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RESEARCH PARKS AND JOB CREATION: INNOVATION THROUGH COOPERATION

HEARING

BEFORE THE

COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION UNITED STATES SENATE

ONE HUNDRED ELEVENTH CONGRESS

FIRST SESSION

DECEMBER 9, 2009

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SENATE COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION

ONE HUNDRED ELEVENTH CONGRESS

FIRST SESSION

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RESEARCH PARKS AND JOB CREATION: INNOVATION THROUGH COOPERATION

WEDNESDAY, DECEMBER 9, 2009

U.S. SENATE,
COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION,
Washington, DC.

The Committee met, pursuant to notice, at 2:34 p.m. in room SR–253, Russell Senate Office Building, Hon. Mark Pryor, presiding.

OPENING STATEMENT OF HON. MARK PRYOR, U.S. SENATOR FROM ARKANSAS

Senator PRYOR. Go ahead and call this meeting of the Commerce Committee to order.

Thank you all for being here; I know that we have several in the audience. And also my colleagues, thank you.

This is the hearing on Research Parks and Job Creation: Innovation Through Cooperation.

I want to first welcome the Assistant Secretary, John Fernandez, for being here today. Thank you for coming, and I'll give you a chance in a few moments to make your opening statement. I know we'll have some questions. And then, we also have a second panel.

The Nation is still experiencing an economic downturn. The national unemployment rate is right at about 10 percent. At a time when the economy has stalled and international competition is growing, we need to do everything we can to provide good-paying jobs for American workers. While fiscal and monetary policies provide dollars to bolster the economy, it is innovation of new ideas, products, and technologies that provides long-term growth.

During the last several years, the United States has undergone a dramatic transformation as the Nation moves to an economy driven by knowledge and technology. However, states and regions must still have a strong economic base that can support the creation of the next generation of manufacturing jobs.

Research parks are a typical public-private partnership that enables knowledge flow, often between parks—excuse me—park firms and universities, and contribute to regional economic growth and development. By providing a location in which researchers and companies can operate in very close proximity, research parks create an environment that fosters collaboration and innovation, leading to the commercialization of new products and technology. A lot of companies and products are spun out of these. And what they really do is, they institutionalize entrepreneurship, and they get good momentum going in certain areas with certain communities

and certain universities, and the successes just keep flowing from that.

Other nations view research parks as the catalyst for the development of innovative clusters that support rapid economic growth. One approach to creating regional innovation clusters is through the deliberate creation of research parks. Today, successful created innovation clusters, such as the Research Triangle Park, are being emulated around the world, often on a much larger scale. Many countries, such as China, Hong Kong, Singapore, India, Japan, and the European Union, are investing heavily in research parks to attract talented, educated workforce. America should, too.

Unfortunately, Federal programs to support research parks and regional innovation clusters have been lacking, but the trend is beginning to reverse itself. This Administration's FY–2010 budget requested $100 million for economic development administration to support a Regional Innovation Cluster and Business Incubator Program.

Now, I know that these work, because we have some firsthand experience in Arkansas, especially in Fayetteville, Arkansas, around the University of Arkansas. And that Arkansas Research and Technology Park has created 27 companies, 273 jobs, at an average salary of $72,000 per person. And they've done a lot of things that we can talk about there, but, really, if you look at the national studies, what's going on in Fayetteville, Arkansas, we're trying to duplicate in Jonesboro, Arkansas, and Little Rock, as well.

If you look at the national studies, you see that there's a lot of upside to this. For example, the typical North American research park is located in a suburban community with a population of less than 500,000. Most parks are operated by university or university-affiliated nonprofits. More than 300,000 workers in North America work in a university science park, and every job in a research park generates an average of 2.57 jobs in the economy. So, we need to continue this, and invest in this, and not fall behind the rest of the world, when it comes to these research parks.

But, again, I want to thank the Assistant Secretary for being here today. I look forward to hearing from you.

But, first, I want to ask Senator Johanns if you have an opening statement.

STATEMENT OF HON. MIKE JOHANNS, U.S. SENATOR FROM NEBRASKA

Senator JOHANNS. Well, Mr. Chairman, thank you.

Very briefly, I want to start out and just tell you how much I appreciate what you're doing here. This is something that we can really dig our teeth into and work together on a bipartisan basis.

There are so many good examples, around this country, of industry and universities developing very powerful partnerships. And through these partnerships, they pool their talents, their resources; they assemble that critical mass of expertise and training and basic research that results in that investment that you alluded to in the job creation. Not only is it a win-win for the direct participants, but the community wins, the economy wins, the state wins. And that's just good news, in the current economic environment.

I would be remiss if I just didn't mention a wonderful example of all this occurring back at the University of Nebraska. The university is in the process of constructing and developing what has been called the "Nebraska Innovation Campus." It's a public-private research campus. It's set on 250 acres that I believe will be an economic catalyst for our state. And it sits right on the edge of the downtown in Lincoln.

What you are trying to do here today could complement not only the efforts of those folks in my state, but other States, as well. The university and the community are really doing their best to accomplish several goals. They're reaching out, they're working with the community to foster innovation, expand economic growth, and create jobs. They're also putting their money where their efforts are; they're offering the expertise of their professors, and technical instructors to help drive R&D that supports economic development and also advances job training.

Well, I wanted to be here today to applaud this effort, but also to applaud your efforts. This really makes a lot of sense. I think it's going to get a lot of support. I think if we lay the proper groundwork, we've got a winner, here.

Thank you.

Senator PRYOR. Thank you.

Senator Nelson.

STATEMENT OF HON. BILL NELSON,
U.S. SENATOR FROM FLORIDA

Senator NELSON. Mr. Chairman, thank you for having this hearing. And, of course, it comes at an enormously important time. And this little agency is—just can be absolutely critical to helping out a number of areas.

Now, you particularly tied the—this hearing to the research parks. And when this agency has the premise of helping Federal economic development by promoting innovation and competitiveness, then it is exactly—when you tie it in with the research park, it just makes all the more to create private investment and to generate jobs.

I have had the privilege, Mr. Chairman, of talking to the Assistant Secretary before, because we—and I'm going to wait, because I want you to hear this particular part, because you're my chairman and I'm going to have to come to you, because we are about to experience some massive layoffs at the Kennedy Space Center. Here is some of the finest technical expertise in the world, and, through no fault of their own, NASA had dropped the ball in the last 10 years and doesn't have the new rocket developed in time for when the Space Shuttle is going to be shut down. And so, the Kennedy Space Center, being the launch center, doesn't have that business. But, they do have the beginning of a research park, called Exploration Park, that does a lot of stuff in life sciences right now. And you're going to have this wealth of talent, skilled labor, that needs to be employed.

And so, when we get around to the questions—and I've already talked to Mr. Fernandez about what could the EDA—and I think he's going to have some answers—help us with the situation where 7,000 people are going to be laid off. And you know how many fam-

ilies that affects. That ripple effect is three to one; that's 21,000 people, all within a confined geographical area.

And so, as we get into this, I want to look at the unique assets that the Kennedy Space Center has, and how that can be leveraged to increase the private-sector investment and attract jobs, in addition to what we already have going on there.

So, thank you, Mr. Chairman.

Senator PRYOR. Thank you.

Senator Warner, do you have an opening statement?

Senator WARNER. No, Mr. Chairman. Are we still on opening statements?

Senator PRYOR. We are.

Senator WARNER. Good. OK, I will——

STATEMENT OF HON. MARK R. WARNER, U.S. SENATOR FROM VIRGINIA

Senator WARNER. Thank you, Mr. Chairman.

And a real pleasure to see you again, Mr. Fernandez.

And I just want to make a couple quick comments.

One, I appreciate your service as mayor and as somebody who has been involved in the nitty-gritty of economic development, I just want to commend—I know you've got, in your written testimony—you cite some of the wonderful roles that research parks can play, particularly in rural communities, and I just wanted to point out two in my home State of Virginia, one being down in Danville, Virginia, Mr. Chairman, who is a part of our State that, not unlike part of Arkansas and part of Florida, that tobacco, textile, and furniture, where the long-term industries have been hard hit. We've got a very innovative collaboration between Virginia Tech and the community, with an advanced learning research institute, where we've actually taken some of the research components from the home-based Virginia Tech in Blacksburg, and moved them down to a rural community, where they have built a close to $20-million building—fully staffed up, at this point, about 20-odd start-ups in and around it. And I appreciate the fact that you recognize that. And on kind of a more expanded basis, back—again, citing Virginia Tech, which I think has got some of the best records of research facility—or research university trying to branch out around the state, where—and, again, in more rural Southwest Virginia, the corporate research park there has now expanded to over 400 companies that are actively engaged in collaboration with the university.

So, I do appreciate and concur with my colleague from Florida, Senator Nelson, that the real value of these research facilities and their economic development potential.

I also want to put a plug in for another issue that you and I have discussed, and as a—I've got a former mayor, to the right of me, who constantly reminds me of how much better mayors supposedly are than Governors. But, whether you're a mayor or a Governor——

Mr. FERNANDEZ. I'll stay out of that.

Senator WARNER.—you'll be——

[Laughter.].

Senator WARNER.—you know, one of the things that we have—we do a lot of in both of these positions is economic development.

Mr. FERNANDEZ. Yes.

Senator WARNER. And—whether it's a state or local economic development effort—and one of the things we've been working closely with you on in your department—and this is really to share with my colleagues—and we've got another Governor, a good friend, Governor Johanns—or Senator Johanns, behind—across the table—we've been working on developing legislation, in conjunction with EDA, that would say, "How do we supplement existing State and local economic development efforts for site location for those companies that—where the jobs might otherwise be going abroad?" So, we've got and America Recruits Act legislation, that we're looking at introducing shortly, that would add a—up to a $10,000 forgivable loan; basically a $5,000-per-year credit that would be—for 2 years—that would be forgiven, as long as the jobs actually stay in this location, that would supplement existing economic development efforts. Because, too often, you know, it's—our economic development is Virginia steals from Arkansas, and Arkansas steals from Florida, and vice versa. This would be an effort that would not allow to supplement those efforts, but it would be for those companies, particularly foreign companies and others, that are looking at investing in America.

I recall, a few years back, competing for a Dell plant that ended up—was looking at Korea, as well, where their national government was putting a lot of resources on the table. This is a small effort to add, at a national level, supplemental assistance to the kind of State and local economic development efforts, so that—again, not to compete between Nebraska and Virginia, but if we've got that German company that's looking at choosing Nebraska or Quebec, or that Indian company that might be talking about moving back some of those mid-tech jobs that went abroad, that, kind of, call-center-plus, where we weren't competitive a few years ago, but now, with broadband and—a lot of our rural communities are much more competitive—could be that supplemental assistance. It would be money that would only be spent if jobs were added to the marketplace. It would not require—it would be a—working through EDA—but it would not require massive new bureaucracy administration, because we've already got that in place at the local level or at the State level; it would be that add on. And for those jobs that otherwise might end up aboard, to try to make sure those jobs locate in this country. I think it would be a great value, and I'd welcome my colleagues' ideas and input on this legislation. We hope to be introducing it in a bipartisan fashion in the next few weeks.

And, again, I want to thank, particularly, Administrator Fernandez for his great effort in helping us get this program together.

Thank you, Mr. Chairman.

Senator PRYOR. Thank you.

Senator Begich.

STATEMENT OF HON. MARK BEGICH, U.S. SENATOR FROM ALASKA

Senator BEGICH. Thank you, Mr. Chairman. I'll be brief. I'm anxious for the Assistant Secretary to talk a little bit about how he sees this working.

I want to commend you, as mentioned earlier by several of our colleagues here, for your effort in bringing this forward. I think this timing couldn't have been better, in a lot of ways, as we struggle in figuring out how to move our economy forward with an over-10-percent unemployment rate, and working to figure out what's the right approach in engaging and partnering with entrepreneurs, small businesspeople, universities, and others, to find the best way to bring new jobs to the equation. But, also recognizing that, as we move forward, hopefully after the first year, on some new energy policy for our country—and energy technology is going to be huge in the future. It's big now, but I think the United States is losing its positioning in the global markets and the technology development, and I think this type of research-park job-creation idea may be able to, again, put us back in the forefront.

So, I thank the Chairman for bringing this forward. I'm looking forward to helping support in any way I can, and then also hearing from the Administration how we can—not only if successful—the Chairman is successful in bringing the bill forward to a positive conclusion, how we implement it on a rapid basis, because I think sometimes we get great legislation, but it sits idle in the bureaucracy and waits and waits, and before we know it, we're—you know, other countries are moving much more—I mean, they're just moving at a rapid pace. And we have—need to catch up, in some cases, and be the leaders. And, obviously, in my area, of energy for Alaska, you know, the scenario—we're losing ground in. And yet, we develop some of the greatest technologies, but other countries have moved much further than we are. So, I look forward to it.

Again, Mr. Chairman, thank you for bringing this idea forward and having this hearing today.

Thank you.

Senator PRYOR. Thank you.

I'm going to go ahead and introduce our first panel, our panel of one, and that would be Mr. John Fernandez. He's Assistant Secretary of Commerce for Economic Development and Administrator of the Economic Development Administration. Prior to his appointment, Mr. Fernandez led the New Development and Acquisition Team at First Capital Group, an Indiana-based real estate investment firm. And he has a long resume. I'm not going to read it all, but very accomplished, very diverse background. But, to Senator Begich's eternal glee, he is the former Mayor of Bloomington, Indiana.

So, welcome. Thank you.

STATEMENT OF HON. JOHN R. FERNANDEZ, ASSISTANT SECRETARY OF COMMERCE, ECONOMIC DEVELOPMENT ADMINISTRATION, U.S. DEPARTMENT OF COMMERCE

Mr. FERNANDEZ. Thank you, Chairman Pryor.

You've all been so kind, I'd, kind of, like to just quit while I'm ahead and say thank you, but——

Members of the Committee, I really do appreciate the opportunity to testify on behalf of the Economic Development Administration.

