coordination and Dialogue
9. Ethics Education
10. Ongoing Evaluation of Objections
11. Fostering Responsibility and Accountability
12. Periodic Assessment of Security and Safety Risks
13. Oversight Controls
14. Scientific, Religious, and Civic Engagement
15. Information Accuracy

Ethics of Synthetic Biology

- We can expect that ethical concerns will arise with synthetic biology
- Can be divided into two large categories
  - Physical harms
  - Non-physical harms
    - Precautionary
    - Pro-actionary



Non-Physical Harms

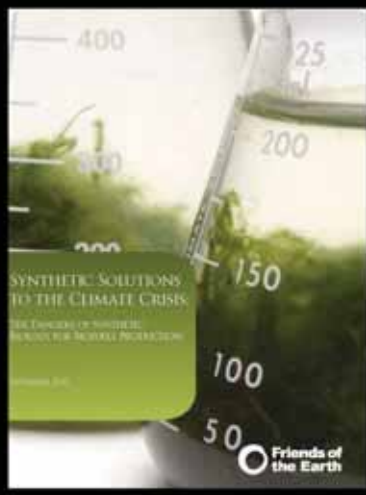
- How to fairly distribute the tools needed to do synthetic biology?
- How to fairly distribute the benefits of synthetic biology?
- What is the appropriate attitude to adopt toward ourselves and the rest of the natural world?
- Moral and Religious concerns

Physical Harms

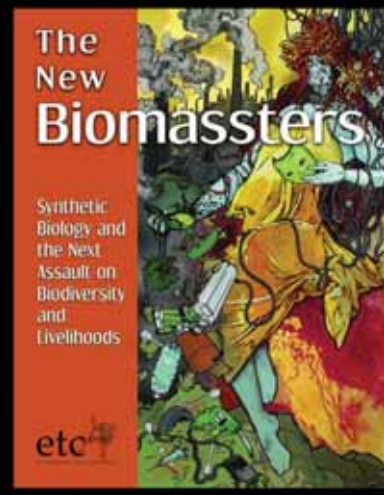
- Largely safety and security questions
  - Environmental health
    - Interactions of synthetic organisms with naturally occurring organisms
  - Human Health
    - Exposure to synthetically designed organisms
  - Security concerns
    - Bioterrorism etc.
      - New strains of viruses

Environmental Implications

- Ecological Risk Assessments Lacking
  - What happens when there are intentional or accidental releases
    - How will they interact with the natural environment?
    - "kill switches"
- Synthetic biology is completely different from an environmental clean up perspective compared to synthetic chemistry
  - once they are released you cannot get them back
  - Biological organisms tend to "live on" despite out best efforts to control or kill them



http://www.foe.org/



http://www.etcgroup.org/

DoItYourself BIO

- DIYbio.org was founded in April 2008 by Jason Bobe and Mackenzie Cowell in order to help organize the efforts of amateur biologists, citizen scientists, and other non-traditional practitioners of biology, worldwide.

Citizen scientists are beginning to adopt practices like genome sequencing and biological engineering that were once accessible only to institutional investigators.

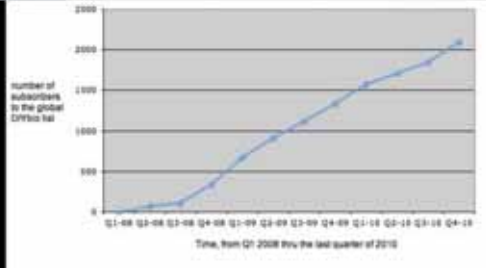
As the number of contributors to the life sciences extends beyond traditional academic and corporate institutions in the 21st century, DIYbio.org aims to help organize a vibrant, productive and safe community.

The global DIYbio mailing list has approximately 2000 members;

More than 20 regional groups and associated venues, the largest has 400 members;

Community labs in three cities;

And a handful of hybrid spaces where some portion of an existing workspace is dedicated to DIYbio activities.



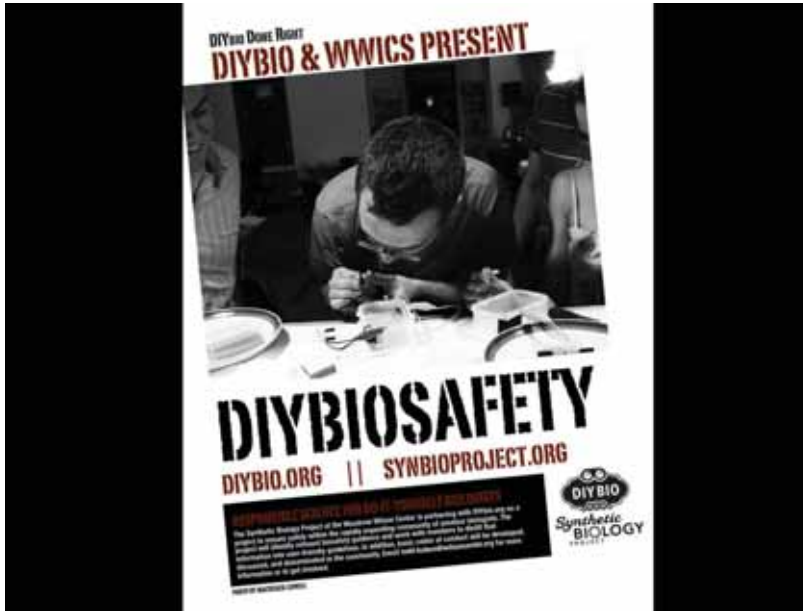
(1) A cancer biotech company incubated its business in a garage in Mountainview, CA, although they have since vacated it and moved to a commercial facility.[1]

(2) Kay Aull built a small lab in her bedroom closet in Cambridge, MA and used it to perform allele-specific genotyping for HFE, a disease that runs in her family.[2]

(3) Meredith Patterson working from her kitchen in the Bay Area on a project to engineer yogurt bacteria to sense the food contaminant, melamine.[3]

(4) The start-up company OTYP, an educational biotechnology business, ran an R&D lab out of the founder's college apartment in Ann Arbor.[4]

[1] http://www.flickr.com/photos/sugargliders/4561317461/in/pool-1296598@N22/
[2] http://www.boston.com/news/science/articles/2009/05/11/do_it_yourself_genetic_sleuthing/
[3] http://www.msnbc.msn.com/id/28390773/ns/technology_and_science-innovation/
[4] http://www.biotechniques.com/news/biotechniques/news/biotechniques-301745.html



International Genetically Engineering Machines Competition (iGEM)

- Student teams are given a kit of biological parts at the beginning of the summer from the Registry of Standard Biological Parts
- Working at their own schools over the summer, they use these parts and new parts of their own design to build biological systems and operate them in living cells

2004

2010


Universidade Estadual de Campinas
iGEM 2009
Team:UNICAMP-Brazil
The MICROGUARDS
UNICAMP
LGE
Nowadays, there are numerous industrial processes that use microorganisms such as Escherichia coli and Saccharomyces cerevisiae to produce compounds of interest, like insulin, ethanol and various enzymes. The success of these processes depends on the absence of contamination by other microorganisms in the culture medium. The presence of contaminants in a fermentation process reduces its efficiency due to competition between the contaminant and the fermentative organism, causing losses of 5 to 10% of the gross production. To try to solve this problem, the aim of our project is to engineer strains of E. coli and S. cerevisiae that are able to recognize and destroy contaminants during industrial processes.
The MICROGUARDS
Welcome to microcity!
Bacteries and yeasts are happy producing the most important products in the microcitizens
Suddenly... some contaminants showed up to destroy the peaceful environment of the harmless microproducers.
MONSANTO
Braskem
OLYMPUS
http://2009.igem.org/Team:UNICAMP-Brazil
http://2009.igem.org/files/video/UNICAMP-Brazil.mp4

AMYRIS

Synthetic Biology:
New Frontiers of Innovation

April 18, 2010

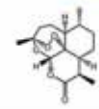
Joel Velasco
velasco@amyris.com

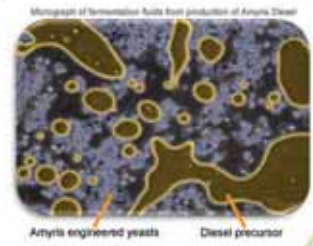
Amyris
Leading the next generation of renewable products

- Amyris is an integrated **renewable products** company focused on providing sustainable **alternatives to a broad range of fossil-based** products.
- We uses our industrial **synthetic biology** platform to **convert plant sugars into a variety of hydrocarbon** molecules, ranging from diesel to lubricants and surfactants to cosmetics.
- Our innovation is the **practical integration of biology with chemistry to create novel solutions** to address global, regional and local challenges.

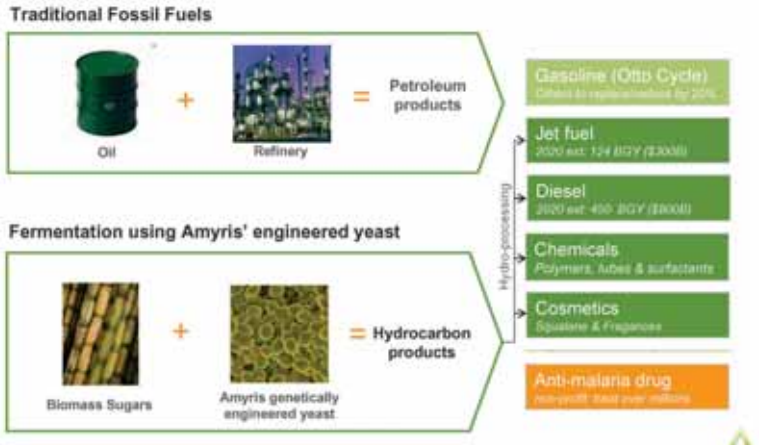
Building the Technology
A History of Innovation

- Started in 2004 based on molecular engineering work from University of California - Berkeley Professor Jay Keasling's laboratory
- Initially funded in 2005 by a grant from the Gates Foundation to develop a lower cost, consistent supply of artemisinin, key component of a malaria drug
  - Every year, malaria kills 1 million people – mostly children under the age of five in Africa
  - Drugs exists but are in short supply and unaffordable to poorest populations
  - Expanded products to broad suite of petroleum replacements; issued patents covering diesel, jet, polymer and lubricant products
  - Successful public offering in 2010 in the NASDAQ
  - Marketing and distribution channels to deliver products in the United States and other global markets