You know, our policy priorities are designed to encourage collaborative regional economic development. You know, you noted, at the beginning, the title included "cooperation," and I think that's an essential part of what we try to do at the local and State level as we work to promote competitiveness, innovation, cultivate entrepreneurship, and spur our economic development partners to take advantage of opportunities in a global marketplace.

The Obama Administration has developed a strategy to lay a new foundation for America's innovation economy, investing in American innovations, such as fundamental research, world-class workforce, our physical infrastructure, and information technology. These all comprise key elements of the President's strategy.

As the economy begins to stabilize, our focus shifts from rescue to recovery. And at EDA, our priorities will reflect our view that, moving forward, we need a new framework for sustained economic growth.

And this framework builds on two very important economic drivers, and that's innovation and regional strategies. Now, this new framework really helps build the 21st-century infrastructure, which includes science and technology parks.

Science and technology parks, when integrated into the region's innovation strategy, can help create the environment where America's world-class scientists can collaborate with entrepreneurs, they can commercialize technologies, create jobs and businesses that provide the products and services that are in demand in the global marketplace.

Science parks are seen by many as a very effective policy tool to realize larger, more visible returns on the Nation's investments in research and development. The intent of science parks is to encourage greater collaboration between our universities, private research labs, large and small companies, all in order to convert new ideas into innovative technologies for the market. They're widely used as a tool to encourage the formation of innovation, innovative high-tech companies, they generate employment and make existing companies more competitive through cooperative R&D, shared facilities, and all the benefits derived from colocation. These are important—an increasingly important tool for national and regional economic development.

As was mentioned by many of you, the investments in research parks are being launched all over the world. In many instances, our international competitors come to the United States, they visit the Research Triangle, they go to other places around the—our country, and they learn from us some of the best techniques for building these innovative economies, and then go back to their countries and invest very heavily in this same innovative approach to economic development. It's important, here, that we continue to sustain our efforts and investments in this proven methodology for innovative job creation.

The Surrey Research Park outside of London, for example, is currently a home of 110 tenant companies that help to support the tech transfer work from the University of Surrey and a wider

knowledge economy into their international commerce efforts. Now, the Surrey Research Park continues to contribute significantly to their regional economy, even during the global recession. These are important sources of income and employment for all of the southeast region. And this is just one of many international examples.

As was alluded to earlier, here in the United States there are many examples that EDA has helped fund. I won't go into all of them. And we're going to run short on time, so I'll be happy to, maybe, present some examples, if you need them, during the Q&A.

But, as was mentioned, as well, the 2010 budget for EDA includes additional funding to support regional innovation clusters, which are a part of this important innovation infrastructure.

I'm going to just wrap it up there, and, again, just thank the Chairman and the members of the Committee for inviting me here today, and I certainly look forward to any questions you might have.

Thank you.

[The prepared statement of Mr. Fernandez follows:]

PREPARED STATEMENT OF HON. JOHN R. FERNANDEZ, ASSISTANT SECRETARY OF COMMERCE, ECONOMIC DEVELOPMENT ADMINISTRATION, U.S. DEPARTMENT OF COMMERCE

Introduction

Chairman Rockefeller, Ranking Member Hutchison, and members of the Committee, thank you for this opportunity to testify on behalf of the Economic Development Administration (EDA). EDA's mission is to *lead the Federal economic development agenda by promoting innovation and competitiveness, preparing American regions for growth and success in the world-wide economy.* Through grants to local government entities and eligible non-profits to create jobs and generate private investment, EDA continues to seed our communities for success. Our investments create the conditions in which jobs are created, often in the midst of economic hardship or adjustment.

EDA's investments have two major goals: creating higher-skill, living-wage jobs and attracting private capital investment. EDA's achievements are a reflection of our policy priorities: to encourage collaborative regional economic development; to promote competitiveness and innovation; to cultivate entrepreneurship; and, to spur our economic development partners to take advantage of the opportunities of the global marketplace.

Obama Innovation Strategy

The Obama Administration has developed a strategy to lay the foundation for America's innovation economy of the future. The Office of Science and Technology Policy and National Economic Council's *A Strategy for American Innovation: Driving Toward Sustainable Growth and Quality Jobs* builds on well over $100 billion of American Recovery and Reinvestment Act (Recovery Act) funds that support innovation, education and infrastructure in the Recovery Act, the President's Budget, and novel regulatory and executive order initiatives. One of the key areas focuses on investing in American innovation, such as fundamental research, a world-class work force, physical infrastructure, and information technology.

EDA is working to sharpen our strategic priorities in order to better promote innovation and entrepreneurship while integrating economic growth, environmental sustainability and global competitiveness. One way in which we can achieve these priorities is greater support for science and technology parks, which I would like to address here today.

Science and technology parks provide the perfect environment for America's world-class scientists to collaborate with entrepreneurs to commercialize technologies and create the products and services that the global marketplace is demanding. Some might argue that in today's world, where advances in telecommunication have made it easier to share information and collaborate from dispersed locations, the need for science and technology parks is a thing of the past. However, ongoing economic research finds that commercialization and technology-based entrepreneurial activity continue to cluster near world-class scientific institutions where

scientific discoveries take place. U.S. universities provide the base for new industries and jobs of the future, but discoveries alone are not enough to form these industries. This is where science parks come in.

Specifically, these types of science parks are seen by many as an effective policy tool to realize larger and more visible returns on a nation's investments in research and development by bringing together established technology companies, technology incubators, and world-class universities. The intent of science parks is to encourage greater collaboration among universities, research laboratories, and large and small companies, in order to facilitate the conversion of new ideas into innovative technologies for the market. They are widely used as a tool to encourage the formation of innovative high-technology companies, generate employment, and make existing companies more competitive through cooperative R&D, shared facilities, and the benefits derived from co-location. Science Parks are a rapidly growing phenomenon and an increasingly common tool of national and regional economic development.

International Community

Many nations are currently adopting a variety of directed strategies to launch and support the development of science parks, often with significant financial commitments and policy support. To create a better understanding of the scope and scale of programs overseas to support the growth and development of science parks and to improve our understanding of the scale and contributions of parks in the U.S., the National Academies convened an international conference on global best practices in science parks. The resulting report captures the rich discussion of the diverse roles university and laboratory-based science parks play in national innovation systems. It was noted that in many cases, science parks are expected to generate benefits that go beyond regional development and job creation. Science parks are seen increasingly around the world as a means to create dynamic clusters that accelerate economic growth and international competitiveness.

In the European Union, science parks are supported through a variety of local, national and EU programs. There are many programs that support the individual companies located within the parks.

The Surrey Research Park outside of London is currently home to 110 tenant companies that help to support the technology transfer from the University of Surrey and wider knowledge economy into the international business world. The Research Park, developed by local and county planning authorities and the University, continues to contribute significantly to the regional economy, even during the recession, and is therefore an important source of income and employment for Surrey and the entire South East region.

In Daejeon, South Korea, the national government began construction of Daedeok Science Town in 1973, an immense science park that has evolved today into Daedeok Innopolis, a research and development district made up of more than 20 major research institutions and more than 40 corporate research centers. Over the last few years, a number of IT venture companies have sprung up in this region, which has a high concentration of Ph.Ds in the applied sciences and is famous for registering around 30,000 patents in Korea and abroad.

EDA Funded Projects

There are many examples of successful science parks across the nation, and EDA is proud to have played a role in their development.

- The Sandia Science and Technology Park in New Mexico, in which EDA has invested nearly $3 million, is an entire community dedicated to linking public sector research with private sector business opportunities. The park has 30 companies employing over 2,100 people in higher-skill, higher-wage jobs.
- EDA also invested $4.7 million in Recovery Act funds to support the development of the Arizona Bioscience Park in Tucson. The new biosciences park will provide a separate facility designed especially for companies working in biosciences, biotechnology, life sciences and pharmaceuticals. Its sophisticated, high-technology biosciences facilities will be integrated into a multi-use development, including a hotel and conference center, retail and residential development.
- Another example is the Virginia Tech University Institute for Advanced Learning and Research in Danville. Virginia Tech established a branch of the University in this very rural area near the North Carolina border. The regional economic impact of this science park may be felt well beyond the state line. EDA's University Center, Planning, and Public Works grants have supported this effort for its entire history. Most recently, EDA awarded $1.8 million for tech-

nology commercialization activities (focused on nanotechnology, polymer science, etc.).

The United States has made great progress in park creation and the generation of high-tech clusters, but we must continue to pursue public policies that encourage innovation and the commercialization of new technologies if we wish to remain a leader in high-tech industries.

As you know, the President's Fiscal Year 2010 Budget requests $50 million for EDA regional planning and matching grants to support the creation of regional innovation clusters that leverage regions' existing competitive strengths to boost job creation and economic growth. Science parks play an important role in this equation. The request would enable EDA to provide greater support for science and technology parks so that the United States can seed future science park successes similar to the past successes I have just discussed.

Conclusion

Chairman Rockefeller, Ranking Member, Hutchison, and members of the Committee, thank you for your time today and for inviting me to discuss what I consider to be a critical component of our Nation's economic recovery. Please note that this testimony does not address S. 583, which is pending before the Committee. Before the Committee considers that bill, I would appreciate the opportunity to share the Administration's views on it. Thank you. I look forward to answering any questions you may have.

Senator PRYOR. Thank you.

And what I'm going to do for my colleagues—I'm going to split my time here, I'm just going to ask one question, and then go around the horn here with my colleagues, and allow them to have their allotted time to ask questions.

But, the first question I have, just to lead us off here, is, How do you envision universities, research parks, business incubators, regional clusters all working together to make the U.S. more competitive and to stimulate the jobs that we need in this country?

Mr. FERNANDEZ. Well, thank you. I think the—you know, the question sort of frames the answer in a way that, hopefully, is understandable. But, you know, they have to work together. Investing in research parks or science parks—it's not the notion of a "field of dreams," that you just build a facility and everyone comes. It's really just part of that entire ecosystem that has to be created to support entrepreneurship and support innovative-led economic development.

In most instances, there is a strong public-private organization that brings together all those—the leadership from those key stakeholders, to ensure that there is a shared strategy, that every one is moving in the right direction, that we're leveraging the key competitive advantages of that region. But, it's through that kind of public-private partnership that develops the regional strategy that enables all of the stakeholders to work together in a very smart way.

Senator PRYOR. Thank you. And we may have some follow-ups on that.

Senator Johanns.

Senator JOHANNS. You mentioned, in your testimony, that you'd have some examples. I would like to hear about some of those examples. I'm especially interested in your opinion as to what they were doing right. What is the combination of things that make it work, if you will?

Mr. FERNANDEZ. Sure. You know, in Sandia Science and Tech Park in New Mexico, that's a park that has really supported a

broad public research institution and integrated it well into the private-sector companies. There are 30 companies there now, that employ over 2,100 people in very high-wage high-skilled jobs. Senator Warner mentioned the Virginia Tech example, in Danville. You know, there are others, but I think the key element—and that's why I say that, you know, the—this is an important part of the infrastructure, when it's embedded in a sound regional innovation strategy. And that way you bring into it not just the physical component, whether it's the real estate or a building, but you're pulling together venture capital, seed capital, you're building in technical assistance from serial entrepreneurs that can help creative people figure out the best way to move an idea into an actual business. It's the support of shared facilities, when appropriate, particularly in biotech. It's a combination of all these different elements that create the entire ecosystem that supports innovation economy.

Senator JOHANNS. From your perspective, give us some advice, in terms of what role we might play, here at the national level. You know, these are going to be driven at the State level, local level. They will be the main partner, if you will, the—kind of, the controlling-interest partner. But, what can we do? If you were to give us some advice, what are some key elements we should be focused on as we think about our role here?

Mr. FERNANDEZ. Well, I guess I would just go back to what was included in our current budget proposal, which—and so, my comments will be fairly limited to at least the EDA perspective on this.

I think what we have to do is introduce into the Federal discussion a strong sense of commitment to the notion of regional strategies. Many folks referred to the work in the EU and other parts of the world, and it's very focused on regional advantages. If you're a small business in—you know, pick your town—and you're trying to compete in a global marketplace, independently, that's a much steeper hill to climb than if you're embedded into a regional strategy where there are strength in numbers. So, I think keeping a focus on this idea of regional strategies is very important.

At the EDA, we're trying to, you know, focus the investments we have by using the regional strategies as a organizing principle for where our limited resources go into specific grant requests, because we know if it's tied to that regional strategy, there are so many more opportunities to leverage other State and local support, but also private-sector support, and really build on the competitive advantages of that area. So, I think the regional component is very important.

Senator JOHANNS. OK.

Thank you, Mr. Chairman.

Senator PRYOR. Thank you.

Senator Nelson.

Senator NELSON. Mr. Chairman, thank you again for your zeroing in on this subject of the research parks and EDA. And we're blessed to have quite a few research parks; right now, ten and another two that are coming online in Florida.

But, I want to confine my question to you about the EDA's role in helping out the folks that are going to be dislocated at the Kennedy Space Center, and the fact that we do have the beginning of this research park there that also augments the very significant re-

search park over at the University of Central Florida, in Orlando, this new research park at the Kennedy Space Center, called "Exploration Park." And given the fact that the new rocket is not going to be ready for another 6 years after the Space Shuttle is shut down, a decision that occurred as a result of budgetary decisions that occurred over the last decade, and now this dislocation of highly-talented, highly-skilled people, what are some of the things that you think that EDA might be able to do to help?

Mr. FERNANDEZ. Well, you know, I guess, fortunately and unfortunately, depending on how you look at it, EDA has, you know, a lot of experience in dealing with plant closings and BRAC changes. So, there's a wealth of experience, in terms of how to pull together some of the key institutions and develop renewed strategic plans.

You know, as recent as October, I know the people in our Atlanta regional office were having discussions with the Technological Research and Development Authority to look at potential proposal to expand the original incubator, which EDA actually helped fund, back in 2005. The Brevard Workforce Development Board, along with the TRDA, in June 2009, began a major study of some of the workforce issues around the NASA facility, and that was an EDA-funded study. So, that work has already begun, in terms of assessing some of the human capital and how to develop a longer-range strategy to, kind of, create the businesses and accelerate some of the job opportunities for the existing workforce.

You know, and it's kind of a—one of the points I wanted to mention, that I did not get out very clearly, in the context of the previous question, is that, you know, when we look at what makes a science or research park successful, another very critical piece of it is the workforce and building into the strategies, you know, the traction of the right kinds of entrepreneurial activities that feed into the existing workforce. So, that's clearly a very important ingredient, among these others, that make a successful research park environment.

Senator NELSON. Well, are there any particular things that come to mind, in the Kennedy Space Center's assets that could be leveraged to increase the private-sector jobs and to attract jobs?

Mr. FERNANDEZ. Well, clearly, there's an incredible amount of research talent and engineers and scientists. I won't pretend that I know the best roadmap today, in terms of how to connect all the dots that are part of that industry, but there have been, like I said, the—they are working together at the local level, already, to start identifying the most strategic way to leverage those assets.

Senator NELSON. If we just leave it up to those local institutions—and I've been involved in getting appropriations, in order to carry out what you said, with the TRDA and the Brevard Economic Workforce Board—but those are studies. And studies are one thing. Moving jobs is another thing entirely.

Mr. FERNANDEZ. Yes.

Senator NELSON. So, how do we get from a study over to the next thing?

Mr. FERNANDEZ. Well, I mean, the truth of the matter is, a lot of it really does depend on those local stakeholders. We can provide technical assistance. We can help identify and build strategies. But, ultimately, it is the private sector and the local players that have

to implement it. And so, hopefully, we can provide the—some of the resources to help build the plans. We can seed some of the investments, whether it's in additional workforce investments, whether it's in support of the research, or even into the infrastructure. But, you know, they have to fit into that local strategy if it's going to have traction that's sustained over the long haul. And we're—you know, I think we can build a toolkit that can help folks rebuild their, you know, new future, but the local actors ultimately have to be highly motivated and engaged to build that future.

Senator NELSON. And that seeding of the investment, seeding of the infrastructure; that would apply as well to the research parks.

Mr. FERNANDEZ. Absolutely. And, you know, we—at EDA, we certainly have funded quite a bit of infrastructure as part of research and science parks—incubators, graduation facilities, et cetera. And, you know, if we embed that into a well-developed regional strategy, it can be a great way to accelerate immediate job growth while also building the right foundation for more sustained effort.

Senator NELSON. Thanks.

Senator PRYOR. Senator Begich.

Senator BEGICH. Thank you very much.

I want to kind of stick on the bill, for a second, if I can, just, kind of, some technical comment or questions.

First, obviously you've read the legislation, gone through it, to some degree. What do you believe—do you think, first, that your department, with the current resources you have and the ones that may be allocated through this legislation, will be enough for you to have the expertise and be able to move requests through in a timely manner, and also set up the program?

Mr. FERNANDEZ. Yes——

Senator BEGICH. What do you think some of the challenges might be that we need to be aware of?

Mr. FERNANDEZ. Well, you know, to—I mean, candidly, the bill has not been fully vetted through the DOC and OMB structure, so it's a little difficult to get too technical at this point, but we certainly are prepared to do that as the bill moves forward.

I think the—in terms of the personnel, I'm confident that we have the expertise and the capacity to implement a program like this. And if the bill moved forward, we would certainly want to work with committee staff and others to develop the right kind of application mechanisms and metrics to make it a very strong program.

Senator BEGICH. Do you—in recognizing your statement that it hasn't gone through its whole process on your end of it, do you have any red flags that have popped up, just from the cursory review or discussion within your area? I understand there's more vetting to continue.

Mr. FERNANDEZ. Well, in a general way. The initial conversations I've had with Chairman Pryor have revolved around just ensuring that the—as part of the process—and I think it's something that can be dealt with in the context of developing the applications—it's to ensure that you really have that kind of strong public-private governance structure——

Senator BEGICH. Right.

Mr. FERNANDEZ.—so that if—you know, I mean, the private sector and the public sector are going to have slightly different objectives, in terms of how to look at investments in the science part. If it's a fully—if it's strictly a private-sector investment, their motivations might be a little different than if it's a broader regional public-private partnership. And I'm not saying that's a—you know, it's a better motivation, or a worse; it's just different.

Senator BEGICH. Just have different criteria, potentially, in the decision.

Mr. FERNANDEZ. Yes, in terms of——

Senator BEGICH. Yes.

Mr. FERNANDEZ.—timelines and motivations, in terms of how they define success. And—but, I think the important thing is to ensure that you have that broad governance structure of a public-private partnership that's looking at the entire regional strategy for innovation-led economic development, so that you've got the workforce folks involved, the research folks involved, the business community involved, so it's not just entirely focused on the real estate component, but the much broader regional strategy.

Senator BEGICH. Very good.

And if I can follow up, because the Chairman pointed out, and I appreciate that it—you know, I love mayors, and I think they know exactly what they're doing, and so, I appreciate—I had to do that for my Governor friend, next to me.

[Laughter.].

Senator BEGICH. But, knowing that—one of the things you mentioned to Senator Nelson's commentary and concern that he has, how does EDA engage in local community when they're trying to figure it all out, in the sense of a situation as he laid out. How—where does EDA play a role? When do they play a role?—I guess is the first point. And then, how do you see their role?

Mr. FERNANDEZ. Well, you know, EDA is administered through six regional offices, and we have economic development representatives assigned to various regions within regions. And so, their daily activities involve maintaining a strong network and ongoing communications with many of the people on the ground throughout the region, so that they—like in the case of—that Senator Nelson mentioned, I mean, those conversations about what to do when the program slows down, they start well before the program slows down, because they have that kind of on-the-ground intelligence. And in that context, there are lots of opportunities to provide consultation, to point folks in directions, not just in terms of the programs that EDA is engaged in, but the entire Federal Government. You know, we're pressing very hard—and I'm sure you've heard this before, but the Obama Administration is absolutely committed to blowing up silos and looking at these things much more from a place-based solution, not individual programmatic solutions, but how do we marshal the resources of all the relevant Federal agencies to come in and engage. And, you know, the people at EDA, in the regions, are professionals, understand the wide array of Federal programs that can be helpful.

So, we do that. We do some, you know, networking, matchmaking, seeding of strategic thinking, and try and support those projects on an ongoing basis. And in many cases, as was mentioned

with the incubator near the Kennedy Center, you know, we did the initial investment 5 years ago, but once an investment's made, we don't—usually that relationship doesn't stop. There's ongoing communication, and we look for other opportunities to leverage investments.

Senator BEGICH. Very good. Thank you. My time has expired, but thank you very much.

Mr. FERNANDEZ. Thank you.

Senator PRYOR. Thank you.

Senator Warner.

Senator WARNER. Thank you, Mr. Chairman.

I just want to make one comment and one very brief question.

The comment is just that I'm very supportive of your effort, in terms of these innovation centers and research capabilities, and commend, again, Administrator Fernandez for some of the efforts that EDA has taken in my State, in Virginia.

But, you know, one question I'd love us to think about—I'm not sure this is the right forum, and I'm not going to put the Administrator on—but, you know, I used to be in the venture capital business for years, and be one of those folks who tried to help fund those innovations as they came out of those research parks, through that valley of challenge or death, 'til they get to the point where they're sustainable and, you know, one thing, as an overall system, we've seen in the last decade, I believe, is an enormous migration that is already in the tax code, but it seems to have been expanded, of debt over equity. And, you know, why would anybody go innovate anymore? Why would anybody go and be an entrepreneur and—if you can go create some financial engineering instrument on Wall Street? And I've nothing against Wall Street, but—you know, but if—you can supposedly get much better guaranteed returns, supposedly with no risk—and how we rebalance our financial system to give a little more—to take away some of the preference of overleveraged debt to equity. We're going to need more equity. As much as EDA can do, we're going to still need people that will then be willing to go be innovators, go be entrepreneurs. And then having a path to success that existed in the 1970s, 1980s, and 1990s, and, I think, unfortunately has—if we look around our country, in the last decade, has not been as prevalent as—and in—both from the kind of quality of talent becoming entrepreneurs and, kind of, the system and where the financing has gone. I—just a comment.

And my quick question is, I would love for you to take a moment—and I know this is more about the Chairman's bill and innovation centers—but, if you wouldn't mind taking a moment and commenting on the initiative we've been working on, in terms of having this site location initiative, to try to support—particularly bring offshore jobs back into America, that can supplement local economic development efforts. I'd appreciate any comments on that.

Mr. FERNANDEZ. Thank you, Senator Warner.

The offshoring concept, I think—you know, I guess one of the things that strikes me about it is that, not only is it a mechanism to potentially bring back that sector of employment to the United States, but bring it back into some of the most highly targeted areas, in terms of distress. So, it could be a very meaningful way

to leverage the competitive advantages of some of these rural areas while also supporting the broader national agenda, in terms of bringing those kinds of jobs back to the United States.

We've not delved deeply into the vetting process on that particular bill, as well. So, I think I probably need to leave my comments there. But, we certainly look forward to continuing the conversation.

Senator WARNER. Look forward to working with you.

Thank you, Mr. Chairman.

Senator PRYOR. Thank you.

Senator LeMieux.

STATEMENT OF HON. GEORGE S. LEMIEUX, U.S. SENATOR FROM FLORIDA

Senator LEMIEUX. Thank you, Mr. Chairman, and thank you for holding this meeting today and focusing on this important issue.

Administrator, I want to follow up on something that Senator Warner just mentioned, this death valley issue, where entrepreneurs—you have scientists at the bench coming up with a good idea, but the venture capitalists want to see a prototype, and that middle section there, where good ideas go to die. We need funding for those matters. I just had, recently, some folks in my office affiliated with the life sciences industry—which I'll also throw a question to you about in a minute—and University of Florida, which does very good at tech transfer in Florida—and they tell us that, "If we could just get some more funding in that middle area, that we could bring so many more inventions and so many more jobs to our State." And I wonder if the administration has a theory about that. Is that a ripe area for us to be focusing on?

Mr. FERNANDEZ. Yes, absolutely. You know, within the EDA, we don't directly engage in direct investment in private companies. We've supported revolving loan funds that have the potential to serve that purpose. There are certainly other parts of the Federal Government that are focused on this very clearly. I mean, the SBA has had a number of discussions about how to accelerate access to capital. Our Secretary of Commerce has, you know, launched his Office of Innovation and Entrepreneurship. These are all very front-burner issues for the administration, although it's outside the focus of the EDA.

Senator LEMIEUX. Right. I am following up on your thread of eliminating silos and having everyone work together. I hope that that's something that you can bring back, because it is a frustration. We—folks are having a frustration with the SBA. I'm not casting aspersion as to which administration, but it just doesn't seem like it's working as quickly as it could have. And to the extent that you can bring that message back, I would appreciate it.

Mr. FERNANDEZ. Will do.

Senator LEMIEUX. I also want to speak to you—Senator Nelson spoke a lot about the space industry and concerns there—I want to talk to you about the life sciences industry in Florida, and research parks. We are very fortunate that Florida is becoming an emergent life science power, a bioscience power. But, the challenge that we have—and this goes to your idea of a regional strategy, and maybe you could just give us some advice for Florida—is that

these life science centers are spread out all through—across the state. And I've talked to venture capitalists—it's something I focused on even before my time in the Senate—and they're challenged, in Florida. They're challenged by trying to get around the state. We're a big state. We're geographically disparate. It's hard to get from one place to the other. We've got University of South Florida doing life science, we have University of Florida, we have Burnham in Orlando, we have Torrey Pines, we have Scripps, Max Planck, down in Palm Beach County, and the University of Miami. These are tough places to try to find your way around, as opposed to other places in the country, where you can do some one-stop shopping.

What advice do you have for emerging industries in different states, trying to focus on particular areas of the market, about how they can work together to establish these clusters? Because I think our challenge down in Florida is that if you put all of these locations together, we'd be a super powerhouse. It'd be a life sciences Silicon Valley. But the fact that they're disparate makes it challenging.

Mr. FERNANDEZ. Yes, and I think—you know, part of that is developing this—if you will, a public-private partnership that serves as an umbrella organization that facilitates the cooperation and integration as strategy among those various regions or parts of your state. You know, we provide, and can provide, a lot of the technical assistance to facilitate those conversations. That's what we're seeing work elsewhere. And there's no magic bullet here. But, if you can get all the right people at the table to start addressing those issues and looking at how they can work in a collaborative way, they can identify who's doing what and where they can work together and not compete against each other in certain ways, I think you make tremendous progress.

I mean, not all—you know, there's an opportunity to do some of these things virtually, as well, as we've seen with some other examples—the folks who are up in Cleveland, with JumpStart, very successful organization that's really designed to bring together venture capital as well as the innovators, to accelerate job creation. They've done a phenomenal job of bridging geography and using, you know, some virtual mechanisms, as well.

But, I think, at the end of the day, the most important thing is to get people together and start building those strategies among the various stakeholders.

Senator LEMIEUX. I appreciate your answers.

Thank you, Mr. Chairman.

Senator PRYOR. Thank you.

Senator Udall.

STATEMENT OF HON. TOM UDALL,
U.S. SENATOR FROM NEW MEXICO

Senator UDALL. Thank you, Chairman Pryor.

And let me, at the beginning, just ask to put my statement in the record, and then get directly to——

Senator PRYOR. Without objection, thank you.

Senator UDALL.—questions—questioning, here.

[The prepared statement of Senator Udall follows:]

PREPARED STATEMENT OF HON. TOM UDALL, U.S. SENATOR FROM NEW MEXICO

I want to thank Chairman Pryor for holding this hearing today and for his leadership in promoting innovation and job growth through stronger science parks.

Senator Pryor's bill to promote science parks, the "Building a Stronger America Act," would help research parks across America by providing grants and loan guarantees. These are appropriate investments to spur innovation and promote technology transfer.

New Mexico is home to five science parks that employ more than 4,200 people. I am proud that Sandia Science and Technology Park, located in Albuquerque, was recognized by the Association of University Research Parks (AURP) as the Nation's "Outstanding Research Park of the Year" in 2008.