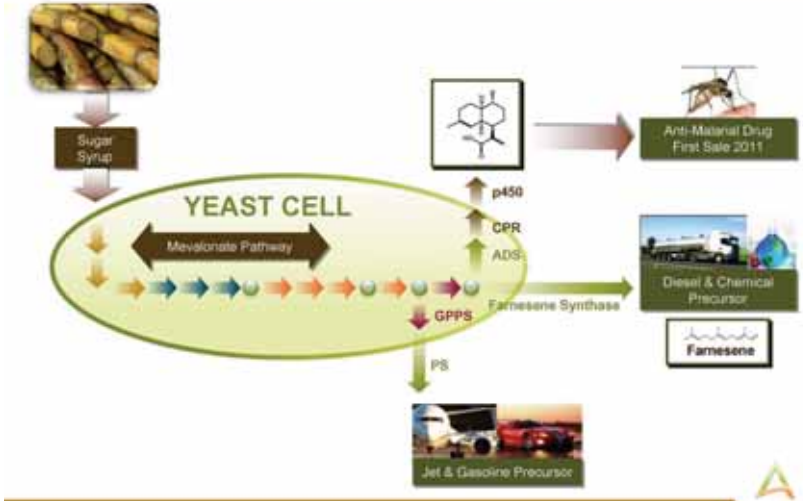


Our Vision
How Amyris is enabling a bio-based economy



Amyris Innovation

Delivering multiple products through fermentation



Amyris Innovation

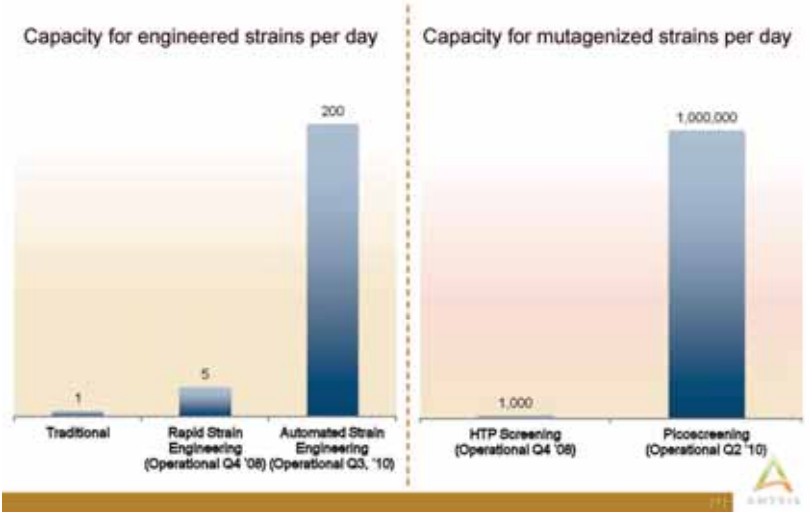
Automation Accelerates Strain Engineering

Traditional Construction

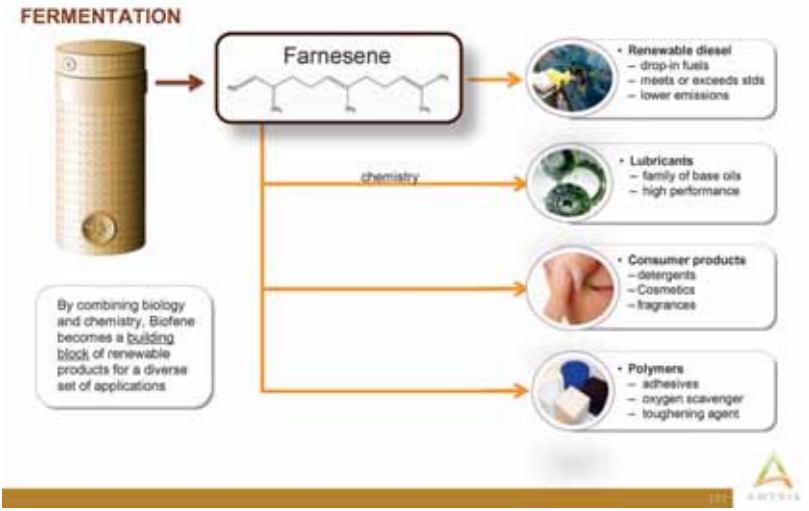
Amyris Construction

Simple and reliable enzyme and/or chemical treatments for the genetic manipulation of organisms

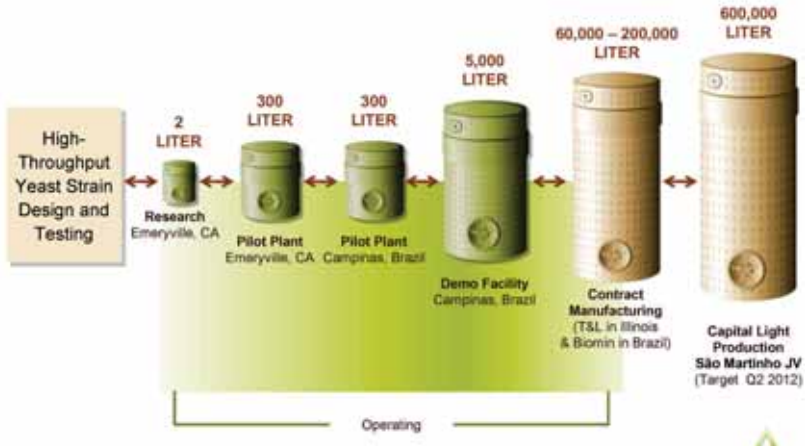
Amyris Strain Engineering
Innovation in Strain Design



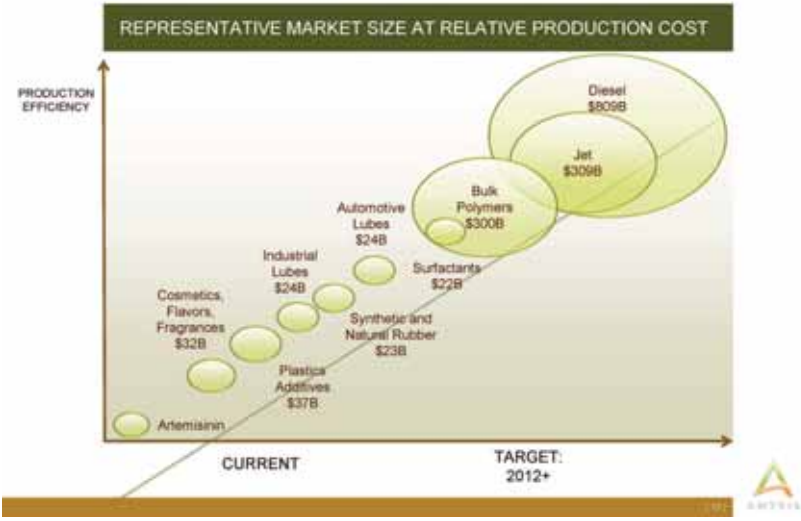
BioFene: Amyris Innovation
First of 50,000 molecules to be the base for many products



Amyris Platform
Integrated Research & Production Processes



Amyris Strategy
Technology Improvement Expands Target Markets



Amyris in Brazil
Three Areas for Policy Focus

- **Will the regulations be ready for new fuels?**
  - Current laws are either technology prescriptive or focused on fossil-fuels only
  - Innovative solutions (e.g., cane diesel) are restricted from marketplace
- **Biotechnology policy is strong but can be improved**
  - Biotech laws were written for agriculture (GMOs) but today's innovations go beyond the fields and labs
- **Human capital is our (and your) biggest challenge**
  - Our ability to deepen our R&D activities in Brazil is limited in large part by lack of a qualified labor force
    - *Amyris has +100 Brazilian employees, of which "only" 12% are PhD; in California, with 300 employees, 30% are PhDs*
  - We are going to invest in education because it's a core business for our innovation

providing
high-performing
renewable alternatives
to petroleum-sourced
products

Amyris Renewable Diesel

Amyris Fuels

No Compromise™ Fuels: Drop-in and Better Performance

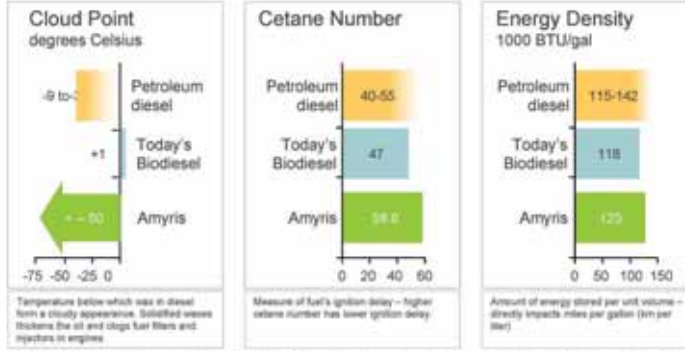
- **Derived using diverse sugar feedstocks**
  - Direct sugar to hydrocarbon fermentation
- **Hydrocarbons, not alcohols or esters**
  - Can be used in existing engines with no performance trade-offs
  - Can be blended up to 50%
  - Can be delivered using existing distribution infrastructure
- **Superior properties**
  - No sulfur
  - Lower particulates, HC, CO and NOx
  - Excellent cold flow characteristics
  - Comparable energy density
  - 80%+ lower greenhouse gas emissions than petroleum derived fuels

Amyris diesel fuel (clear) in front, petroleum diesel (yellow) in the back

Amyris Renewable Diesel

Only approved by EPA for 35% Blends

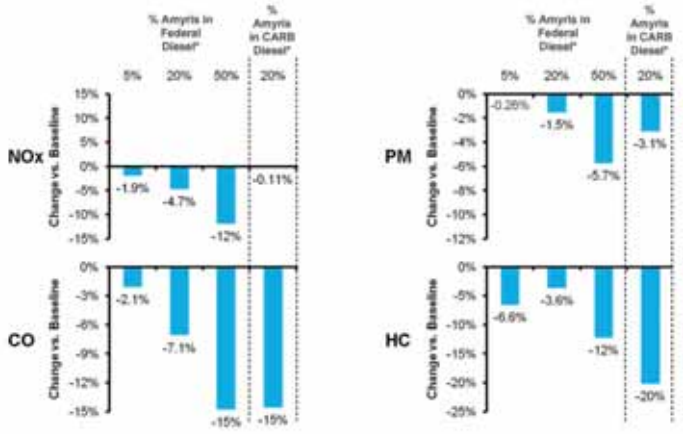
Validated by external labs as a "best-in-class" product, meeting ASTM D975 fuel properties with zero sulfur.



- *Amyris diesel will be used in blends with conventional fuels; values shown for Amyris diesel is for our biomass derived blending component*

Amyris Renewable Diesel

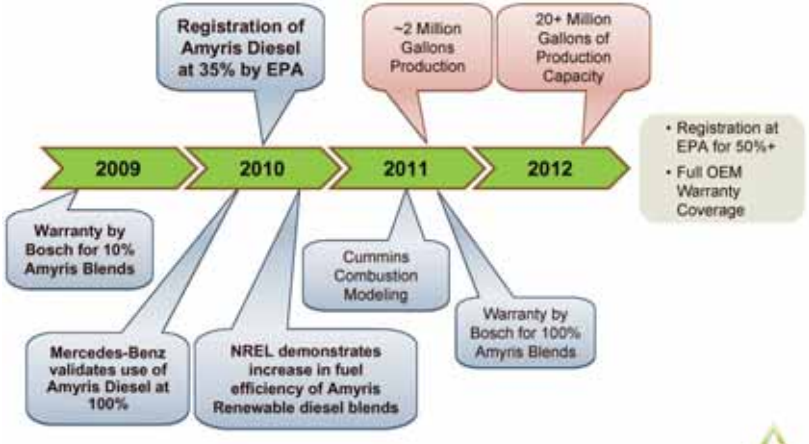
Significant reductions in NOx, PM, CO, and HC emissions - OEM validated



* Detroit Diesel Series 60 engine (5 gram NOx) no EGR., tested at SwRI May 2008 ** Source: EPA (http://www.epa.gov/otaq/models/analyses/biodiesel/p02001.pdf)

Amyris Renewable Diesel

Fuel Testing & Market Development



providing
high-performing
renewable alternatives
to petroleum-sourced
products

Amyris Renewable Diesel


TechNet
The Voice of the Innovation Economy
The National Broadband Plan:
Progress & Prospects
John B. Horrigan, PhD
Vice President, Policy Research


Plan for today
• Motivation for U.S. National Broadband Plan
• How it was developed & what it says
• How the NBP is faring after a year
• Will the NBP deliver?
TechNet

Why do a National Broadband Plan?

- Sense that the U.S. trails other countries in broadband
- Belief that better broadband is better for the economy
  - Direct economic benefits (e.g., job creation)
  - Innovative platform
- Notion that broadband is a tool for addressing societal challenges (health care, education)

Summary of the Plan

How did the FCC tackle the problem?

- Ambitious goal: 100 Mbps connections to 100 million homes by 2020
- The idea was to characterize 3 things:
  - Deployment of infrastructure
  - Adoption of broadband among consumers
  - How broadband can be used for national purposes (health care, education, energy efficiency, civic engagement)

Infrastructure I: Wireline

- NBP analysis found that about 95% of U.S. households have at least one wireline broadband provider.
  - 80% have access to two wireline providers.
- Cost to wire final 5% = $24 billion
- Stimulus funding devoted to broadband infrastructure = $7.2 billion
- Annual private investment in broadband infrastructure ~ $30 billion

Infrastructure II: Spectrum

- NBP cites looming spectrum crisis for U.S.
  - Smartphone generate 24 times the wireless traffic as cell phones.
  - Tablets generate 120 times the wireless traffic as cell phones.
  - Wireless data traffic projected to grow by **35 times** by 2014.
- Call to action:
  - Free up 500 MHz of spectrum to market within 10 years
  - Key mechanism: Incentive auctions

Adoption I: Problem

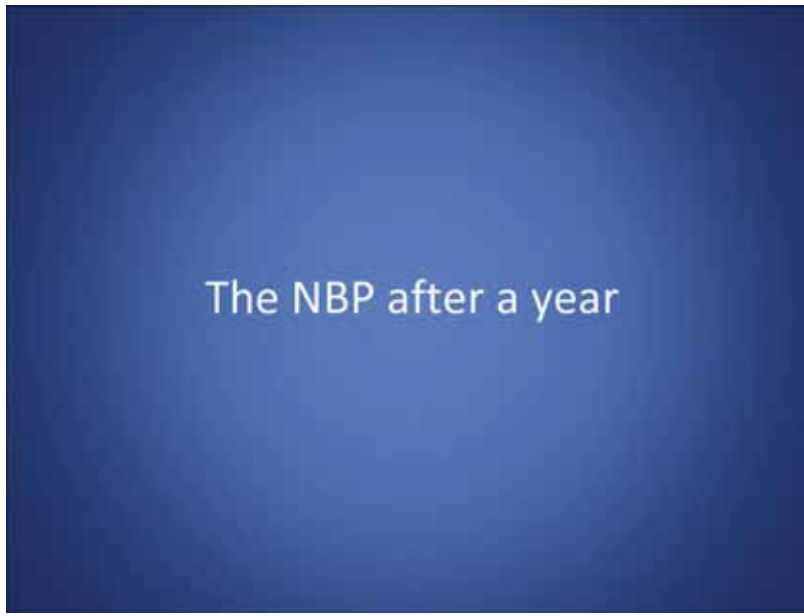
- **Gap**: Two-thirds of Americans have broadband at home – roughly at that level since 2009.
- **Barriers:** Non-broadband users face multiple barriers to adoption:
  - Monthly fee for service
  - Lack of computer skills
  - Lack of awareness of broadband's utility

Adoption II: Possible solutions

- Create a digital literacy corps
- Develop public-private partnerships to train non-users on how to use computers/internet
- Share best practices on adoption-promotion programs around the country

National purposes

- Energy and environment
- Government performance
- Health care
- Education
- Economic opportunity
- Public safety



Infrastructure

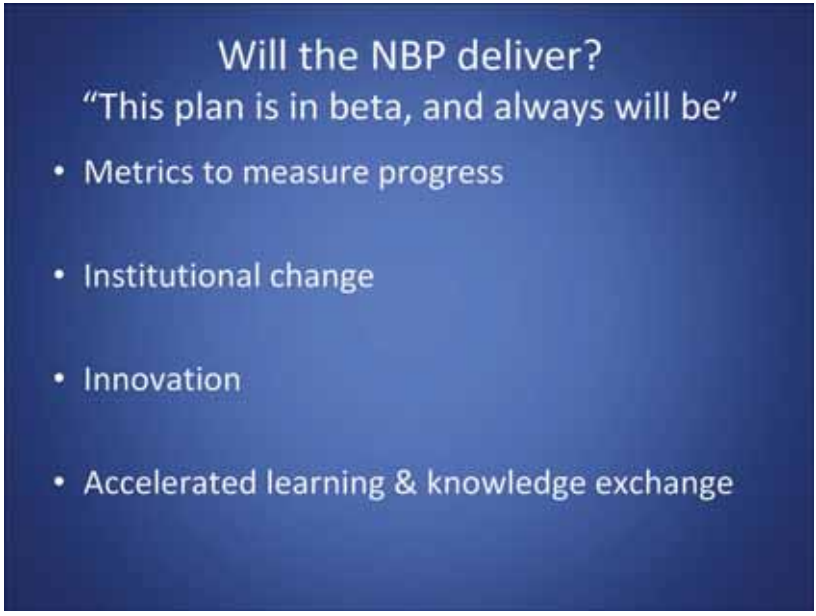
- President's wireless initiative:
  - 98% of country covered by 4G within 5 years
  - Free up 500 MHz of spectrum
  - Incentive auctions to bring in $28 billion in revenue
    - Wireless Innovation Fund: $3 billion for mobile app innovation R&D
    - $5 billion one-time spending for rural high-speed
    - $10 billion for public safety network
- Department of Commerce grants for "middle mile" fiber infrastructure

Adoption

- Department of Commerce Broadband Technology Opportunities Program (BTOP)
  - Sustainable broadband adoption grants ($250 million)
  - Public computing centers ($250 million)
- Public-private partnerships
  - Apps for Inclusion
  - Comcast initiative
- Reform Universal Service Fund

National Purposes

- Education department plan
- Smart grid (e.g., NIST on standards, DOE grants)
- Public safety (e.g., D Block)


Will the NBP deliver?
"This plan is in beta, and always will be"
• Metrics to measure progress
• Institutional change
• Innovation
• Accelerated learning & knowledge exchange

April 18, 2011

Brazilian Congressional Study Mission on Innovation

Stephen J. Ezell
Senior Analyst
Information Technology and Innovation Foundation

ITIF is a public policy think tank committed to articulating and advancing a pro-productivity and pro-innovation policy agenda internationally, in Washington, and in the states. ITIF focuses on:

- Innovation policy, processes, and metrics
- Science policy related to economic growth
- Digital transformation (E-commerce, e-government, e-health, etc.)
- ICT and economic productivity
- Innovation and trade policy

ITIF

Today's Presentation

1. **ICT as an Economic Growth Engine**
2. **Thoughts on ICT and Innovation Policy**

"General Purpose Technologies" Drive Transformation

- Most innovations come incrementally, with modest changes in products, processes and business models.
- But approximately every half century, a new technology *system* emerges that changes everything.
  - Steam power
  - The Railroad
  - Electricity
  - Steel
- And today: Information and communications technology

"General Purpose Technologies" Drive Transformation

- These new technology *systems* impact virtually everything:
  - what we produce;
  - how we produce it;
  - how we organize and manage production;
  - the location of productive activity;
  - the infrastructure needed, and
  - the laws and regulations required.

GPT's Have 3 Main Characteristics

1. They undergo rapid price declines and performance improvements.
2. They are pervasive and a part of most industries, products and functions.
3. They enable innovation in products, processes, business models and business organization.

Rapid Growth in Storage Capacity

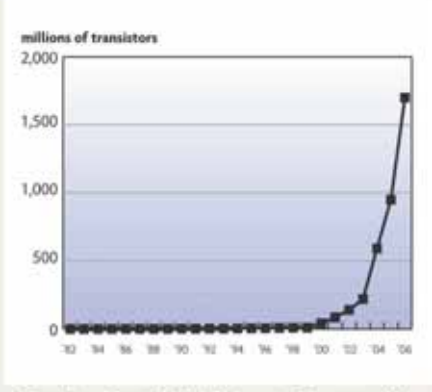
How much would 5 GBs of storage have cost using 1995 technology?

1) $55
2) $550
3) $5,500
4) $55,000

5 GBs cost $5,500 in 1995.

THE INFORMATION TECHNOLOGY & INNOVATION FOUNDATION

Rapid Growth in Computing Power (Moore's Law)



Transistor Growth in Intel Computer Processor Chips

Cost of Today's $5 Electronic Greeting Card in 1946?

1) $4.6 Million
2) $46 Million
3) $460 Million
4) $4.6 Billion

THE INFORMATION TECHNOLOGY & INNOVATION FOUNDATION

ICT is "Super-Capital;" Driving Productivity and Growth

- IT capital has 7 times the impact on GDP and productivity than non-IT capital in nations with lower levels of IT usage, and around 3 times more in other nations.
- In large U.S. firms, every dollar of IT capital is associated with $25 of market value.
  - However, $1 of non-IT capital is associated with only $1 of market value.

IT is Driving Economic Growth

How much does the commercial Internet add annually to the global economy?

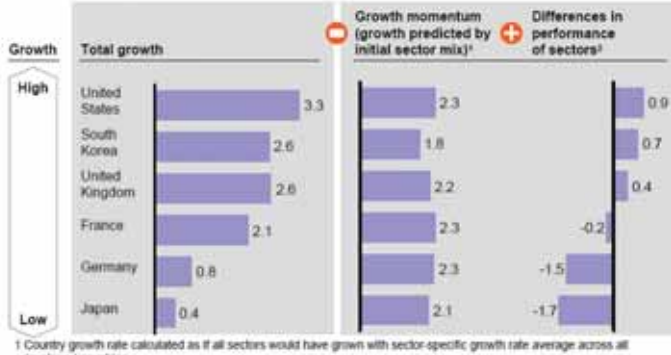
1) $500 billion
2) $750 billion
3) $1 trillion
4) $1.5 trillion

Because of the impact of the IT revolution, U.S. GDP is approximately $2 trillion larger than it would otherwise be.

Implications of ICT on Economic Growth

Sector performance has mattered more than the mix of sectors for overall GDP growth in developed countries

Contribution to total value added, 1995–2005
Compound annual growth rate, %



1 Country growth rate calculated as if all sectors would have grown with sector-specific growth rate average across all developed countries.
2 Actual country growth minus growth momentum of initial sector mix.

SOURCE: Global Insight; McKinsey Global Institute analysis

12

Sector performance matters more than sector mix in developing countries as well.

Contribution to total value added, 1995–2005
Compound annual growth rate, %

1 Country growth rate calculated as if all sectors would have grown with the sector-specific growth rate average across all developing countries.
2 Actual country growth minus growth momentum of initial sector mix.

SOURCE: Global Insight; McKinsey Global Institute analysis

13

Insights on Economic Growth from ICT

1. Across-the-board productivity growth is more important than changing the sectoral mix of an economy.
2. 80 percent of the benefit of ICT comes from its usage, only 20 percent comes from its production.
3. The real power of ICT is in using to boost the productivity of all sectors of the economy.
4. Barriers to ICT flows only damage an economy.