Sandia Science and Technology Park helps private firms commercialize technology developed at nearby Sandia National Lab. This science park helps almost 30 firms that employ over 2100 workers at the science park.

In addition, the Sandia science park has indirectly created over 5,000 jobs. These are very good jobs, too. The average wage at this science park is about $70,000 a year, which is almost twice the average wage for the surrounding region.

This is just one example of how research parks in New Mexico and across the country help create good jobs and fuel American economic growth.

However, there are many challenges to building successful "innovation clusters" or regional hubs for high technology or other strategic sectors. Not every science park has been as successful as those hubs at Stanford in Silicon Valley or the Research Triangle in North Carolina. America also faces stiff competition from other countries that are eager to create innovation clusters of their own.

So, I look forward to hearing from Assistant Secretary John Fernandez and all our witnesses today about what policies will best assist science parks and spur economic growth in all areas of the country.

Senator UDALL. And thank you for holding this hearing. A very important subject, science parks, and I'm glad you've focused in on this. And I also think, Mr. Chairman, you have a very good bill—S. 583, Building a Stronger America Act—and I'd like to be included as a co-sponsor on your bill, because I think——

Senator PRYOR. OK. We'll take care of that.

Senator UDALL.—it's a fine piece of work.

Senator PRYOR. Thank you.

Senator UDALL. The—your testimony, Assistant Secretary Fernandez, on science parks, talked about the Sandia Science and Technology Park. And you're probably aware, they just received an outstanding award, called the "Outstanding Research Park of the Year," which I'm very proud of. Sandia is in Albuquerque, New Mexico. And it's one of these quality institutions that's always out there on the cutting edge.

And I'm wondering—you know, your testimony cites that the EDA has invested $3 million to support this leading science park, which, last year, this award was given to—and I'm wondering how that compares. You know, when we talk about Europeans and other countries investing, how much are they investing? What are the comparative numbers there, and what do they tell us?

Mr. FERNANDEZ. Well, you know, I can't tell you that. But, I know that there are several gentlemen, behind me, who are coming up here, who have some very detailed numbers on that, from what I would suspect.

But, the interesting thing about what—at least in part what I'm hearing, is that while there's a very—I guess—I can't talk about the numbers, specifically, but I can talk about the policy framework. And relative to the United States, at least in the European community, I mean, you have, you know, Cabinet-level, regional policymakers. And they look at things in that kind of regional no-

tion, which is a big difference from the way we are organized here. So, there's a focus that's different.

In terms of the specific investments, again I'd have to get back to you on that, Senator. But, I suspect that one of the folks behind me has got that in their testimony.

Senator UDALL. OK. Well, the—and I'm sure they do. I—and the comparison, I think, is that China and Hong Kong and France and others—and we're going to probably hear from them—are investing a lot more. And I think that says a lot about where we should be heading.

One of the important things that we try to do in New Mexico, and push Sandia National Laboratory in this area, is the area of technology transfer. So, you're taking research institutions and trying to—such as the national labs, and then trying to get that technology out in the community. And I'm wondering what else the EDA can do to promote science parks as incubators and engines for economic growth and job creation in regions across the country, and especially promoting technology transfer and commercialization.

Mr. FERNANDEZ. Well, again, Senator, I think we're—the role we try and play is to, at the front end, ensure that—either through a process that we fund or just in recognition of processes that have already happened, ensure that there's a really well-grounded strategy in place to leverage the investment. And, as I had mentioned before, it's not a "field of dreams" kind of approach to economic development; you have to have the other complementary activities and investments in place so that those facilities really do produce the kind of job creation that you need.

So, I mean, if the strategy's there, we can build on it. If it's not, we can help provide technical assistance to build a strategy. And then, where necessary, get in and actually invest specifically in the facility.

I'll just make one other comment, if I could. And, you know, the—Senator Warner was talking about, sort of, the differences, in terms of how our economy is changing, and one of the big differences is that many of our large companies, you know, aren't building the massive R&D labs within their own facilities anymore. And they're relying heavily on small entrepreneurial scientists who are developing some of the base research and early commercialization activities. And then, as those products or those ideas move forward, they acquire and bring them into the fold for, you know, further development and distribution. In the context of that kind of business model, investing in science parks, investing in wetlabs, investing in incubators, graduation facilities, that's all very critical infrastructure for the 21st century economy. And that's why I think the science parks and other kind of work we're doing with incubators and graduation facilities is absolutely essential.

Senator UDALL. Thank you very much.

Thank you, Mr. Chairman. I yield back.

Senator PRYOR. Thank you.

Senator Klobuchar.

STATEMENT OF HON. AMY KLOBUCHAR, U.S. SENATOR FROM MINNESOTA

Senator KLOBUCHAR. Thank you very much. And thank you, Senator Pryor, for holding this important hearing. I know you've been long advocating for this important subject, and trying to get more research parks out there.

As Chair of the Competitive Innovation and Export Promotion Subcommittee, I've traveled all around my State to try to figure out how can we increase jobs and, particularly, high-end jobs. And one of the things I've really settled upon is this export market, and with the weak dollar and the possibilities there. But, the only way we're going to get that export market going is not just to have the available resources so small and medium-sized businesses can access these, but it is also to have the products and the development and the things that we need to get there. And I come from a State that produced everything from the Post-it note to the pacemaker. So, we truly believe in science and research and technology, with Medtronic's pacemaker starting out in a garage and growing into a worldwide global company. And a lot of that was, you know, risks and taking the risk of doing research and putting the money into it. So, I want to thank you for this.

I guess my question here, Mr. Fernandez, is, first of all, To what extent do you think that, when you look back—and we used to have those AT&T, General Electric, IBM labs, during the heyday of the beginnings of research in this country—to what extent can research parks or other regional tech collaborations pick up where those industrial labs left off?

Mr. FERNANDEZ. Well, as I mentioned, I think that's a very important part of the new, kind of, business model, is to provide those facilities, to invest in those facilities where there's some shared risk up front, and bring down the cost, in some cases, for entrepreneurs. You know, particularly with the wetlabs and some of those kinds of facilities, it's very difficult to go out and get financing, to—if you wanted to build those new ideas within your own, you know, facility, as an entrepreneur, it can be extremely difficult to get financing to do.

Senator KLOBUCHAR. Right. You know——

Mr. FERNANDEZ. And so——

Senator KLOBUCHAR.—so I heard some of my colleagues mention, obviously, other countries—China and Japan and what they've done. Do you think that they're doing better than we do, in terms of developing research capabilities? What can we learn from them? Are we falling behind?

Mr. FERNANDEZ. I think that, you know, America's position to continue to be a strong leader in innovation—we—you know, many of the investments that are made abroad are built on the models we created. And we've not lost the leadership, but it's threatened. And it's important that we ramp up our commitment and investment now, to maintain that leadership.

Senator KLOBUCHAR. A recent National Research Council Report found that soft infrastructure, the human capital that encourages networking and entrepreneurship, is often as important as physical facilities in ensuring success, especially in today's economy. How do

we encourage and maintain those important relationships as we look at these research parks?

Mr. FERNANDEZ. I'm glad you raised that question, Senator, because that's often underappreciated, and that's clearly a place where EDA can play very effectively, in terms of investing in that soft infrastructure. And that's—you know, part of my job, I think, is to try and help broaden the definition of "infrastructure," particularly infrastructure in the context of an innovation economy. And that soft infrastructure—you know, seeding those public-private partnerships, helping to build that structure in place that ensures effective collaboration and cooperation and networking—that's very important infrastructure. And in many cases, especially with the regional strategies, you start bridging across all kinds of various jurisdictional lines within a State, across State borders. It's very difficult to find folks willing to finance those kinds of soft infrastructure investments. And that's certainly an area where EDA can play a very important role. And that's why we're trying to organize our entire framework for sustained economic development around these regional strategies for innovation.

Senator KLOBUCHAR. Now, one last question. A Minnesota private developer is working to launch a biomedical-oriented research park outside of Rochester—obviously, the home of the Mayo Clinic—it's in Pine Island, Minnesota—with the goal of recruiting researchers from the University of Minnesota, as well as Mayo Clinic and other Minnesota biotech companies and medical device manufacturers. What role do you see private developers would have in the construction and promotion of research parks? In other words, if private developers build these parks, will they come?

Mr. FERNANDEZ. I guess, depending on—well, I—I guess it depends. You know, if they have a big enough balance sheet and they're going to seed research and VC-type activities to other companies, I think they would come. But, I think, again, any—whether it's a publicly-funded research park or a private research park, if it's going to have sustained success, there needs to be a network of other kinds of stakeholders that are integrated into their strategy, from workforce, especially, to higher ed, to community colleges, the business community, the VC community, and others.

So, I think a private research park definitely can be very successful, but I think it still has to have all those essential ingredients that bring the stakeholders from the region into play.

Senator KLOBUCHAR. Thank you very much.

Senator PRYOR. Thank you.

I want—Secretary Fernandez, thank you for being here.

Mr. FERNANDEZ. Thank you.

Senator PRYOR. You've been great. I really appreciate your time and your willingness to be here and change your schedule for us. Thank you very, very much.

I'm going to go ahead and introduce the second panel now. And what I thought I would do is go ahead and do the introductions of the individuals on the second panel, as we—as I do the introductions so that—I mean, as they take their seats, so that we can do both at once, and save everyone a little time here.

Let me start by saying that I would very much appreciate everyone keeping their opening statements to 5 minutes, if possible. That helps speed things along.

The first witness we have on the panel is going to be Dr. Charles Wessner. He's Director of the Program in Technology Innovation and Entrepreneurship at the National Research Council of the National Academies. He is recognized nationally and internationally for his expertise on innovation policy, including public-private partnerships, entrepreneurships, early stage financing for new firms, and the special needs and benefits of high-technology industry.

Second, we have Mr. Brian Darmody. He is the Associate Vice President of Research and Economic Development at the University of Maryland and President of the Association of University Research Parks. He's the principal author of "The Power of Place," a national policy document focused on technology-led economic development, and serves as co-principal investigator on the $3.5-million Proof of Concept Alliances, a Department of Defense-funded commercialization project.

Next, we have Mr. Jonathan Sallet. He's the Managing Director of The Glover Park Group, but is testifying in his capacity as co-author of "The Geography of Innovation: The Federal Government and the Growth of Regional Innovation Clusters," published by *Science Progress* at the Center for American Progress. And as I understand it, he also used to be a big celebrity on the Brown campus radio station.

Mr. SALLET. It's a long time ago.

Senator PRYOR. And last, but certainly not least, we have Dr. Anthony Townsend. He's a Research Director for the Institute of the Future. His work focuses on several interrelated topics: mobility and urbanization, innovation, science and technology parks, and economic development.

So, I want to thank everyone for being here. And I would ask you to keep your opening statements to 5 minutes, if possible.

Dr. Wessner, would you start for us? Thank you.

STATEMENT OF CHARLES W. WESSNER, PH.D., DIRECTOR, TECHNOLOGY, INNOVATION, AND ENTREPRENEURSHIP, BOARD ON SCIENCE, TECHNOLOGY, AND ECONOMIC POLICY, NATIONAL RESEARCH COUNCIL, THE NATIONAL ACADEMIES

Dr. WESSNER. Thank you very much.

Please let me know if the audio is not what you need.

The—I thank you for the honor of being able to speak before you today. As mentioned, I direct a program on technology, innovation, and entrepreneurship.

At the National Academies, we've recognized the importance of targeted government promotional policies for innovation around the world. And, consequently, we have been studying foreign innovation programs, and comparing them to U.S. programs.

Only too often in this town, strangely enough, we talk about the global economy, and then we reason, in completely local, often inside-the-Beltway, terms. And I think it's important, as a last resort, to do what we would do with any good football team, and that is, look at what the opposition is doing. And that is, in essence,

what we've been focused on in our program on comparative national innovation policies.

One of the basic findings we have is that there is an enormous growth in locational competition. We have jobs, we have technologies, we have industries, and the rest of the world—our friends and competitors—are willing to take them from us. And if we don't work to avoid that, that is exactly what will happen.

Countries as diverse as China, Singapore, France, and Mexico are undertaking very substantial national efforts to develop research parks of significant scale and significant scientific and innovative potential. One of the Senators, Senator Udall, just a few minutes ago, asked about the levels of investment, and was there more overseas. I think the short answer would be that where we invest millions, our colleagues are investing billions. We'll have to decide how that comes out in—over time.

But, the—China, in particular, is a leading practitioner of research-park strategy for economic and regional development. They have made enormous investments in order to grow and become internationally competitive.

If possible, I'd just like to bring to your attention—the scale there is really significant. On the green side, that's one park; that's 54 parks. We, on the other hand, have one park that approaches that size. So, I just assume that we're 50 times smarter than our Chinese friends, or we're being out-invested very substantially. The park, where you can barely see it, is the average size of most American parks.

Now, that doesn't mean—I don't mean to imply that we should invest exactly the way our Chinese colleagues are investing. But, when you take, for example, the Zhong Guan Cun science park outside of Beijing, there are some 20,000 enterprises, with nearly a million employees. The park has attracted almost 10,000 "sea turtles." These are people who have worked in the United States or elsewhere in the world, who are first-quality researchers, administrators and managers.

The contribution of parks, I think you understand. Whether it's Dr. Dan Mote, the President of the University of Maryland, who emphasizes the key role that it helps the university to reach beyond its walls and help develop the region, or President Barker of Clemson University, came to see us, as part of this conference that is captured in this volume here, where the Clemson University ICAR technology park has been instrumental in attracting—in helping to keep technologically advanced manufacturing in the United States.

Interesting enough, the National Cancer Institute has been working on a park in Fredericksburg. We provided guidance, early on, for this very successful Sandia park. Also, for a park that hasn't been mentioned yet today, the NASA Ames park, where there were wide-scale predictions that that would never work. It has been a massive success.

I'm always amused when people say that only losers place themselves in science parks. I'm not sure that Google and HP would be included in that category. They're both there.

The U.S., in short, has led the way in park creation and generation of high-tech clusters. As is often the case, we have not followed

up on that success. But, a message of hope that I would bring you is that, in the past when we got things wrong, we redoubled our efforts, as in the semiconductor industry, where we set up SEMATECH to emulate the effects of the koretsus in the 1980s. Others have imitated us since then, on a massive scale.

And I want to stress that we don't need to do exactly what our competitors are doing, but we do need to recognize the scale, the focus, the commitment, and the massive investments that are being made. And the question is, What can we do? And I'd be happy to discuss more about that in the discussion.

But, just in closing, I would like to commend this volume, which captures what much of the rest of the world is doing, and I would also like to extend a small thanks to my colleagues—who is here today, Dr. Sujai Shivakumar, behind me, who also played an instrumental role in developing this volume.

Thank you, sir.

[The prepared statement of Dr. Wessner follows:]

PREPARED STATEMENT OF CHARLES W. WESSNER, PH.D., DIRECTOR, TECHNOLOGY, INNOVATION, AND ENTREPRENEURSHIP, BOARD ON SCIENCE, TECHNOLOGY, AND ECONOMIC POLICY, NATIONAL RESEARCH COUNCIL, THE NATIONAL ACADEMIES

Good afternoon, Mr. Chairman and members of the Committee. My name is Charles Wessner. I direct the program on Technology, Innovation, and Entrepreneurship at the National Research Council's Board on Science, Technology, and Economic Policy. The Research Council is the operating arm of the National Academy of Sciences, National Academy of Engineering, and the Institute of Medicine of the National Academies, chartered by Congress in 1863 to advise the government on matters of science and technology.

Recognizing the importance of targeted government promotional polices relative to innovation, the National Academies Board on Science, Technology, and Economic Policy is studying selected foreign innovation programs and comparing them with major U.S. programs. My statement today captures the insights and observations made by leading national and international experts during a high-level conference at the National Academies that focused on best practices among science and technology research parks around the world.

The Growth of Locational Competition

There is an intense and growing competition among nations and regions of the world for economic activity that creates high-value jobs and improves living standards

- Research parks are seen increasingly as a means to create dynamic clusters that accelerate economic growth and international competitiveness.
- Today, countries as diverse as China, Singapore, France, and Mexico are among those undertaking substantial national efforts to develop research parks of significant scale and scientific and innovative potential.

China is a leading practitioner of the research parks strategy for economic and regional development.

- China's large science and technology industrial parks symbolize that nation's strong determination to grow and become internationally competitive through significant national and regional investments in science-based economic development.

Both the absolute number and scale of Chinese research parks are remarkable.

- China's 54 state-level science and technology industrial parks are designed to help develop the industrial base for advanced, high-growth industries in electronics and information technology, new materials, renewable energy, and biomedicine.
- The average major science park in China is over 10 million acres. By comparison, the average American research park is 358 thousand acres. Research Triangle Park, one of our largest, is 7 million acres in size.

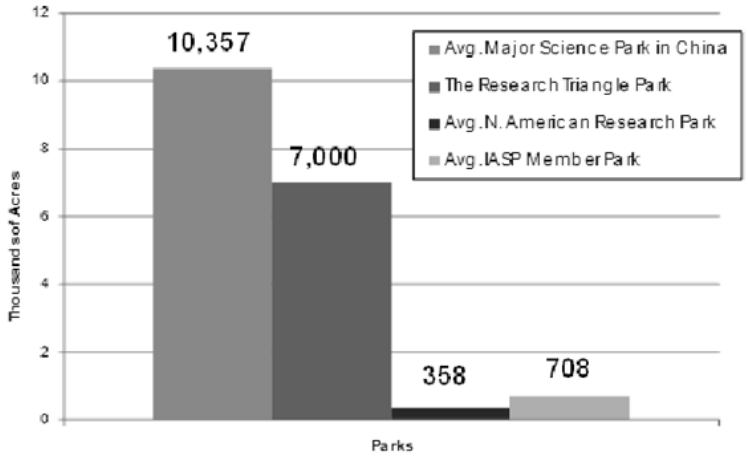

Figure 1: Research Parks in Comparative Perspective—an Issue of Scale [1]

The growth of *Zhang Jiang High Tech Park (ZHT)* near Shanghai is illustrative.

- Beginning almost from a clean slate, Chinese authorities encouraged more than 30 research institutions to team up with R&D centers of multinationals to anchor the park site. Some 200 small and medium sized Chinese high-tech companies have joined these large research centers.
- Outside the park, the Shanghai Jiao Tang University and Fudan University contribute to the park's 8,600 strong workforce of scientists and researchers
- The park also benefits from national polices to attract Chinese overseas scientists back home with low rent, tax breaks, and assistance with living needs. There were over 250 such "sea turtles" in 2004 alone.
- The Chinese government is also a major financial supporter for biotechnology companies in ZHT Tech Park. This includes:
  - Grants from the National Technology Innovation Fund for SMEs.
  - The establishment of the Shanghai Pudong New Area Venture Fund to attract additional venture capital. In 2006, this amounted to more than $2.5 billion in venture funding for the ZHT Tech Park.

The *Zhong Guan Cun Science Park in Beijing* is another example of the scale of Chinese efforts.

- The park hosts over 20,000 enterprises and 950,000 employees, receiving total income of 850 billion Yuan (about US$ 124 billion). More than 800 enterprises among these each earn $15 million or more in revenue.
- The park has attracted almost 10,000 "sea turtles," who have set up 4,200 companies in Zhong-guan-cun Science Park.

To the extent that they are effective in achieving their goals, these large-scale, well-funded research parks have the potential to enhance China's capabilities in leading technological sectors

The Contribution of Research Parks

Research parks are widely seen, both in the United States and abroad, as an effective pubic-private partnership tool to increase the return on a nation's investment in research and development.

[1] "Average North American Research Park" data are from "Characteristics and Trends in North American Research Parks: 21st Century Directions," commissioned by AURP and prepared by Battelle, October 2007; "Average IASP Member Park" data are from the International Association of Science Parks annual survey, published in the 2005–2006 International Association of Science Parks directory.

- According to Dr. Dan Mote, President of the University of Maryland, research parks can play a key role in helping the university reach beyond its walls and help develop regional innovation clusters.
- Similarly, President Barker of Clemson University sees research parks as playing a key role in promoting university-industry collaborations. He cites the Clemson University-International Center for Automotive Research (CU-ICAR) as a positive example of how such collaborations can help support technologically advanced manufacturing in the United States.
- Interestingly, leaders of national laboratories, such as Sandia, NASA-Ames and the National Cancer Institute, have all found that research parks are an important tool for advancing their missions by building and maintaining ties to the private sector, generating greater returns on existing Federal facilities and capabilities, and helping to grow the local economy with well-paid jobs.

By advancing the research and commercialization missions of universities and national laboratories, research parks often serve as catalysts for the development of innovative clusters.

- The co-location of creative activity within the concentrated geographical area of a research park can help transfer of new ideas from universities and national laboratories to the marketplace.

Research Parks in the United States

The United States has led the way in park creation and the generation of high-tech clusters.

- In the United States, innovative clusters and parks have developed as a result of government action and private initiatives, and in some cases around government-funded laboratories.
- One example is the high-technology industries that emerged and grew around the government laboratories and major universities in the Boston area.
- In the case of Silicon Valley, multiple private industries interacting with a major university, and irrigated with substantial and sustained Federal funding, created powerful developmental synergies.
- A third approach to the development of innovation clusters is through the deliberate creation of research parks, such as North Carolina's Research Triangle Park, begun nearly sixty years ago, or the Sandia Research Park created in 1999.

Despite our early leadership, the United States is not making comparable efforts, nor are Federal programs supporting regional and state efforts to the same degree.

- Investments by the world's leading nations in research parks reflect an appreciation of their capacity to spur knowledge-based growth and a national commitment to enhance technological competitiveness through innovation.
- While research parks such as those at NASA Ames and Sandia have recorded significant progress, and new Federal initiatives such as that of the National Cancer Institute are underway, the potential of research parks appears to be less appreciated by policymakers and the public in the United States.

In the United States, support for research parks is principally undertaken by state and local governments with limited support by the Federal Government.

- Given the limited scale of these efforts, some believe that the U.S. Government should pursue a more comprehensive strategy to support the growth of research parks and the benefits of economic growth and national competitiveness that they bring.

Senator PRYOR. Thank you.
Mr. Darmody.

STATEMENT OF BRIAN DARMODY, PRESIDENT, ASSOCIATION OF UNIVERSITY RESEARCH PARKS AND ASSOCIATE VICE PRESIDENT FOR RESEARCH AND ECONOMIC DEVELOPMENT, UNIVERSITY OF MARYLAND

Mr. DARMODY. I'm Brian Darmody, President of the Association of University Research Parks, and Associate Vice President of Re-

search and Economic Development at the University of Maryland. And thank you for inviting me to the Committee.

AURP represents over 300 research parks and communities of innovation in the United States and the world, and works closely with other organizations representing technology, commercialization, seed, and angel investing, incubator development, and State economic development. And I think some of these topics have already been discussed in the questions by the Senators.

Research parks account for over 750,000 jobs in North America, according to a recent study. This year, AURP held its annual conference in Vancouver, British Columbia, and I learned that, in 1927, Charles Lindberg wouldn't fly to Vancouver, because the airport was too small. Well, the Vancouver government immediately bought land and built a larger airport for the fledgling air industry, and that today serves as a major hub for international trade to the Pacific Rim and major—as a major job generator for British Columbia.

We view—at AURP, we view research parks as the Nation's 21st-century innovation infrastructure, just as airports and railroads did in earlier centuries. Innovation is the key to job creation, and support for innovation is an important global competitiveness issue for the United States.

The United States invented the research park model at Stanford in 1951. But, as Dr. Wessner has pointed out, other countries have copied this model, building large research parks, and attracting U.S. corporate research and development. So, we no longer lead the world in research parks.

And, just to bring this—this is a atlas of innovation from—and the United States section in here is about 10 percent. I've clipped its pages. You can see how heavy this thing is. This is a worldwide atlas of innovation centers, and the United States comprises maybe 10 percent of that.

The—but, also importantly, the United States also invented university technology transfer, with the 1980 Bayh-Dole Act, linking our best-in-the-world research university system with technology commercialization. But, we no longer lead in this, either, as research universities in the United Kingdom now outperform U.S. universities on a proportionate basis, in terms of technology commercialization.

We recognize, at AURP, that the U.S. Government is facing severe budget constraints, but we have a five-point plan to help harness more innovation and help build our research parks. Here are our five points:

Number one, we support Senator Pryor's bill on Building a Stronger America Act, to establish a loan guarantee program for research parks and park development.

Two, taxes and financing of research facilities. We need to encourage development of privately financed facilities and support corporations to keep research and development in the U.S. Current IRS regulations on tax-exempt bonds need to be reformed to remove tests on technology licensing, to give greater flexibility to universities to negotiate with corporations on intellectual property. And in my testimony, I have the IRS regulation regarding limitations on tax-exempt bond and corporations.

Three, the Federal lab system. There has been some discussion about NASA and other Federal labs. Twenty-five billion dollars is annually spent in research and development activity internally within Federal labs. We're suggesting that Congress create a new intermediary organization, modeled on best practices at States and at universities, such as the WARF Institute at Wisconsin, to more efficiently commercialize Federal intramural technology.

When we—when the Congress wanted to help build—rebuild Pennsylvania Avenue, they set up the Pennsylvania Avenue Development Corporation. If we want to develop technology at Federal labs, we need to think about setting up an intermediary organization to take on that task.

And we also need to work on programs to allow Federal researchers work more closely with the private sector. And I cite—we cite, in my testimony, an article I wrote regarding that.

Fourth point, improving university technology commercialization. We have "cash for clunkers," we need cash for commercialization. There are many "valleys of death" confronting university technology commercialization, but the first valley of death takes place when universities elect to take title to federally sponsor research under the Bayh-Dole Act. That's at the very earliest stages. Often, unless an additional development work is done—and Senator Martinez mentioned that—these potential technologies lie fallow.

So, developing a program to provide flexibility and recognize the cost of technology commercialization, and to develop proof-of-concept evaluations in Federal overhead rates or as a direct charge to research grants and contracts, would improve the success rate of university-owned technology development. That's not an EDA issue, that's really an issue about funding research at our Federal labs that goes to colleges and universities. And OMB Circular A–21 is a reference; it's cited in my testimony.

Finally, supporting science, technology, engineering and math—STEM programs—they traditionally focus on science and engineering skills. But, as has been mentioned, the key to employment growth in the U.S. is, we need to build careers and companies, not only jobs. Incubators and research parks are ideal places for new technology formation. Therefore, we want to suggest that, in the STEM idea, we also add the second 'E', so these would be STEEM programs—move from STEM to STEEM—so that would be science, technology, engineering, entrepreneurship, and math. Because, that philosophy is really what is embedded in the idea of research parks and research clusters.

The Obama Administration singled—signaled its strong willingness to work on innovation, entrepreneurship, and we support what the EDA and others within the Administration are considering. And we also support, very strongly, Senator Pryor's bill.

I want to thank the Committee.

[The prepared statement of Mr. Darmody follows:]

PREPARED STATEMENT OF BRIAN DARMODY, PRESIDENT, ASSOCIATION OF UNIVERSITY RESEARCH PARKS AND ASSOCIATE VICE PRESIDENT FOR RESEARCH AND ECONOMIC DEVELOPMENT, UNIVERSITY OF MARYLAND

I am Brian Darmody, President of the Association of University Research Parks (AURP), and Associate Vice President for Research and Economic Development at the University of Maryland.

AURP represents over 300 research parks and communities of innovation in the U.S. and world, and works closely with other organizations representing technology commercialization, seed and angel investing, incubator development and state economic development policies. Research parks account for over 750,000 jobs in North America, according to a recent study.

This year AURP held its annual conference in Vancouver, British Columbia. On his 1927 tour to celebrate his solo flight across the Atlantic, Charles Lindbergh wouldn't fly to Vancouver because the airport was too small. The Vancouver government immediately bought land and built a larger airport for the fledgli ng air industry, which today serves as a major hub for international trade to the Pacific Rim and major jobs generator for British Columbia.