Today's Presentation

1. ICT as an Economic Growth Engine
2. Thoughts on ICT and Innovation Policy

Explaining International IT Leadership

ITS Leaders:

1) Japan
2) South Korea
3) Singapore

Health IT Leaders:

1) Denmark
2) Finland
3) Sweden

Contactless Mobile Payments Leaders:

1) Japan
2) South Korea
3) Singapore

E-government Leaders:

1) Singapore
2) South Korea
3) Canada

PP Lessons: Market Failures Around Innovation

1. "Chicken-or-egg" challenges inhibit the development of technology platforms.
   - E.g. Contactless mobile payments, ITS, health IT, digital signatures, etc.
   - Success depends on all parties in an ecosystem acting simultaneously.
2. Many industries and firms lag in adopting proven technologies.
   - Principal agent problem where innovation hurts its implementers (e.g. real estate).
   - Market fragmentation problems (e.g. construction/health care).
3. High levels of risk and expense stifle private sector development of complex new technology platforms.
   - Especially next-generation technologies with lengthy R&D timeframes.
   - Government must increasingly be a partner in technology research projects.
4. Innovators can't capture all the benefits of their innovation, so under-produce it.
   - RoR to society from R&D and innovation is at least twice the rate the company itself receives.

Countries Increasingly Focused on Innovation-Based Growth

"The United Kingdom has made a conscientious decision to place innovation at the center of our nation's economic growth strategy."

- Anabelle Malins, British Consul General, 2010

Comparing Countries National Innovation Policies (4/11)

Country	Existence of National Innovation Foundation (s) or Agency	Definitively Articulated National Innovation Strategy/Policy	Stated Commitment to Lead the World in Transitioning to a Digital Economy	Implemented a National Broadband Strategy
Denmark	Yes (2006)	Yes	Yes	Yes
Finland	Yes (1983)	Yes	Yes	Yes
Japan	Yes (1960)	Yes	Yes	Yes
The Netherlands	Yes (2004)	Yes	No	Yes
Portugal	Yes (2003)	Yes	No	Yes
South Africa	Yes (2006)	Yes	No	Yes
South Korea	Yes (2001)	Yes	Yes	Yes
Sweden	Yes (2001)	Yes	Yes	Yes
United Kingdom	Yes (2009)	Yes	Yes	Yes
United States	NO	In part	NO	Yes
Uruguay	Yes (2008)	Yes	-	-

Countries Leading the World in Innovation Took 3 Step Approach

1. They recognized the need to approach innovation systemically;
2. They set a vision and strategy for action, with clearly articulated goals and ambitions;
3. They implemented institutional reforms to drive their country's innovation strategy.

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The debate on patent legislation reform in the USA: Implications for Brazil

Jay Thomas
Georgetown University
April 18, 2011

Patents and Innovation

"History should guide us. The USA led the world economy in the 20th Century because it led in innovation. Today, competition is fiercer; the challenge is more difficult; motives for which important is more important than ever."

President Obama, August 5, 2009

Patents and Innovation

- Probably the main government mechanism for promoting
  - Inventions
  - Investment in R&D
  - Technological promotion
  - Technology sales
  - Placement of proprietary technology in the public domain

Requests for patents in USA

Year	Number of requests deposited
1990	176,264
1995	228,238
2000	315,015
2005	417,508
2010	520,277

First year in which most deposits are from abroad

Origins of Patent reform

- The last significant change in USA patent legislation was in 1952
- *To promote innovation*
  - Report from the Federal Trade Commission (2003)
- *A patent system for the 21st Century*
  - Report from the National Academy of Science (2004)
- First bill for reforming patent legislation was presented in 2005

The "America Invents" Law

- Passed in the Senate on March 8, 2011
  - Vote was 95-5
- Passed in the Sub-Commission on Constitutional Justice on April 14, 2011
  - Vote was 32-3
  - A prior version of the bill passed in 2007
- Awaiting a vote by the full House and harmonization of the two versions

Objectives

- Modernize the patent system in a period of technological explosion
- Improve the environment for innovation
- Increase domestic competitiveness
- Adopt the best practices for equivalent patent systems

Specificities of the approved bill

- Adopt system's global norm to prioritize the first inventor to deposit
- Improve the capacity of the USA trademark and patent body
- Reduce costs for resolving patent disputes

First-Inventor-to-Deposit

- When two inventors develop the same technology, at the same time, who wins the patent?
  - Brazil and other countries – First to deposit
  - USA – First actual inventor
- Parallel development: Permit the deposit of a request by an assignee

Improve the patent body

- USPTO has extraordinary challenges
  - Backlog in patent request analyses
  - Flexibility in practices
- Provide the USPTO with more control on budget issues
- Promote decentralization of tasks
- Improve interaction with the technological community

Reduces costs for resolving disputes

- Improve patent quality
- Introduce administrative procedure after concession
  - Cheaper alternative than legal action
  - Use USPTO's experience
- Eliminate or modify subjective requirements of USA patent legislation
  - Better means of execution
  - Unfair conduct

Implications for Brazil

- INPI initiative to reduce backlog in patent request analysis
- Patent pipeline
  - Term of validity
  - Validity and constitutionality
- Protection of confidential data submitted for medication registration (ANVISA)
  - Generic medications and similar

Innovation in Brazil
Public Policies and Business Strategies

prospectiva.
negócios internacionais
e políticas públicas

April 2011
Washington, DC

Ricardo Sennes
rsennes@prospectivaconsultoria.com.br

1

TOPICS:

1. General context of innovation in Brazil:
   I. Comments on policies for stimulating innovation
   II. Comments on company perception
2. Evaluation of some of the results
3. Some recent movements

2 prospectiva.

TOPICS:

1. General context of innovation in Brazil:
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3. Some recent movements

General context of innovation in Brazil

Main diagnosis:

- Brazil's difficulty is in "D" (development), because "R" (research) is advancing

Undeniable advances:

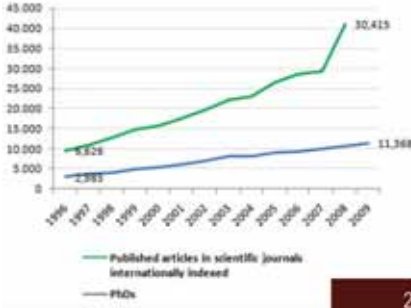
- Unusual consensus surrounding the theme (executive and legislative)
- Regulatory instruments, policies and initiatives are in place
- Some results are already visible

But it still needs:

- Response is still concentrated in universities
- Private investment is still very low
- Focus of innovation is still domestic (not the international market)
- Focus more on company demands (and not on university offer)
- Focus still lacking in network innovation and open innovation
- Room for inter-sector learning in the government
- Bureaucratic and regulatory bottlenecks
- Room for attracting EMN

General context of innovation in Brazil

PhDs and Scientific Papers/year



Source: Capes/MEC, MCT. Elaboration: Prospectiva

Patents registered

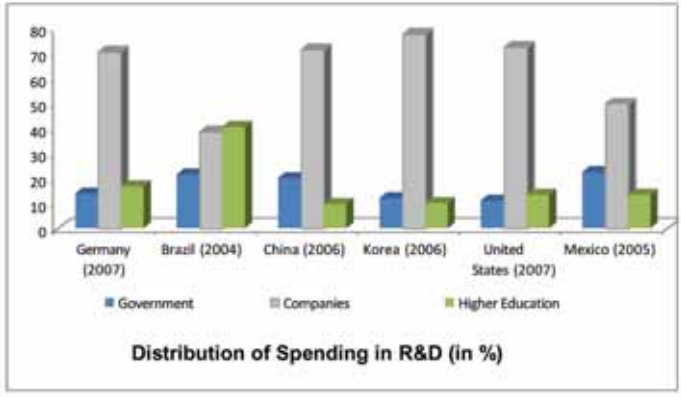
Source: Prospectiva, 2010

2.63% internationally indexed articles

0.2% of international patents

prospectiva.

General context of innovation in Brazil



Source: http://www.mct.gov.br/index.php/content/view/8377.html

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Comments on policies for stimulating innovation

- Innovation: what is it?
  - Continuous and structured process that involves several dimensions of economic and business activity
  - Systematic application of knowledge in economic activity: processes, products and service
  - Innovation is the result of business decisions
  - FOCUS: companies
- Challenge of innovation policy: how to stimulate it?
  - Create an integrated environment of incentives (involving educational university, scientific, regulatory and financial dimensions)
  - There are no success cases based on linear and directed policies
  - Reduce risk, investment, uncertainty or favor future returns

prospectiva.

Comments on policies for stimulating innovation

Comments on policies for stimulating innovation

Linear models of technology push and demand pull are today considered insufficient for stimulating innovation.

- research in networks
- research in partnerships
- opportunities in open innovation

Tendency to reduce vertical strategies of RD&I:
- Cost and risk problem
- Opportunity problem

Comments on policies for stimulating innovation

Brazil has policies and institutions capable of designing, implementing and financing this effort – at least in part.

Promotion institutions:

- FINEP as a "bank"
- BNDES
- Sector funds
- FAPs
- Research centers (Embrapa, ITA, FioCruz, Butantan Institute, INPE, etc)

Coordination agency:

- ABDI

Regulatory frameworks:

- Law of the Good (2007)
- Innovation Law (2004)
- Intellectual Property Law (1996)
- State Innovation Laws

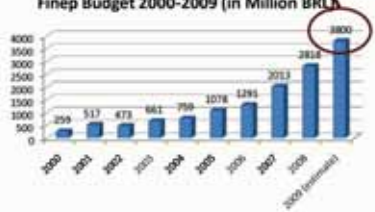
Public Policies:

- PITCE (2004)
- S&T PAC (2007)
- PDP (2008)

prospectiva.

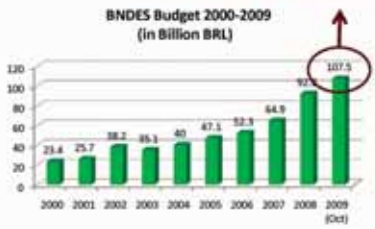
Comments on policies for stimulating innovation

2.2 Billion USD



Source: Finep. Elaboration: Prospectiva

100 Billion USD in 2010



Source: BNDES. Elaboration: Prospectiva

Estimated BNDES budget for innovation (based on broad definition of innovation), but still with difficulty in assuming risks → 7%

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Comments on policies for stimulating innovation

Brazilian government designed at least 5 different models of public research institutions

- Different relations with the public sector
- Different relations with the private sector
- Different financing standards
- Different standards with the university

ITA Model | Embrapa Model | FioCruz Model | INPE Model | CENPES Model

→ With different results

Comments on policies for stimulating innovation

But some basic conditions are missing

- Innovation culture at schools and universities
- Lack of coordination among the different instances and levels:
  - Example 1: innovation and export
  - Example 2: innovation and traditional knowledge
  - Example 3: innovation and services
- Still need to shift axis of incentives to companies
- Still need to remove more impacting bureaucratic obstacles (fiscal, tariff, customs, etc.)
- Still need to remove regulatory obstacles (genetic assets, some cases of PI, etc)
- Brazil still needs to integrate global innovation chains

TOPICS:

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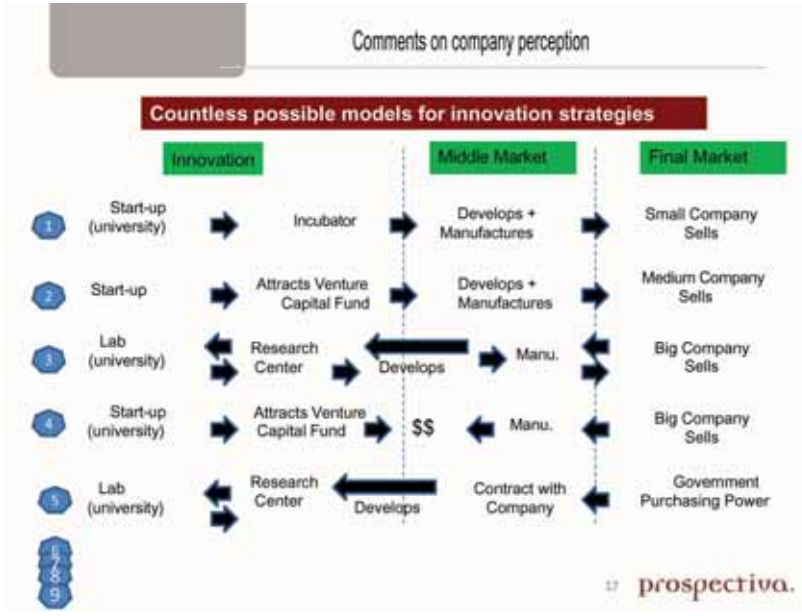
Comments on company perception

For companies, innovation must be approved by the rate of return and the business strategy (competition)

Innovation directly related to international strategy

- There is no innovation for the domestic market
- Companies seek the best environment (lower costs, fewer risks, more opportunities)
- Decentralization
- Governance with international standards


Comments on company perception
Countless possible models for innovation strategies
Innovation
Middle Market
Final Market
1
Start-up (university)
Incubator
Develops + Manufactures
Small Company Sells
2
Start-up
Attracts Venture Capital Fund
Develops + Manufactures
Medium Company Sells
3
Lab (university)
Research Center
Develops
Manu.
Big Company Sells
4
Start-up (university)
Attracts Venture Capital Fund
$$
Manu.
Big Company Sells
5
Lab (university)
Research Center
Develops
Contract with Company
Government Purchasing Power
6
7
8
9
17
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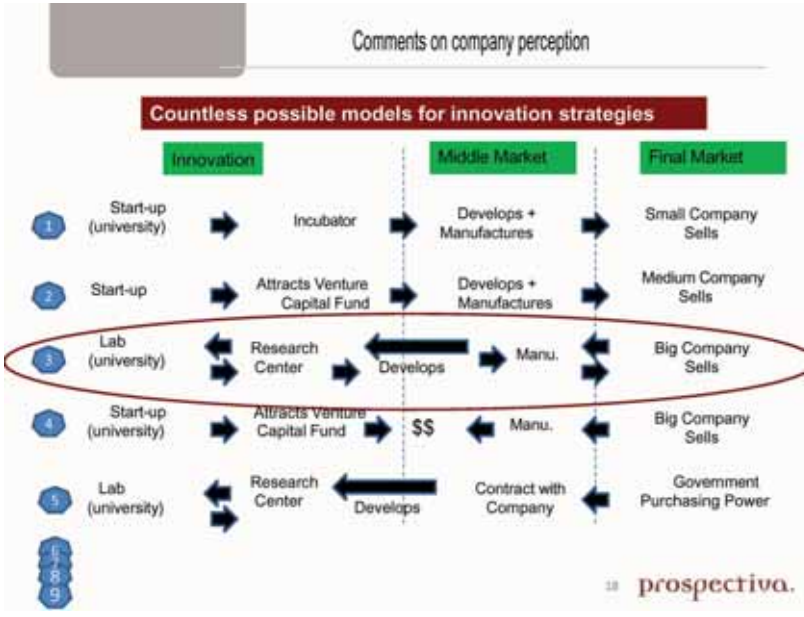
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Final Market
1
Start-up (university)
Incubator
Develops + Manufactures
Small Company Sells
2
Start-up
Attracts Venture Capital Fund
Develops + Manufactures
Medium Company Sells
3
Lab (university)
Research Center
Develops
Manu.
Big Company Sells
4
Start-up (university)
Attracts Venture Capital Fund
$$
Manu.
Big Company Sells
5
Lab (university)
Research Center
Develops
Contract with Company
Government Purchasing Power
6
7
8
9
18
prospectiva.

Comments on company perception

Some of Brazil's competitive differences:

- strong local scientific base
- ample industrial capacity
- biodiversity
- ITC infrastructure
- substantial presence of multinational companies
- significant purchasing power of the government
- stable intellectual property rules

Companies still do not perceive substantial change in pro-innovation environment:
- identify advances by important bottlenecks prevail
- Brazil cost in R&DI still higher than competitors

Sources: interviews (2008-2009-2010-2011). Elaboration Prospectiva.

TOPICS:

1. General context of innovation in Brazil:
   I. Comments on policies for stimulating innovation
   II. Comments on company perception

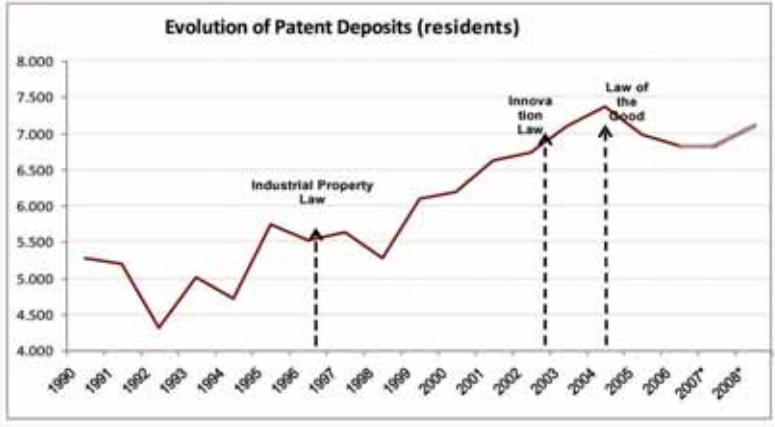
2. Evaluation of some of the results

3. Some recent movements

Evaluation of Results

Brito Cruz, C.H. Recursos humanos para ciência e tecnologia no Brasil. In: Inovações Tecnológicas: políticas públicas e estratégias empresariais. Editora Unesp 2011. Forthcoming.

Evaluation of Results



Source: INPI and MCT – Elaboration: Prospectiva Consultoria * Preliminary data not consolidated
Privileges of Invention (PI) and Models of Utility (M.U) of residents accounted for

Patents deposited by companies

Rank	Company	Sector	Names Searched	Date Consulted	INPI Patent Deposits	USPTO Granted	USPTO Requests	EPO
1	Petrobrás	Oil and Gas	Petrobrás	4/29/2010	1.177	179	113	125
2	Vale	Mining	Vale (CVRD, Vale do Rio Doce, Vale Inco)	4/28/2010	471	40	18	37
3	Usiminas	Metallurgy and Steel	Usiminas	4/28/2010	446	2	1	1
4	CSN	Metallurgy and Steel	Companhia Siderúrgica Nacional	4/28/2010	343	0	0	0
5	Tigre	Construction and Decoration Material	Tigre	4/29/2010	238	7	5	1
6	Embrapa	Specialized Services	Embrapa. Empresa Brasileira of Pesquisa Agropecuária	4/29/2010	221	8	0	12
7	Duratex	Construction and Decoration Material	Duratex	4/29/2010	193	1	0	0
8	Cosipa	Metallurgy and Steel	Companhia Siderúrgica Paulista	4/28/2010	135	0	0	0
9	Natura	Pharmaceutical and Cosmetics	Natura (Natura Cosméticos)	4/28/2010	91	44	13	37
10	Alpargatas	Clothing, Textiles Leather and	Alpargatas	4/29/2010	89	5	1	1

Source: INPI, USPTO and EPO – Elaboration: Prospectiva

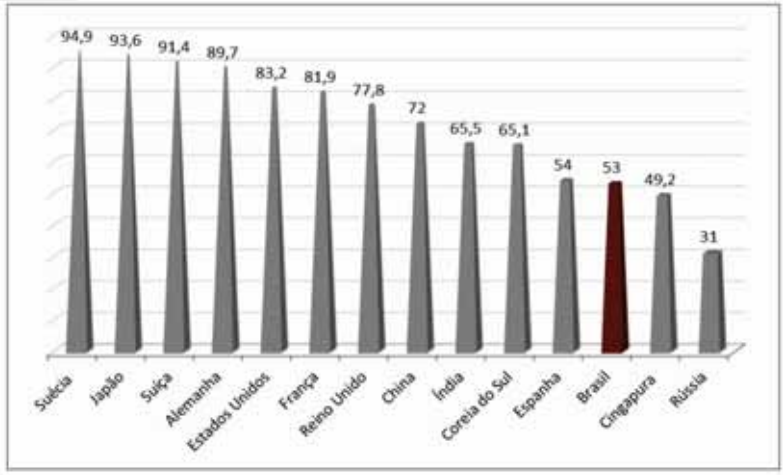
Patents deposited by universities

Rank	Institution	Names Searched	Date Consulted	INPI Patent Deposits	USPTO Patents	USPTO Requested	EPO
1	UNICAMP	State University of Campinas, Unicamp	4/29/2010	637	0	4	9
2	USP	Usp, University of São Paulo	4/29/2010	543	4	3	10
3	UFMG	Federal University of Minas Gerais	4/29/2010	302	2	2	5
4	UFRJ	Federal University Rio Janeiro	4/29/2010	238	2	1	17
5	FIOCRUZ	Oswaldo Cruz Foundation	4/29/2010	114	13	10	26
6	UFRGS	Federal University of Rio Grande do Sul	4/29/2010	105	0	0	1
7	UNESP	State University of São Paulo	4/29/2010	92	0	0	1
8	UFPR	Federal University of Paraná, UFPR	4/29/2010	85	1	0	1
9	UFV	Federal University of Viçosa	4/29/2010	64	0	0	0
10	UFPE	Federal University of Pernambuco, UFPE	4/29/2010	63	0	0	2

Source: INPI, USPTO and EPO – Elaboration: Prospectiva

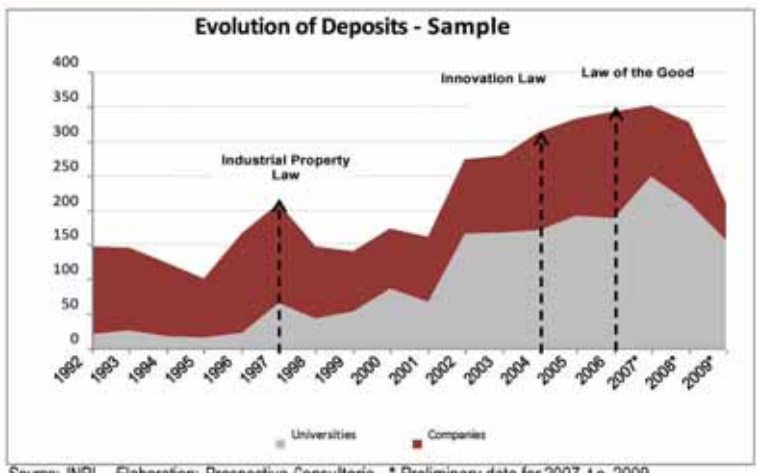
prospectiva.