We view research parks as part of a nation's 21st century innovation infrastructure, just as airports and railroads did in earlier centuries, and high bandwidth Internet backbone serves today. Innovation is key to job creation, and support for innovation an important Federal mission.

The United States invented the research park model at Stanford University in 1951. However, other countries copied this model, building large research parks with investments from national governments, and attracting U.S. corporate research and development facilities. The U.S. no longer leads the world in research parks; See *Wainova Atlas of Innovation* (2009), and National Research Council, *Understanding Research, Science and Technology Parks: Global Best Practices* (2009).

The United States also invented university technology transfer with the 1980 Bayh-Dole Act, linking our "best in the world" research university system with technology commercialization. However, we no longer lead in university technology commercialization as research universities in the United Kingdom now outperform U.S. universities on a proportionate basis in terms of technology commercialization.

AURP recognizes the U.S. Government is facing severe budget constraints, but we believe we can harness our existing research and development infrastructure to create new jobs, new opportunities, and new companies with administrative reforms and relatively modest Federal direct investments. See, *Power of Place , A National Innovation Strategy* AURP (2008).

Here are our five points:

1. *Infrastructure for Innovation: Research Parks*: We strongly support Senator Pryor's *Building A Stronger America Act* to establish a loan guarantee program to develop research parks, and grant program for new park development.

2. *Tax-exempt financing of research facilities*: We need to encourage development of privately financed facilities and support corporations to keep research and development in the U.S., instead of at research parks in other countries. Current IRS regulations on tax-exempt bonds should be reformed to remove tests on technology licensing to give greater flexibility to universities to negotiate with corporations on intellectual property issues. See, IRS Rev. Pro. 97–14 regarding limitations on university technology licensing in facilities financed with tax-exempt bonds.

3. *Federal Laboratory System*: $25 billion annually in research and development activity takes place internally in Federal labs. Congress should: (i) create a new intermediary organization, modeled on what universities (such as WARF at U. of Wisconsin) and states (such as TEDCO in Maryland) use to more efficiently commercialize Federal intramural technology; (ii) develop programs to allow Federal researchers to work more closely with private sector, and (iii) create more Federal research parks. See Washington Business Journal, *Unleashing Federal R and D*, B. Darmody, Oct 30–Nov. 5, 2009.

4. *Improving University Technology Commercialization*: There are many "Valleys of Death" confronting university technology commercialization, but the first potential valley takes place when universities elect to take title to federally sponsored research under the Bayh-Dole Act. Often unless additional development work is done, these potential technologies lie fallow. Developing a program to provide flexibility and recognize the cost of technology commercialization and the need to develop 'proof of concept' tests or evaluation of these technologies in Federal overhead rates would improve success rates of university-owned technology developed with Federal funds and create more companies to fill our incubators and research parks. See, OMB Circular A–21.

5. *Supporting Entrepreneurship: From STEM to STEEM*: Science, Technology, Engineering, and Math (STEM) programs traditionally focus on science and engineering skills. The key to employment growth in the U.S. needs to include building careers and new companies, not only jobs. Incubators and research parks are ideal places for new technology company formation. Therefore we call

for *Entrepreneurship* to be imbedded in STEM programs and ideas, so the acronym would be STEEM: Science, Technology, Engineering, *Entrepreneurship* and Math.

The Obama Administration has signaled its strong willingness to work on innovation and entrepreneurship, such as by creating the Office of Innovation and Entrepreneurship. We look forward to working with the Administration and Congress to efficiently and effectively build Communities of Innovation in the U.S. in a comprehensive fashion and maintain U.S. technological competitiveness.

I want to thank the Commerce Committee and Senator Pryor for inviting AURP to the Committee.

Senator PRYOR. Thank you.

Mr. Sallet.

STATEMENT OF JONATHAN SALLET, MANAGING DIRECTOR, THE GLOVER PARK GROUP

Mr. SALLET. Mr. Chairman, members of the Committee, thank you very much for the chance to testify today and to apply some of the ideas that came out of our paper for the Center for American Progress to your legislation.

You know, Mr. Chairman, if we were to look at an aerial view of an area with a science park, if we were up in an airplane, the landmass of a science park might be very small. It might not be a big part of the county or city in which it resides. But, the small mass of land is a very big idea. It's a big idea because the notion that's in your legislation is that there are areas that can act as innovation catalysts and therefore have economic effects, creating jobs much bigger than merely the area that they occupy. They do that because we understand how clusters work. And I commend you, Senator Pryor, for specifically saying, in your legislation, that the goal of the science parks is to promote the clustering of innovation.

What we've learned about regional economic competitiveness over the last several decades is that the competitive advantages of a place, of a region, stand apart from the Nation, stand apart from the next area. They are unique, but that they have to be taken advantage of; that they are taken advantage of with real competition, but also, with very important collaboration; collaboration, particularly with universities, with local governments, with community colleges, and with nonprofits.

This is something that we know. We know they help create jobs, they help spawn new businesses, and they help spur economic growth. And yet, as your bill recognizes, for far too long the Federal Government has administered economic development programs as if they didn't have to be connected to regional economic strategies. But, that doesn't make sense.

The key point here is that leadership comes from the local people, the local businesses, but that there is an important role the Federal Government can play. It can help frame big national challenges that ought to be met, that would benefit the Nation as a whole. Clean energy is a good example. I know, recently in Arkansas, I think you were at the announcement of a new wind turbine factory that's being constructed. That will have a positive impact, not just for Arkansas, but for the Nation, as we go to renewable energy.

The second thing the Federal Government can do is to help facilitate success at the local level, particularly through information ex-

changes between data that the Federal Government has, and the local areas need, as well as best practices from among different clusters.

And the third thing it can do is, in an appropriate way, as your legislation suggests, is fund activities.

Now, what you call for in the legislation is for cooperation within a cluster, particularly with institutions of higher learning, in order to promote technology transfer; and you would award these funds through a competitive process. Those are very important goals, because those are the lessons we've seen in the last two decades.

You also emphasize the importance of ensuring that innovation comes to every part of America, including rural America. And that is also a lesson we've seen as innovative state programs have led to greater development of economic possibilities in rural areas of America that we might not think of, at first glance, when we think about innovation.

That's why I believe that this is a very important piece of legislation, and one that I think can be put into the framework of a larger national strategy. The Administrator talked, in the first panel, quite rightly about having regional strategies. We need to do this at the Federal level. We need the kind of efforts that he is leading in EDA. We need to make sure all Federal programs are aligned with the strengths of their cluster. Export promotion, for example, ought to be promoting in an area the kind of exports that that area can best create.

And third, there are a series of programs in the Federal Government, from the Department of Commerce to SBA, including programs like SBAIR, in the Department of Energy and Labor, in the Department of Agriculture, where the Secretary has talked about rural economic development, in the National Science Foundation, and the Department of Labor. These need to work together. The Federal Government needs to speak with a single voice to local leaders to make it as easy as possible to move forward.

Senator, you were kind enough in your introduction to note that I was, at Brown, a college disc jockey, and one of the songs I used to play was the song called, "Won't get Fooled Again." And, I think a lot about your legislation is that we won't be fooled again. We won't be fooled again into forgetting one lesson, that "Made in America," as an economic strategy, means we have to apply those lessons in America. That's what your legislation would do, and I hope it's speedily enacted.

Thank you.

[The prepared statement of Mr. Sallet follows:]

PREPARED STATEMENT OF JONATHAN SALLET,[1] CO-AUTHOR, *The Geography of Innovation: The Federal Government and the Growth of Regional Innovation Clusters*, PUBLISHED BY SCIENCE PROGRESS, A PROJECT OF THE CENTER FOR AMERICAN PROGRESS

Summary

I believe that the Federal Government can maximize the benefits of science and research parks, an integral part of sparking innovation and creating jobs in the

[1] Jonathan Sallet served as Assistant to the Secretary of the Department of Commerce and Director of the Office of Policy and Strategic Planning from 1993–96. He is employed by The

Continued

U.S., by supporting regional innovation clusters to promote a comprehensive, long-term economic growth and development plans across regions in the United States.

My recommendation is that regional innovation clusters should become the centerpiece of a reauthorized Economic Development Administration (EDA), empowering the agency to work with businesses, universities, community colleges, state and local governments and community leaders to foster regional competitiveness strategies. This will help boost job creation and business growth by spurring the creation and growth of successful regional ecosystems, striking exactly the right balance between Federal leadership and local responsibility and between the private and public sectors. Science parks and regional innovation clusters are two vital parts to a long-term solution—science parks will drive the clusters forward while the regional innovation cluster will strengthen and support the local framework in which the park can thrive. This broader effort will be the most effective and sustainable.

Testimony

Introduction

Chairman Rockefeller, Ranking Member Bailey Hutchison, and members of the Committee on Commerce, Science, and Transportation, thank you for the opportunity to testify today on innovation through collaboration and cooperation—particularly in the realm of regional and innovation "clusters."

Innovation is central to economic prosperity—driving productivity, ensuring sustainable broad-based economic growth, creating quality jobs and shared prosperity, and increasing national competitiveness. Innovation will aid economic recovery by: creating new jobs in high-tech and traditional sectors; creating higher returns to workers and increase living standards from better, more quality jobs; and making the economy more resilient and dynamic in the long-run, adapting to future challenges.

With the current economic crisis and increasing unemployment throughout the nation, state budgets are tighter than ever, reducing education spending and R&D efforts, making this the best time to consider how the Federal Government can work with state and local entities, business, universities, community colleges and communities to restore long-term economic health to our Nation.

Your focus today on the manner in which research, science, and technology parks can serve as a model for economic growth is welcome—and important. For too long, the Federal Government has administered programs for economic growth disconnected from regional strategies for growth and development. That is an omission that, in this economy and in a very literal sense, we can no longer afford.

In September, Science Progress, of the Center for American Progress, released a paper that I coauthored with Ed Paisley and Justin Masterman.[2] In that paper, we set forth the reasons why, we believe, the Federal Government should take an active role in supporting regional economic strategies. I should emphasize that when we talk about "regional innovation clusters", we do not mean that regional growth is necessarily focused on high-technology businesses. Rather, we mean that local leadership has the resources necessary to promote innovative strategies for economic growth—from any sector, from any kind of business, in any kind of region—urban, rural or suburban.

Science Progress, led by Ed Paisley, is now engaged in a new project to extend those lessons to the Pittsburgh region. That geography includes Western Pennsylvania, Northern West Virginia and Eastern Ohio. The specific goal of our work is to identify the manner in which Federal efforts currently contribute to economic growth in that region, and to recommend specific ways in which the Federal Government could do an even better job in the future.

We aim to advance the understanding of two important questions:

- What is the current impact of Federal efforts on regional growth and job creation, and
- How could the Federal Government be more effective in supporting local leadership?

In this manner, the study of the Pittsburgh region will, we hope, yield national lessons of general application.

The Pittsburgh region offers specific advantages to our work. It crosses state lines, which is characteristic of America's regional economies but which poses obvious

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Glover Park Group, a private consulting firm. This testimony reflects Mr. Sallet's personal views.

[2] *http://www.scienceprogress.org/wp-content/uploads/2009/09/eda_paper.pdf.*

challenges in terms of state coordination and even the deployment of Federal efforts. It mixes the old and the new, from hard-hit automobile manufacturing in Ohio, to web-based start-ups in Pittsburgh and, of course, the National Energy Technology Laboratory in Morgantown, West Virginia. It spans urban and rural economies. It includes institutions, including foundations, universities and nongovernmental organizations that have carefully considered and implemented strategies of growth. Finally, and like the rest of America, the people and businesses of the Pittsburgh region are searching for better, more effective, means of creating jobs and growing their economy.

In this work, we are building on much that is already known about the impact of regional economic units.

The Geography of Innovation

We know that "clusters"—geographically concentrated areas of specialization—form the foundation of regional, and the basis for national, competitiveness.[3] Clusters are geographic concentrations of firms, suppliers, support services, specialized infrastructure, producers of related products, and specialized institutions (such as training programs) whose expertise reinforces one another's. So, for example, a successful cluster can connect firms with academic institutions, research labs, and other nonprofit organizations in order to create the kind of virtuous cycle of competitiveness that creates jobs, stimulates business formation, and improves productivity. Examples of U.S. clusters include metal manufacturing in the upper Midwest, entertainment in Los Angeles, information technology in Silicon Valley, and furniture in Mississippi. Clusters are common to every advanced economy.

What are the kinds of advantages that are shared by the participants in clusters? They could be a set of workers who have honed particular skills, like building boats in Maine. Or community colleges that offer training to advanced manufacturing workers in places where advanced manufacturers have located. Or research centers that conduct basic research in biotechnology close to biotechnology firms. Anything, really, that creates what an economist would call a "positive externality"—a benefit that is captured not just by a single firm, but that enriches the community as a whole. Positive externalities are nothing new—the externalities produced by K–12 education is the basis for our public school system—but what is new is this: The notion that regions can consciously focus on the creation of shared advantages within clusters to create jobs, help businesses be created and, of course, stimulate long-term economic growth.

Regional clusters enhance collaboration and value-creation, drive productivity, and play a fundamental role in knowledge creation, innovation, the accumulation of skills, and the development of pools of employees with specialized skills. They effectively lower the cost of capital, increase accessibility to specialized labor, create positive learning effects and decrease the cost of finding talented workers. They create an ecosystem that is helpful to the creation of new firms in which specialized advantages reinforce each other to the benefit of firms, workers and communities. Their operating principles could be phrased as *"Innovation, Collaboration, Value Creation."*

Scholarship from leading scholars[4] has established the real advantages of "clusters" for a growing economy, including strong correlations between:

- Per-capita GDP and cluster concentration,
- Cluster strength and wage levels, and
- Cluster strength and higher wages.[5]

In other words, clusters are good homes for the high-growth, high-wage companies that move quickly to take advantage of competitive opportunity and create jobs as a result. And that means, of course, that successful clusters are important to the creation and application of successful innovation policy. Innovation—the use of

[3] Among Professor Porter's extensive writings on the importance and nature of "clusters" is a recent paper summarizing both his academic work and his public-policy recommendations. "Clusters and Economic Policy: Aligning Public Policy with the New Economics of Competition" (Revised December 17, 2008). His analysis is based on extensive research into the sources of competitive advantage, which he first discussed in *The Competitive Advantage of Nations*, (New York: Free Press, 1990) and explained in, for example, "Clusters and the New Economics of Competition" (Harvard Business Review, 1998).