International patent deposits (PCT)% ownership of companies



prospectiva.

Evaluation of Results



Source: INPI – Elaboration: Prospectiva Consultoria * Preliminary date for 2007 to 2009

prospectiva.

Evaluation of Results

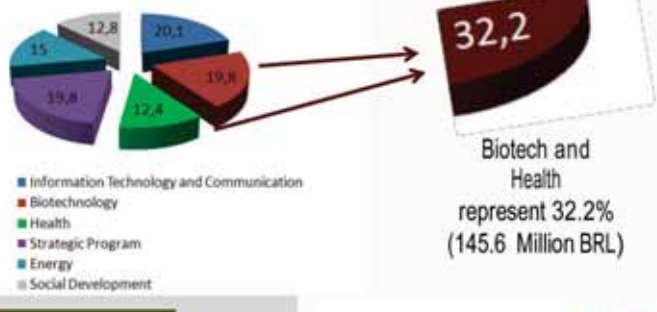
	Total Researchers		Researchers at Companies		
	Qty (full time)	In rel. to BR	Qty (full time)	Per million inhab.	In rel. to BR
Mexico	48,401	0.7	24,367	230	1.1
Brazil	119,571	1.0	41,341	218	1.0
Chile	13,427	1.3	n.a.	n.a.	n.a
Argentina	38,681	1.5	4,158	102	0.5
Portugal	27,986	4.2	8,639	815	3.7
Spain	122,624	4.3	42,101	931	4.3
Russia	469,076	5.2	237,408	1,658	7.6
France	211,129	5.2	118,568	1,851	8.5
Germany	284,305	5.4	172,744	2,089	9.6
Canada	134,300	6.3	81,960	2,448	11.2
United Kingdom	254,599	6.6	89,600	1,466	6.7
South Korea	221,928	7.2	166,289	3,428	15.7
United States	1,425,550	7.5	1,130,500	3,748	17.2
Japan	709,974	8.8	483,728	3,777	17.3

Brito Cruz, C.H. Recursos humanos para ciência and tecnologia no Brasil. In: Inovações Tecnológicas.

prospectiva.

Evaluation of Results

Finep Subvention 2008 (% Total 452 Million BRL)



Biotech and Health represent 32.2% (145.6 Million BRL)

prospectiva.

TOPICS:

1. General context of innovation in Brazil:
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prospectiva.

Recent movements

Cases of Brazilian companies: standard international innovation

- Embraer:
  - Partnership in risk and in result: integration of international chain
- Petrobras
  - Leading research center with development and purchase of technology
- Sabó
  - International partnership for development and sales with WV
- Microbiológica
  - Brazil-USA-UK development and sale to Novartis-Vaccine

- All dispute the global market
- All developed products for the global market
- All based on domestic and international partnerships

30 prospectiva.

Recent movement

Global companies with R&D in Brazil

Shell · SIEMENS · BASF · syngenta · GM · MONSANTO

Global companies with R&D in Brazil - Recent

- Oil and gas
- Infrastructure
- Aviation
- Life Sciences

- ITC
- Logistics
- Infrastructure
- Transport

Source: MCT, Indicators

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Recent movement

Clinical Trials

Brazil is implementing the Brazilian Registry of Clinical Trials (Rebrac) to become part of the WHO International Platform

Ranked 17th

Posição	País	Número de sites	Participação (%)	Média relativa de crescimento anual	Capacidade	Densidade
1	Estados Unidos	36.281	48.7	-6.5	43.7	120.3
14	República Tcheca	799	1.1	24.6	4.5	77.6
15	Argentina	757	1.0	26.9	4.8	19
16	India	757	1.0	19.6	5.8	0.7
17	Brazil	754	1.0	16.0	5.1	4.0
20	Hungria	622	0.8	22.2	4.1	62.5
23	China	533	0.7	47.0	5.3	0.4

Fonte: Thiers et al, 2007

Rank Country Number of Sites Share Relative average annual growth Capacity Density
United States Czech Republic Argentina India Brazil Hungary China

Source: Pesquisa Clínica no Brasil II. Análise crítica do sistema CEP-CONEP e propostas of aperfeiçoamento. Abril 2009

Brazil is already much consolidated in Phases III and IV

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FOUR KEY CONCEPTS:

(a) ample concept of innovation, not restricted to applied research activities

(b) centrality of public policy and private strategy interaction

(c) innovation as an activity related to international dynamics of markets and competitive differentials

(d) Brazil: challenge to go from "R" to "D".

Nanotechnology in Brazil: Advances and Challenges

Dr. Noela Invernizzi

Fellow, Woodrow Wilson Center
Professor, Federal University of Parana, Brazil

Nanotechnology

- Nanotechnology is the understanding and control of matter at the scale of 1-100 nanometers where unique phenomena enable the design and production of materials, devices and systems with novel applications.

(1 nm is one-billionth of a meter)

- Considered the base of a **new industrial revolution**

Why is nanotech considered revolutionary?

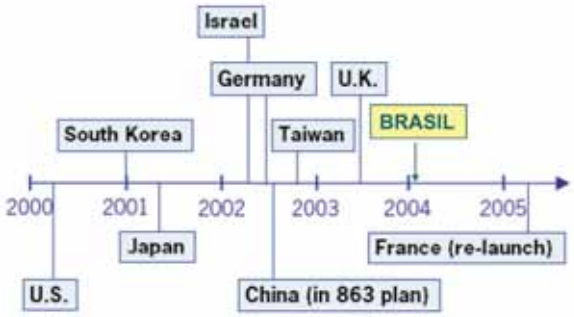
1. New fabrication methods
   Bottom-up – manipulating atoms and molecules to create new structures
   Top down – going nano (ex. Lithography)
2. New materials can be designed, and known materials improved, exploring the different chemical, mechanical, magnetic, and optical properties of matter at nanoscale (quantum effects, surface effects)
3. At nanoscale there might be no difference between living and non-living "building blocks" of matter. Hybrid materials and devices.
4. *Enabling* technology that can be applied to any sector of the economy

Emerging technology

- 1980s - New microscopes and some fundamental discoveries
- 1990 - Atoms are positioned for the first time with an AFM at IBM lab

- 1997- First nanotechnology company
- 2000 – US National Nanotechnology Initiative
- Now - More than 60 countries have nanotechnology programs

Nanotechnology initiatives have proliferated globally



(Lux Research, 2006)

Innovation drivers

- A new technology in search of problems?
- Limits in chip manufacturing → "Moore's Law" pushed it into the nanoscale. More radical innovations to come
- Several world's top drugs' patents expired by 2008. Patent revamping + new ways of drug design
- "Intelligent" and more integrated products across every sector

Some figures

- US: more than US$12 billion invested since 2000 (NNI)
- Global funding (public +private): US$18.2 billion in 2008, almost doubling the US$9.6 billion invested in 2005
- Nano market
  - **US$ 2.5 trillion by 2015** (close to 15 % of current global manufacturing output) Hype? Overstated?
  - Current global market: **US$ 224 billions** (2009)
- Nanotech leaders: US, Japan, Germany, China

Context in Brazil

Short term, conservative competitive strategies

- Only 38 % of 100,000 companies performed some innovation during 2006-2008 (new or improved process or product).
- Main source of innovation: purchase of new equipment (78% of the companies that performed innovations)
- Only 48,000 R&D workers in 100,000 companies: one every two companies! Only 14 % with master or doctoral degrees. (PINTEC, 2010)
- MNC's subsidiaries perform 40 % of R&D activities in Brazil (Albuquerque, 2009)
- Increasing scientific production, very low patenting activity

New institutional framework for ST&I

- Sectorial S&T Funds (1999)
- Innovation Law (10.973/2004)
- "*Lei do Bem*" (Law 11.196/2005)

- Oriented to promote innovation encouraging more interaction between universities and research institutes and the productive sector

- Increasing budget devoted to S,T&I and to promote companies' R&D

Brazilian nanotechnology policy was inspired and implemented within this new ST&I perspective

Brazilian Nanotechnology policy

- MST started to articulate a policy to promote nanotechnology in late 2000

- First Research Networks and four Millennium Institutes on Nanotechnology launched in 2001

- The STM Multi-Year Plan 2004-2007 included a Program for Nanoscience and Nanotechnology
  - Goal: increasing national competitiveness
  - Benefiting from the window of opportunity opened by nanotechnology

- Industrial Policy (PICTE and later PDP) considers nanotechnology as an strategic area ("bearer of the future")

Brazilian Nanotechnology policy

- 2005 **National Nanotechnology Program**
- 2009 Nanotechnology Competitiveness Forum

- Increasing coordination of several government ministries and agencies to implement the NNP.
- 314 million *Reais* (~200 million dollars) invested by the MST over the period 2004-2009

Accomplishments

Nanotechnology policy has been very successful in creating a good research infrastructure and qualified human resources trough a combination of:

- ***Multi-user laboratories*** – several million *reais* created or updated state-of the art labs (LNLS-Cesar Lattes, LATEO/Inmetro, Nano Agribusiness /Embrapa, Lab.Nano CETENE, LATEO/UFRGS). University and public research centers labs also re-equipped
- ***Cooperative Research Networks***
  2001 - CNPq identified 192 nanotech researchers
  2010 - 1300 researchers and 2000 graduate students; 469 research groups in 104 institutions and 24 states connected through research networks that share lab infrastructure
- ***Decentralization*** (30% of the budget to less developed regions, including important labs)

Performance in S,T&I: Scientific publications

- 18th position in worldwide nanotechnology scientific publications
- Leader in scientific publications in Latin America
- Doing better in nanotech (3,1 % of world science publications) than in science in general (2,3 % of the world science publications)

Performance in S,T&I: Patents

- 2003 - 2006 - 43.887 nanotechnology patents granted worldwide; only 45 Brazilian (Patent Cooperation Treaty databank)
- Nanotechnology patents registered at INPI in 2010:
  - ✓ 11 from universities and 5 from university/foundations/ research institutions
  - ✓ 11 from individual researchers
  - ✓ 6 from private companies
  - ✓ 2 from State controlled corporation (Petrobras)
  - ✓ 1 from university/company cooperation

Total: 36

News are not very new:

- Brazil is doing well in nanoscience
- Brazil has a poor performance in patenting and universities are becoming more active patenting than companies

(The top 30 nanotechnology patent assignees are mostly multinational corporations based in the United States, Japan and Europe (Palmberg et al, 2009).

Patent indicators alone are not enough to grasp the complex process of innovation, and even less in developing countries

So, what is happening in the productive sector?

Performance in S,T&I: Nanotechnology companies

- Incipient nanotechnology development in industry: 155 companies

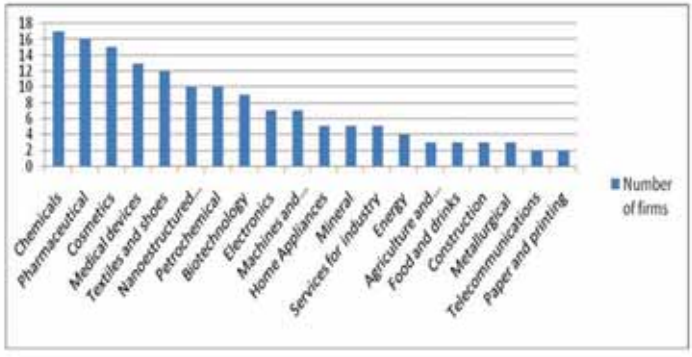
US 1500
China 900
Germany 860
Italy 86
Israel 80
Iran 60

Nanotechnology companies

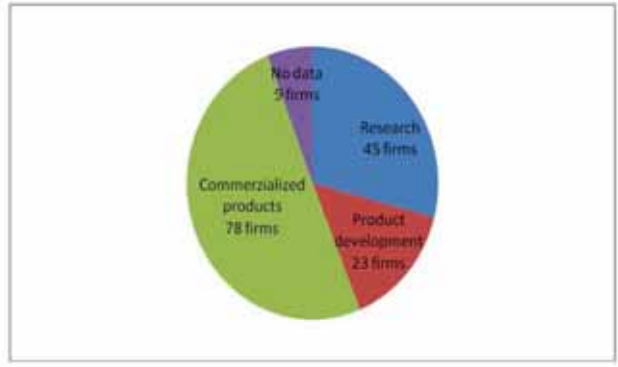
- Large, innovative companies are incorporating nanotechnology to their business (internal developments, technology transfer or importing nanomaterials)
- Start-ups, mostly university spin offs: nanotechnology dedicated companies
- Main sectors involved: chemical/petrochemical, pharmaceutical, cosmetics, medical devices, textiles and nanomaterials.
- Almost half of them obtained R&D financial support from the NNP or other innovation funds
- ~ 80 commercialize or are about to commercialize nanomaterials, nanointermediates or nano-enabled final products

(Invernizzi, 2010)

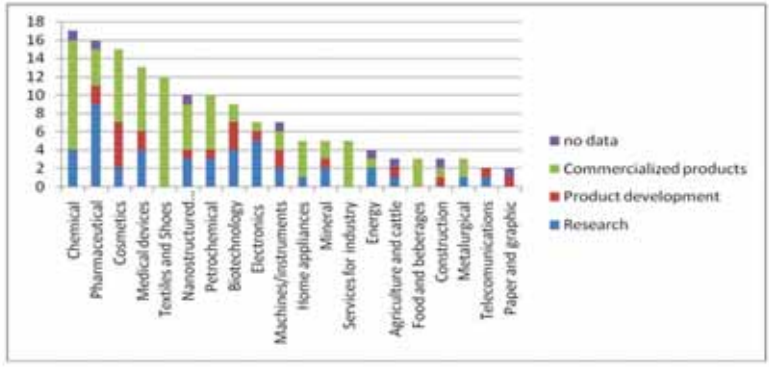
Brazilian companies with activities in nanotechnology, by sector



Nanotechnology activities in Brazilian companies



Nanotechnology activities in Brazilian companies, by sector



Brazilian nano market

- Not comprehensive data available
- Survey conducted by the Federation of Industries of the State of Rio de Janeiro with 29 out of 51 companies benefited with FINEP R&D funding from 2007-2009 showed that the market of these companies is about R$ 115 millions. Partial figure

(FIRJAN, 2009)

- For comparison, FINEP subsidies for nano R&D during 2007-2008 reached R$ 60 millions.

Challenges

- In spite of considerable advances, Brazilian Nanotechnology Policy faces two kind of challenges:

First, regarding its own goals

Second, regarding new goals that could be incorporated

1) Meeting the NNP goals

- The main goal of the NNP – increasing national competitiveness using nanotechnology- faces the persistent low innovative dynamism of Brazilian industry
  - Most of the dynamic companies incorporating nanotechnology are already included within the select an small group of innovative firms (i.e Oxiteno, Petrobras, Brasken...)
  - Some other companies (i.e textile, chemical and cosmetics sector) are using imported nanomaterials
  - *Start-ups*: cases of success (i.e Nanox, Nanum, Nanoendoluminal, etc), but for most of them it remains uncertain if they will survive outside university incubators and without federal funds
- It is unclear, in the NNP, how federally supported R&D is connected to increasing technological autonomy
- The NNP does not pay enough attention to labor force training (61 % of the industrial workforce didn't complete 12-years basic education)

2) Opening another front to enhance benefits of nanotech

- The NNP should stimulate part of the ST&I system to address concrete national social needs. Nanotechnology innovation could be directed to:
  - The vast potencial of the emergent internal market opened up by the recent and incipient weath distribution process
  - Provide solutions to challenges faced by social and environmental policies, such as the public health system, civil construction (Minha Casa, infraestructure...), environmental remediation. Use the State powerful inductive power...
- We have scientific capabilities, and succesful cases of innovation were all stimulated by concrete national needs (Embrapa, Petrobras, Fiocruz). We should try more our own recipy!
- More research on the social, legal and ethical implications of nanotechnology and its potential risks is needed.
- Open and transparent public information and discussion. Civil Society groups are important participants.

Technology Transfer at MIT

Lita Nelsen
Technology Licensing Office, MIT

MIT-Brazil
April, 2011

1

Many forms of "Technology Transfer" from Academia to Industry

- The graduating student
- Publication
- The consulting professor
- Collaborative/sponsored research with industry
- University seminars/courses for industry
- Intellectual Property licensing to
  - **Existing companies**
  - **Spin-Outs**

2

Formal definition of "technology transfer"

- Purposeful transfer of the results of fundamental research from universities and research institutions into the economy via protection and out-licensing of intellectual property

Purposes of University Technology Transfer

Research Development → Invention (and IP) → Innovation

- New products and medicines
- Bring new technology into industry for economic competitiveness
- Encourage entrepreneurship for local and national economic development
- Help solve societal problems (energy, environment)

Bayh-Dole Act of 1980 changed US university tech transfer landscape

- Gave universities title to their patents from federally funded research
- Allowed universities to grant licenses
  - enabling tech transfer at the local level!
- Allowed exclusive licenses
- Allowed universities to take royalties (and legislated sharing of royalties with inventors.)

5

Bayh-Dole looked at research and patents in a new way

- University technology is embryonic—neither its feasibility nor market is known
- Development will require high risk investment by industry
- Intellectual property protection can be used as an incentive to make high risk investment
  - motivating the "first mover" by protecting against later competitors

6

The Tech Transfer Bargain

- University research leads to patent—but technology is unproven and high risk
- University is willing to grant exclusive patent license to Company who will commit to the risk of developing the technology
- If development succeeds, the patent protects the Company from competitors
- University benefits from product being developed and from royalties (shared with inventor)

Patent protection is particularly critical for development of pharmaceuticals

- Development of a new therapeutic or vaccine product is a particularly high risk activity
  - Time frames are long
  - Financial investment is very high
  - Clinical trials are very difficult
  - Probability of failure is high
- Patent protection of the final product is necessary before companies (or biotech investors) will take the risk and make the investment

Other truly innovative technologies requiring substantial investment and time also need patents to induce investment

- New materials (superconductors)
- New fuel sources (biofuels)
- Alternate energy sources (improved solar panels, batteries, …)
- Innovative production methods (3D Printing)

And new technology startups will not get investment without an IP dowry (software exceptions)

9

- But does technology transfer make money for the university?

10


Fiscal Year 2007: 200 US universities and research hospitals
• New Issued US Patents: > 9800
• New License Agreements: >4200
• Total Licenses yielding income: >11,000
• New Startup Companies: >480
11


Even with large number of licenses and spinouts, income was not large on the average
• Licensing revenue from >200 research institutions in FY 2007: $2.0 Billion (U.S.)
• BUT…this is on a research base of:
$ 41 Billion
• Thus, Licensing revenue, after 25 years of experience averages:
only 5 % of research expenditures
12

And the total revenue is very unevenly distributed

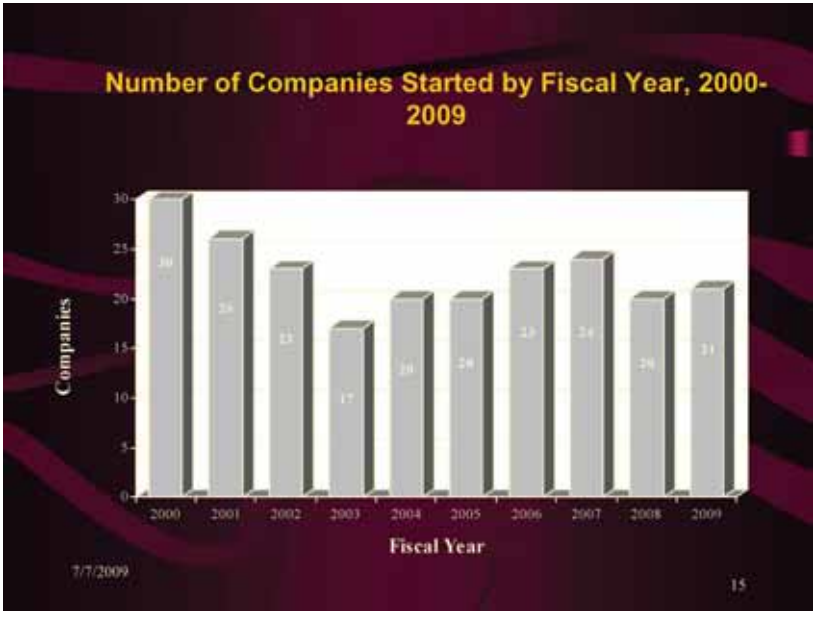
- Dominated by a few very large royalties from fewer than 1% of total patents from research institutions in the U.S.
  - Pharmaceutical royalties are high—but very rare
  - Equity cash-ins from spin-outs are only occasionally large, and are one-time events
- Most universities eventually break even or make a small amount—but very few get rich!

13

MIT Technology Licensing Office Statistics

- 500 new invention disclosures/year
- 100 new technology licenses/year
- 15-30 new companies/year
- Over 650 active licenses
- Over 300 spinout companies total

14


Number of Companies Started by Fiscal Year, 2000-2009
Companies
30
25
20
15
10
5
0
30
26
23
17
20
20
23
24
20
21
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
Fiscal Year
7/7/2009
15


Impact, not Income
We measure ourselves by our impact on the community
• New licenses (bringing innovation to the market
• New products (medicines, batteries, electronic printing, etc.)
• New companies, new jobs
• Education/exposure of students to entrepreneurial thinking and aspiration
16

Strategy: do a lot!

The Volume Strategy

- Aim to maximize the number of technologies being developed
  - Rather than try to pick a few "winners" and concentrate on them
- 100 license/year—20-30 startups/year

17

Advantages of the "Volume Strategy"

- Maximizes participation of faculty and students in the technology transfer process
- Maximizes number of technologies invested in by companies and VC's
- Maximizes probability of hitting a home run
- **Technology is probably too early to be able to pick the winners!**

18

Why are we able to do so much ?