[4] Important additional research on this topic includes Karen G. Mills, Elisabeth B. Reynolds and Andrew Reamer, "Clusters and Competitiveness: A New Federal Role for Stimulating Regional Economies," (Washington, Brookings, 2008) and Robert Atkinson and Howard Wial, "Boosting Productivity, Innovation, and Growth through a National Innovation Foundation," (Washington, Brookings, 2008).

[5] Mills, Reynolds and Reamer, "Clusters and Competitiveness."

emerging and old information to create new forms of value—is absolutely critical to the future economic success of the United States. Indeed, in a globalized economy, our ability to be a smart economy is basically our ability to be growing economy. Innovation not only boosts the creation of value, but it also helps ensure that economic growth is sustainable—from the perspectives of both economic and environmental concerns. For example, increased advanced manufacturing correlates highly with increases in energy-efficient manufacturing—the more process technologies evolve, the more that they can do more with less. From this perspective, cluster policy *is* innovation policy.

If clusters work on their own, what can be done to help them work even better? Specifically, what kinds of efforts can speed regional economic growth? In our paper, we identify four "lessons" that we believe are very important for policymakers to understand:

First, *Place Matters*. It is important for regional economies to emphasize what they can do best, capitalizing on existing strengths or new strengths that spring naturally from existing advantages. Solar power is a good strategy for New Mexico, hydroelectric power is not. Existence of institutions of knowledge-creation, availability of capital and the presence of high-skill labor with programs to spur talent generation will all be parts of a region's assessment of its competitive strengths.

Second, *Networks Are Key*. The economic theory of a cluster recognizes the importance of both competition, which makes businesses more successful and increases consumer welfare, and cooperation, to create an environment of mutual advantage. Universities and community colleges, for example, can add to the store of knowledge and help educate workers in a manner that advantages multiple, even competing, local businesses. But that is best done with explicit networks of collaboration and knowledge-sharing of the kind found, for example, connected to the Albany nanotechnology cluster.

Third, *Practice Makes Perfect*. As demonstrated by North Carolina's Research Triangle and the Greater Phoenix cluster, it can take a long time, even decades, to build a new cluster from scratch. The observation re-emphasizes our belief that short-term gains will come mainly from existing advantages that have yet to be fully realized. For example, in our paper, we describe an analysis of Tennessee's furniture cluster that both identifies existing strengths, as in office furniture, but only areas in which the region can be potentially competitive, such as mattress manufacturing. Areas of potential strength are likely to be areas that will result in quicker results.

Fourth, *Success Depends on Local Leadership*. There is no substitute for the ability of local businesses, governments, non-profits, universities and colleges to all work together. That has been demonstrated in areas and industries as diverse as San Diego's CONNECT program, Toledo's photovoltaic cluster, and Minneapolis's medical devices cluster. Toledo is a particularly good example. University of Toledo (UT), recognizing its strong engineering and manufacturing science programs and the city's highly skilled workforce and economic infrastructure, led a 20-year effort to create a new photovoltaics and clean-energy cluster. UT has assembled a team of world-class faculty in photovoltaics and has built laboratories and support centers that have spun off dozens of businesses and reinvigorated the city. In partnership, the state of Ohio committed $18.6 million to UT in 2007 to spur the continued development of the photovoltaics cluster, generate new high-tech jobs, and to increase industry revenue. From this university and government leadership, the Wright Center for Photovoltaics Innovation and commercializiation is now an internationally recognized photovoltaics research and development center with infrastructure attractive to companies incubating the future generations of photovoltaic technologies.

Federal Support for Regional Economic Strategies

Against, this backdrop what can the Federal Government accomplish? And how?

Let me begin with the specific proposal, S. 583, introduced by Senator Pryor to provide support for the development of science parks. The legislation begins quite specifically, and quite rightly, by emphasizing the creation of science parks "to promote the clustering of innovation. . . ." That is quite wise, and in complete accord with the experience of regional innovation that I have described above.

In carrying out its goals, the legislation specifically calls for cooperation, including with institutions of higher learning, for the exchange of knowledge, through, for example, technology transfer and for the award of Federal funds through a competitive process.

In other words, S.583 is an embodiment of the lessons we have learned for the stimulation of regional economic growth.

Analysis of successful clusters has shown that they succeed with local leadership from industry, non-governmental organizations, including universities and community colleges, and the public sector. Regional leaders have the best grasp of their own competitive advantages and prospects and they are in the best position to execute the kind of collaborative, bottom-up strategies that enhance cluster success.

There is, however, a problem—and one only exacerbated by our current economic crisis. Cluster initiatives are "too few" and they are "thin and uneven in levels of geographic and industry coverage, level and consistency of effort, and organizational capacity."[6] Moreover, traditional clusters are under terrible stress as state governments, under tight budget constraints, are cutting their own support for regional economic development.

Now is the time for the Federal Government to play a critical role in supporting regional efforts by framing, facilitating and funding cluster strategies. By that I mean that the Federal Government can identify the critical national goals, like energy independence, that serve the national interests—an approach endorsed by Congress in the America Competes Act of 2007. The Federal Government can improve the efficiency of cluster strategies by improving the delivery of various forms of Federal expertise to the clusters that need them and by increasing the ability of clusters to learn from each other. And, of course, in difficult fiscal times for states, the Federal Government can provide additional resources that can smartly leverage existing local and private funds.

Thus, in my judgment, S.583 should be supported by a broader effort. Rather, an emphasis on any particular means of regional economic growth, such as science parks or business incubators, should be incorporated into a broader Federal strategy that supports the full range of tools that can support regional economies.

First, we need an explicit Federal focus on regional economic growth. The starting point should be the establishment of the President's regional innovation cluster initiative at the Economic Development Administration of the Department of Commerce.

The President's FY2010 budget provides "$50 million for regional planning and matching grants within the EDA to support the creation of regional innovation clusters . . . and $50 million to create a nationwide network of public-private business incubators to encourage entrepreneurial activity in economically distressed areas."[7]

My recommendation is that this proposal—the conscious Federal adoption for the very first time of a plan to work with state and local governments to foster regional competitiveness strategies—becomes the centerpiece of a re-authorized EDA. In my view, it strikes exactly the right balance between Federal leadership and local responsibility and between the private and public sectors.

For example, the EDA could ask regions, to compete for Federal matching funds by offering proposals created in collaboration with their companies, universities, research facilities and nonprofits. Funding would be provided for implementation of the best strategies. The EDA should establish a set of criteria that allow the plans with the biggest impact and best prospects for success to be funded quickly. Such criteria could include identifying the proposals that:

- Move fast, with significant impact,
- Use public-private partnerships and other forms of regional collaboration,
- Have a proven track record,
- Integrate distressed areas into larger regional economies, and
- Further the goals of national "challenges" in areas such as energy, healthcare, manufacturing and life sciences.

The Federal program should be flexible, of course, in order to respond to the best ideas that come from the regions. The cluster initiative could provide Federal matching funds for targeted, high-leveraged activities, such as university research consortia, business incubators, for community-college training programs and technology-transfer efforts focused on small and medium-sized firms.

At the same time, small planning grants would be made available for those regions that have yet to formulate a cluster strategy. An advantage of the cluster approach, especially as we move into an era of budget-deficit reduction, is that the Federal funding need not be enormous—indeed, the President's proposal of $50 million for regional innovation cluster and another $50 million for associated business incubators will get these efforts off to a strong start.

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[6] Mills, Reynolds and Reamer, "Clusters and Competitiveness."

[7] Office of Management and Budget, "A New Era of Responsibility."

The establishment of this EDA effort would not, of course, be enough. That is why the second key ingredient for effective Federal involvement is this: Agencies that already support regional economies should tie their efforts specifically to locally-led regional economic strategies.

Right now, the Federal Government spends roughly $150 billion annually on R&D. But, by our calculation, none of that money goes specifically to support regional economic strategies and only about $650 million goes to efforts that indirectly support regional innovation clusters. Nonetheless, important current efforts could be better harnessed to this goal, including additional programs from the Department of Commerce, the Small Business Administration (including the SBIR and STTR programs), the Department of Energy, the Department of Labor, the National Science Foundation and the Department of Agriculture. That should be encouraged.

Third, Federal efforts can work better together and the Federal Government can work better in support of local leadership.

The implications are larger, of course, than the EDA alone. One of the advantages of the regional cluster initiative is that it provides the Executive Branch as a whole with a good way of ensuring that micro-economic initiatives are effective and efficient. I would like to see the EDA become an evangelist for high-performance government, tailoring Federal efforts to best meet regional needs, fostering collaboration among Federal programs that are too often operated in "stovepipe" isolation, and ensuring that Federal funds are well-spent.

For example, the Department of Commerce is the agency that, more than any other, focuses on economic competitiveness. Its programs range from assisting exporters to working with minority businesses and the telecommunications sector, to protecting our seas and coastlines, to gathering data on our nation, to working with small and medium-sized manufacturers, to creating industry standards, which are a critical infrastructure innovation. The National Institute of Standards and Technology, for example, has a highly successful manufacturing extension program and has worked with regional economic clusters through its Partnerships for Regional Innovation. As the EDA implements its "clusters" initiative, the Department more generally can align its efforts with the specific needs of regional economies. In this way, for example, the creation of business incubators, as proposed in the President's FY2010 budget, should be constructed to dovetail immediately with regional clusters.

The Federal Government also offers many forms of economic assistance to boost business creation and help communities grow economies that could be better aligned with regional competitiveness strategies. Federal efforts in the Department of Labor, the National Science Foundation, the Department of Energy and the Small Business Administration could all focus on clusters.

In this way, the Federal emphasis on clusters can act as the "mortar" to bind together the "bricks" of economic recovery, providing, in essence, a multiplier effect that makes thriving initiatives even more successful.

In sum, a huge opportunity beckons when the Nation needs economic renewal the most. Science and innovation are critical to the overall renewal of the American economy and to the restoration of the American job market. We know that clusters represent an increasingly important economic unit, but unfortunately it is one that has been virtually ignored in policymaking at the Federal level in the United States. By including regional competitiveness as a key mandate, a cluster approach can allow Federal policies to be implemented more effectively by better connecting them to regional leadership. In addition, Federal policy based on cluster principles will reinforce economic specialization across states and regions, increasing productivity in the economy as a whole. Ultimately, we can create the launching pads for what America needs the most right now—jobs and long-term, sustainable economic growth.

Conclusion

Some of our strongest international competitors, including Japan, South Korea, and many European countries, have invested in significant national cluster initiatives, directing great amounts of money and resources toward making innovation clusters the main focus of their economic and innovation policies. The irony is obvious—foreign innovation policymakers have come to the United States to study our successes and consult with our experts and yet the United States has conspicuously failed to embrace cluster initiatives as an explicit part of its own innovation policy.

France, for example, has a £1.5 billion program called Pôles de Compétitivité that is focused entirely on creating, supporting, and encouraging the growth of innovation clusters throughout the country. In fact, 26 of 31 European Union countries have cluster initiative programs in place. Japan has made similarly large investments in two cluster programs called the Knowledge Cluster Initiative and the In-

dustrial Cluster Program, while South Korea has made innovation clusters the central organizing concept of its industrial policy. Numerous other countries in Europe and Asia, especially China, boast nation programs dedicated explicitly to promoting the development of specific regional innovation clusters.

The lesson is clear. Economic strategies that have been "Made in America" must be "Applied in America" by the Federal Government and local leaders in order to employ more Americans and restore long-term economic growth. S.583 would be an important step toward implementing the lessons of clusters by promoting regional recovery and growth.

Senator PRYOR. Thank you.

Dr. Townsend.

STATEMENT OF ANTHONY TOWNSEND, RESEARCH DIRECTOR, TECHNOLOGY, HORIZONS PROGRAM, INSTITUTE FOR THE FUTURE

Dr. TOWNSEND. Thank you, Mr. Chairman, and members of the Committee, for the opportunity to share my expertise.

I agree that America's research parks are essential infrastructure for the Nation's future competitiveness. Currently, I work as a technology forecaster for the Institute for the Future, which is an independent think tank established in Silicon Valley in 1968.

I've spent the last 3 years working with research park managers and developers in the U.S., in Europe, Asia, and the Middle East. Today, I want to discuss this research park model, some of its advantages and disadvantages, but, most importantly, its future prospects.

It's an appropriate time to consider the research park model, because this year is the 50th anniversary of North Carolina's Research Triangle Park. This is one of the largest and oldest and most successful parks in the Nation—in the world. But, like many parks today, RTP is also facing some potential threats to its success in the future. Put simply, the business model that was developed in 1959 isn't going to work for parks created in 2009. And even established parks are going to need to evolve, as well.

Three years ago, when RTP looked to the future, it established a partnership with our organization, to develop a broad and long-range forecast of the future of research parks, which you have attached as written testimony. We looked 20 years out, we engaged over 50 experts from over a dozen nations. We detailed 14 global trends that will shape the future for research parks, and we developed three scenarios to explore how parks might navigate a volatile and uncertain future.

In the best-case scenario we developed, the research park model gets an upgrade, if you will, in part by building stronger ties to universities and new online science communities.

In the worst-case scenario, the traditional business model, which depends very heavily upon big companies as anchor tenants, simply disappears as companies cut back on R&D and then virtualize or offshore whatever is left.

The third scenario, a more decentralized research park model emerges and starts to challenge the traditional model. And this model uses digital networks to connect together lots of small spaces into clusters that function like today's big research parks, and we call those "research clouds." And these might form around univer-

sities and actually directly compete with research parks, particularly for smaller companies.

But, the most important result from these scenarios is that none of them forecast a world where lots of new research parks succeed, based on this traditional real-estate-driven model that we've known for the last 50 years.