- Large volume of basic research of world class excellence
- Faculty and student awareness of the benefits of IP and entrepreneurship
- Coherent understanding of TLO mission

19

A pervasive entrepreneurial eco-system both within and around MIT

- We are well-networked in a highly entrepreneurial geographical area with investors, entrepreneurs, managers, lawyers, accountants, real estate owners
  - Experienced in the formation and nurturing of early-stage, technology-based companies

20

And the MIT "Entrepreneurial Eco-System"

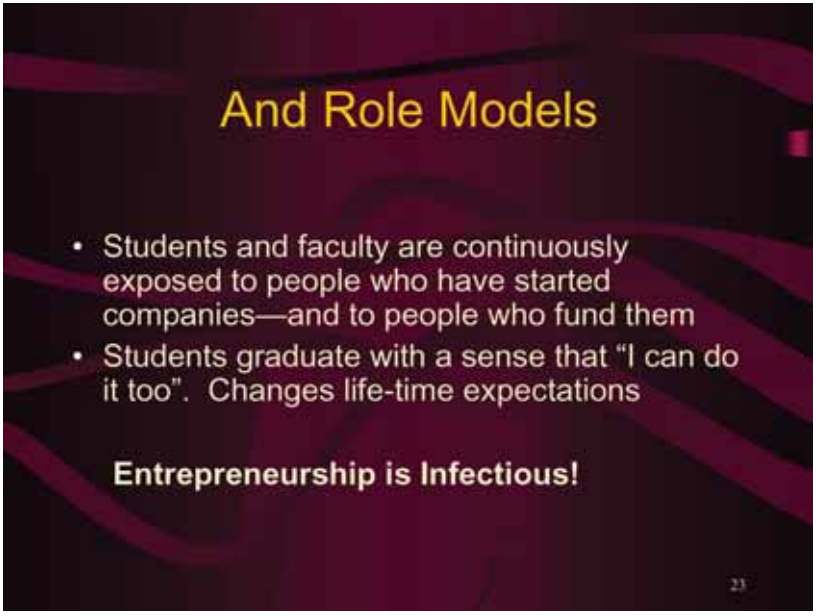
- Many organizations within the university that support the entrepreneurial aspirations of faculty and students
- All of these call upon volunteers from the business and investment community
  - Hundreds participate every month
- A synergistic interaction between "inside" and "outside" the walls of MIT

21

Components of the MIT "entrepreneurial eco-system"

- Deshpande Center: sponsors research "with startup potential"—with business "catalysts"
- $100 K Student Business Plan Contest
- Venture Mentoring Service
- MIT Enterprise Forum
- Entrepreneurship Center at Sloan School of Mgmt.
- Student Venture Capital and Entrepreneurship Clubs
- The Technology Licensing Office

22


And Role Models
• Students and faculty are continuously exposed to people who have started companies—and to people who fund them
• Students graduate with a sense that "I can do it too". Changes life-time expectations
Entrepreneurship is Infectious!
23

Massachusetts Institute of Technology
Industrial Liaison Program

Parlamentares
Brasileiros-Missao de
Estudos

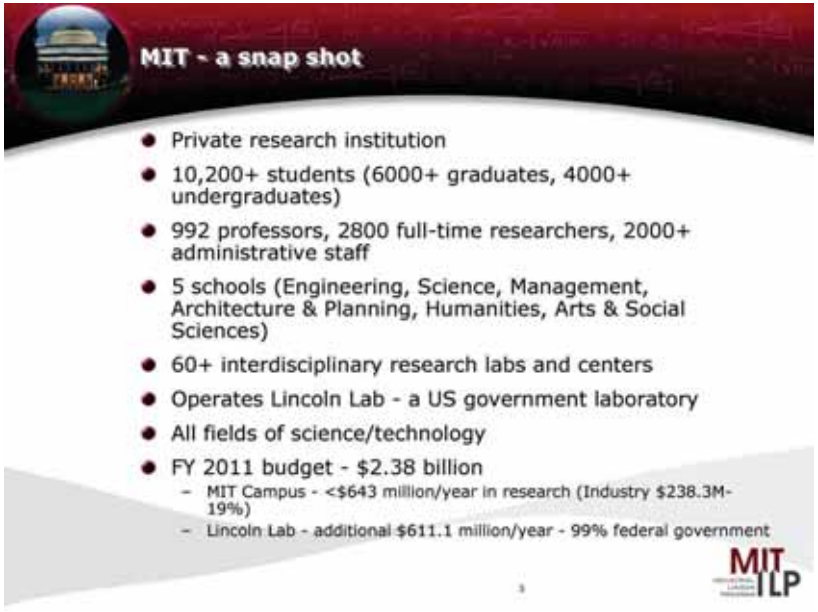
Tony Knopp

April, 2011

MIT-Industrial Liaison Program - - Goal and Objective

- *The Industrial Liaison Program's job is to develop **mutually beneficial** relations between corporations and MIT.*
- *The Industrial Liaison Program's services are **customized** to meet a member firm's needs and objectives, providing direct access for the member's decision makers to MIT's technical, innovative and entrepreneurial faculty, students, and research centers.*

MIT ILP


MIT - a snap shot
Private research institution
10,200+ students (6000+ graduates, 4000+ undergraduates)
992 professors, 2800 full-time researchers, 2000+ administrative staff
5 schools (Engineering, Science, Management, Architecture & Planning, Humanities, Arts & Social Sciences)
60+ interdisciplinary research labs and centers
Operates Lincoln Lab - a US government laboratory
All fields of science/technology
FY 2011 budget - $2.38 billion
– MIT Campus - <$643 million/year in research (Industry $238.3M-19%)
– Lincoln Lab - additional $611.1 million/year - 99% federal government
MIT ILP
3


MIT "behind the scene/under the covers"
76 MIT-related Nobel Prize winners
– Including 9 current faculty members
Solving Real-World Problems - Economic Engine
– MIT researchers focus on discoveries of real practical impact, strong commercial value
– Vibrant patenting/licensing activity
• 530 new invention disclosures FY 2010
• $78.8 million total licensing revenue
• 184 patents filed, 57 licenses granted
– 2009 Kauffman Foundation Entrepreneurship Study
• 25,000+ companies founded by MIT alums
• 3.3+ million jobs
• $2 trillion in annual world sales
– 692 companies provided R&D/gift support in FY 2010
• 36 companies funded $1M+
• 145 companies funded $100K - $1M
• Research budget - <$1.25 billion
✓ MIT Campus - <$643 million/year in research (Industry $238.3M-19%)
✓ Lincoln Lab - additional $611.1 million/year - 99% federal government
Culture: interdisciplinary, entrepreneurial, motivated by unanswered questions
Encourages risk taking
MIT ILP
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Opportunities @MIT (examples)

- **Emerging Technologies**
  - Broad Institute for Genomic Research, Deshpande Center, Institute for Soldier Nanotechnology, AgeLab, houseN, Chemical Engineering, Biology, Chemistry, Material Science
- **Management, and Best Practices**
  - Sloan School of Management, Leaders for Global Operations, Center for Information Systems Research, Center for Digital Business, Operation Research Center, Entrepreneurship Center @Sloan
- **Transportation & Logistics**
  - Center for Transportation & Logistics, Intelligent Transportation Research Center (ITRC), Smart Cities Group, SENSEable City Laboratory, Transportation@MIT programs
- **Energy and Environment**
  - MIT Energy Initiative (MITEI), Gas Turbine Lab, Joint Program on the Science and Policy of Global Change, Ralph M. Parsons Laboratory for Water Resources and Hydrodynamics, Earth Systems Initiative, Center for Geochemical Analysis, Earth Resources Laboratory
- **Information & Communication Technologies**
  - Computer Science and Artificial Intelligence Laboratory (CSAIL), Laboratory for Information Decisions (LIDS), The Data Center, Media Lab, Center for Bits and Atoms, Center for Collective Intelligence, Research Laboratory of Electronics (RLE)

MIT ILP

Reasons for Industry to Come to Academia

- **Expose** management to leading-edge thinking, technology
- **Gain** insight from internationally-recognized experts
- **Strengthen** strategic decision-making:
  - development of new products and processes
  - implementation of innovative management practices
  - achievement of effective growth strategies
- **Leverage** academic research
- **Create** research synergies
- **Find** collaborators
- **Recruit** future company leaders

What is the Industrial Liaison Program?

- The ILP is industry's chief gateway and guide to MIT.

- Provides expert counsel on building productive partnerships
- Develops customized, cost effective programs
  - assess, address strategic research needs
  - facilitate faculty, researcher interactions
  - monitor emerging technologies and innovative management practices

MIT ILP

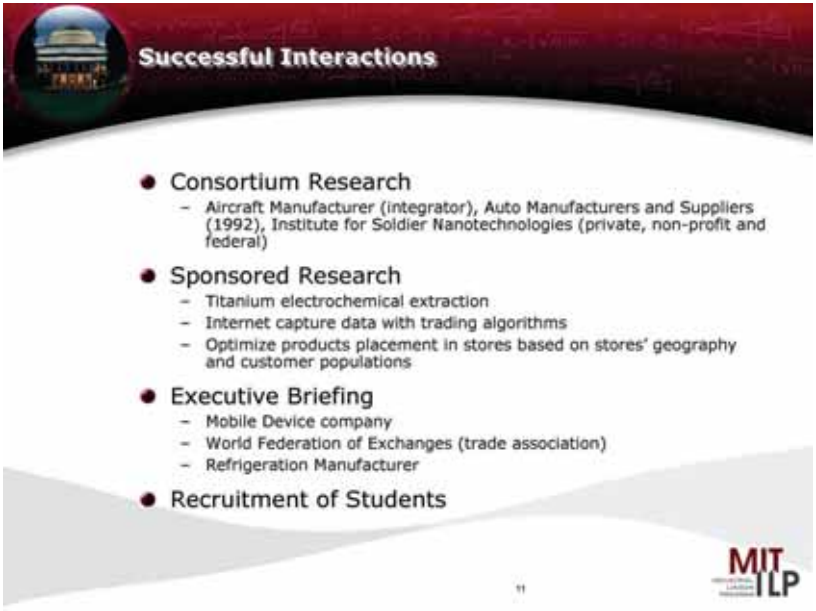
Industrial Liaison Program Facts

- Founded in 1948
- Worldwide industry membership (200+ members)
- Possesses a broad and diverse view of the entire campus
- Cultivates relationships with senior management, faculty and research center staffs on campus
- Pro-active with member's management and staffs
- Supports synergies and network activities between academia and industry
- Advocates for industry within MIT
- 35 staff - 18 Industrial Liaison Officers

MIT ILP


Services, Products and Deliverables
Industrial Liaison Officer (account manager)
On-campus sessions with faculty and research staff
Faculty visits to company sites
Executive research briefings
Customized research reports
Symposia and conferences
Members Only Web Site
News Mosaic
Content from Sloan Management Review and Technology Review
Recent developments within MIT's R&D community
Potential, competitive impact of emerging technologies
ILP insights on how best to access MIT expertise
Digitized content from past ILP events
ILP KnowledgeBase
MIT ILP


Benefits Companies Receive
Monitor emerging/disruptive technologies
Discover new technologies to strengthen existing businesses
Augment the firm's knowledge
Validate or invalidate key investment decisions/ new product development
Solve short term technical problems
Learn about - and exploit - new opportunities
Participate in new industry standards setting
Add to your network
Identify new industry partners
Use faculty for advice
MIT ILP


Successful Interactions
Consortium Research
Aircraft Manufacturer (integrator), Auto Manufacturers and Suppliers (1992), Institute for Soldier Nanotechnologies (private, non-profit and federal)
Sponsored Research
Titanium electrochemical extraction
Internet capture data with trading algorithms
Optimize products placement in stores based on stores' geography and customer populations
Executive Briefing
Mobile Device company
World Federation of Exchanges (trade association)
Refrigeration Manufacturer
Recruitment of Students
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Woodrow Wilson
International
Center
for Scholars
Brazil Institute