And so, I know that you're concerned about creating jobs quickly, as well as creating this long-term capacity for innovation and growth that we've discussed this afternoon. But, I think, rather than solely focusing on encouraging development of new research parks, we should also consider focusing investment on reinventing the parks that we already have. And there ares three key priorities to consider there:

First, you can create jobs immediately by investing in upgrading the hardware of our research parks. It's a great time to convert vacant buildings from single-tenant to multi-tenant, to support startups and younger companies. You can retrofit buildings with green technologies, create green-collar jobs, turn our research parks into living labs for a low-carbon economy. And you can fund shared infrastructure, like large scientific instruments, that create unique value to research parks.

Second, you can invest in upgrading research park software. Research parks need to evolve from a model based on managing dirt—or land—to managing activities that support innovation.

The best chance we have for rapid job creation, over the next year or two, is tapping this goundswell of entrepreneurship happening right now in the country. But, parks need to beef up their capacity to engage and nurture small companies, which is very different than attracting and retaining large ones. Grants that support expanded missions for research park managers, could greatly enhance their effectiveness as economic developers.

And finally, as we've heard all afternoon, we should recognize that research parks are part of knowledge ecosystems; networks of people, organizations, and ideas that operate at a regional scale. We can't just build parks in isolation and expect them to succeed. One reason why Research Triangle has been so successful is that it has had a strong regional partnership at its core from the very beginning. CEO Rick Weddle, of the Research Triangle Foundation, calls this the "grand vision." And it was that vision, that was handed down from generation to generation, that allowed the project to stay on track during transitions in political leadership.

Research park funding, such as was proposed in S. 583, should be tied to regional economic programs, such as what we've heard about from EDA as well as some other bills that are in the Senate right now.

Thank you, Mr. Chairman, members of the Committee, again, for this opportunity. I welcome any questions, and comments you may have.

[The prepared statement of Dr. Townsend follows:]

Future Knowledge Ecosystems

The Next Twenty Years of Technology-Led Economic Development

Anthony Townsend, Institute for the Future; Alex Soojung-Kim Pang, Institute for the Future; Rick Weddle, Research Triangle Foundation

IFTF Report Number SR–1236 [1]

Abstract

The model of self-contained research parks and incubators that dominated the last fifty years of technology-based economic development is being challenged by deep shifts in the global economy, science and technology, and models of innovation . This paper describes fourteen emerging trends that will set the context for technology-based economic development in the coming decades. These trends are used to develop three scenarios for the future of technology-based economic development over the next two decades. In the first scenario, an incremental evolution of the research parks model takes place in a world of rapid, but steady and predictable change. In the second scenario, entirely new networks of R&D space emerge in a "research cloud" that challenges current models to adapt, sometimes dramatically. The third scenario, the research park models is in rapid decline as R&D becomes highly virtualized and parks' legacy cost structure makes them obsolete for young firms. We conclude by highlighting the strategic implications of these scenarios for existing and future parks and economic development.

Forecasting Workshop Participants

Forecasting and scenario development workshops were held during 2008–9. Organized by Research Triangle Foundation and facilitated by the Institute for the Future, these workshops were designed to engage a broad group of experts from different countries and different professions in brainstorming important trends and scenario elements. The results of these workshops are reflected throughout this report. The authors wish to thank Tina Valdecanas of the Research Triangle Foundation for organizing these workshops.

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IASP 2008
Johannesburg, South Africa

Sue Bell
La Trobe University R&D Park

Joan Bellavista
Parc Cientific de Barcelona

Neville Comins
The Innovation Hub

Jeff Finkle
IEDC

Esteban Cassin
Fundacíon Parque Tecnológico Misiones Argentina

Herbert Chen
Tsinghua University Science Park

Douwe Dijk
Zernike Science Park

Mauricio Guedes
Rio de Janeiro Technology Park

Dennis Kekas
NCSU Centennial Campus

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Gary Conley
TechSolve, Inc.

Gene DePrez
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Michael Finney
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Norma Grace
University of New Orleans

Jackie Kerby-Moore
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Paul Krutko
City of San Jose

Gail Lewis
AZ Department of Transportation

Judy McKinney-Cherry

Jay Moon
Mississippi Manufacturers Association

Robin Roberts Krieger
Greater Oklahoma Chamber

Bill Sproull
Richardson Economic Development Partnership

Eileen Walker
AURP

Steve Weathers
Regional Growth Partnership

Rick Weddle
Research Triangle Park

Online Expert Panel

To complement our face-to-face workshops, the Institute for the Future convened an online panel of experts in March 2009 to map trends in areas that will shape the future of technology-led economic development and research parks: real estate, architecture, economic geography, public policy, entrepreneurship, history of science, and incubation.

Thomas Campanella
University of North Carolina

Kamau Gachigi
University of Nairobi

Michael Joroff
MIT

Ilkka Kakko
Karostech Ltd.

Steve King
Emergent Research

Mitchell Moss
New York University

Fergus Murphy
SRI International

Margaret O'Mara
University of Washington

Hugh O'Neill
Appleseed, Inc.

Rachel Park
CUH2A
Matthew Zook
University of Kentucky

Part I—Where We Are Today

Introduction: A Postcard from 2030

Fast forward to 2030, and imagine a late afternoon in Soweto, once a stronghold of resistance to apartheid, now a hotbed of small technology firms bridging Western technology and African ingenuity and markets. Scattered across the community's 65 square kilometers, some 150 small factories and wet labs are engaged in short-run, small-batch manufacturing of lightweight infrastructure technologies of all kinds—solar-powered ovens, nanomesh water filtration, genetically modified seed lines specifically designed for micro-climates across the sub-Saharan region. Collaborative R&D is mostly done in community-funded pop-up labs, cheap facilities built out of shipping containers and governed by open patent agreements—whatever goes in or comes out of them is common property for the whole community.

For many, the future described here may be difficult to imagine, but it is a plausible one. It illustrates the degree of change that can happen in twenty years. In fact, the investment decisions we make today are likely to have impacts for at least this long.

Thus, ask yourself, would I recognize this as a research cluster? Would I call it a research park?[2] What does this possibility mean for how research parks are likely to evolve, in the developing and developed economies alike? In this world, what is the role of research park developers, managers and economic development officials?

The purpose of this white paper is, firstly, to explore the future economic, technological and geographical trends that might converge to make this vision a reality. Second, this is only one of many possible futures for technology-led economic development. Therefore, we present a set of three broad scenarios for the future of research parks and technology-led economic development.

Building on Success: A Brief History of Technology-Led Economic Development

2009 marks an important moment in the history of technology -led development. The Research Triangle Park of North Carolina turns fifty, and over 40 parks are twenty-five years old or more.[3] As we begin thinking about the next twenty years of change and innovation in this field, it makes sense to review how the movement has evolved and the source of its past successes.

The concept of the science city—a city built from the ground up to house scientific and technical research—emerged during World War II. The speed of technological development demanded by the war effort vastly exceeded any existing industrial R&D capability, and the concentration of existing research centers in cities was a security risk. As a result, both Allied and Axis powers created massive R&D facilities, isolated far from population centers. The British concentrated cryptography researchers in Bletchley Park; German rocket developers were centered at Peenemünde; and most spectacularly, America's Manhattan Project built remote complexes dedicated to atomic bomb research and production in Tennessee, Washington and New Mexico.[4]

While the science city model was certainly effective at massive breakthroughs in both basic science and its technological applications, it was frighteningly expensive, and their geographic isolation meant that there were few opportunities for spin-off economic growth. The science city model was later used both successfully and unsuccessful in economies as different as Japan and the Soviet Union. Over time, the notion of science cities as a specific site gave way to "technopoles" as regional concentrations of public and private technological, financial and human capital.[5]

In the early 1950s, first at Stanford University and later in North Carolina, the science city model was adapted to a more manageable scale. Dubbed "industrial parks", "research parks" and "science parks" these projects were land-driven strategies primarily aimed at attracting the regional branch plants of large manufacturing companies. Over time, these places saw a growing share of their tenants engaging

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[2] Throughout this report, we use the terms *research park, science park* and *technology park* interchangeably. All refer to specific, contiguous development sites targeted to attracting and developing technology-intensive economic activity.

[3] 2009 survey of IASP members by Research Triangle Foundation.

[4] "Science: Innovation in the City" *Ten Year Forecast: 2006.* (Institute for the Future: Palo Alto, California)

[5] Manuel Castells and Peter Hall, Technopoles of the World: The Making of 21st Century Industrial Complexes, NY: Routledge, 1994.

in research and development functions. In many countries such as Japan, France and the Netherlands, central governments played a major role in the creation of research parks. In the United States, research parks more often were the result of sub-national governments.[6] Over time, parks have tended to become more specialized, targeting specific industries or sectors.

By the 1980s, the strategic focus of technology-led development shifted from the attract-and-retain model of industrial parks to a model based on business incubation. While technology transfer was an element of the business model behind industrial parks, in incubators it moved to the forefront. The thinking was two-fold: dating companies was a zero-sum game playing regions off against each other, and growing firms locally would be more "sticky" and likely to produce secondary benefits. Beginning with the first known business incubator, established in Batavia, New York in 1959, thousands of incubators opened throughout the world. Today, some 3,000 business incubators exist worldwide, along with thousands of other facilities that perform similar functions under different monikers.[7] The incubator model also marked a shift away from lowering real estate costs as the primary strategy (though rents are still typically subsidized), to providing seed capital, management expertise and intellectual property management needed to grow small companies into big ones. Almost universally, incubators have been positioned around universities, in the hope of leveraging their research and talent.

Today, both the industrial park and business incubator model are widely used. However, in advanced industrial economies these models are less effective as the needs of startups evolve. In their 1991 study of U.S. research parks, Luger and Goldstein found that more than half of all research parks fail or shift their focus. Furthermore they found that "many research parks are unlikely to be appropriate for new start-up businesses, because minimum lots size requirements and high land prices make the cost of entry into parks high."[8] Yet, existing parks still create great value for tenants, surrounding properties and regions—not because of the business model—but because they have become key nodes in larger knowledge ecosystems. This accrued value is being reflected in the market. For instance, land values at the Research Triangle Park have more than tripled in the last 5 years.

But, as we illustrate through one of our future scenarios, the next few years may very well be a period in which no significant new research park projects are launched, and some parks fail. Any number of factors could drive this scenari o to the forefront—a protracted global recession, aggressive corporate cost-cutting and dematerialization of R&D or a return to high energy costs that put "legacy" parks at a carbon disadvantage. Signals of this future are already around us, from the endless delays of Russia's ambitious national technopark project to bubble-era university-based efforts like the Harry Reid Technology Park at the University of Nevada Las Vegas. Even current success stories such as Singapore's Biopolis have been called into question by the World Bank.[9]

On the other hand, the threat to existing parks could also come not from external economic shifts but from the emergence of entirely new models for building and organizing spaces for R&D. In our second scenario, "The Rise of Research Clouds"—digitally connected networks of small spaces challenge existing parks and by providing more collaborative, more flexible and less costly homes for invention. Again, signals of this future abound if we raise our heads and look at innovative communities outside our own circle of peers.

A third possibility, a very real future for many parks, is incrementalism—evolving and upgrading infrastructure and services to the next version, " Science and Technology Parks 3.0". Indeed, an upgrade is desperately needed. Cities and metropolitan regions are increasingly seen as the drivers of national economic growth, making it likely that we will see renewed interest in the research park model as an economic development tool. Yet, while this scenario may involve survival and a limited degree of prosperity for some, it does not realize the full potential for innovation and socioeconomic gains that future scientific breakthroughs may hold. It is a likely scenario for many parks in the absence of external threats, but not necessarily the most desirable one.

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[6] M. I. Luger and H. A. Goldstein. 1991. *Technology in the Garden: Research Parks & Regional Economic Development*. (University of North Carolina Press: Chapel Hill, NC)

[7] National Business Incubator Association.

[8] Luger and Goldstein, p. 181.

[9] Yusuf S. 2006. *Postindustrial Asian Cities: Innovation for Growth*. (World Bank: Washington, D.C.)

Toward Regional Knowledge Ecosystems

Despite their stark differences, in all of these scenarios, we find one common element—regions will play a more important role than at any time in the last century. In fact, there will almost certainly be regions in which all three of these scenarios play out simultaneously over the next twenty years, with upgraded research parks, research clouds, and vacant tracts of research parks that never were, all exist ing side-by-side. The simple fact is that the complexity of science and technology today is too big for any one campus, firm or research park to tackle in isolation.

The literature on knowledge ecosystems, developed in organizational studies over the last few years, provides robust framework upon which to develop a new understanding of how innovation happens in regions. A knowledge ecosystem refers to the events that occur as codified knowledge is transformed into tacit knowledge over time through learning and experience. Studies of knowledge ecosystems focus on how communities of practice interact with established bodies of knowledge and the tools and practices for upgrading that knowledge over time.

At least one study has explicitly applied the knowledge ecosystem framework to understand a technology region.[10] We believe that this framework can be used by the research parks and economic development community to better understand the processes by which communities of practice, embedded in metropolitan areas, generate "sticky know—how" that has real, unique economic value that is difficult to copy.

The regional knowledge ecosystem framework has several advantages. First, it focuses our attention not on the existing institutions of economic development—universities, research parks, large companies, venture funds, etc—but on the dynamics of how they interact with each other and new non-institutional elements (talent, bodies of knowledge, virtual communities). While the economic development field is awash in talk of "networks", the concept has lost all meaning. A rigorous application of knowledge ecosystem theory will allow us to begin specifying the kinds of networks and how they ought to operate. Second, it brings a holistic approach to how we think of innovation in regions—not as an isolated activity that happens within specific firms or clusters, but as a cohesive system. Dysfunctional knowledge ecologies are costly to organizations, but in a regional context, they also impose costs on everyone else (if only opportunity costs). Finally, the knowledge ecosystems approach is particularly attuned to understanding how organizations perform in "hyper-turbulent" chaotic environments, which certainly describes the global technological and economic landscape.

Applying a knowledge ecosystem frame to regions immediately yields several insights that may dictate strategic shifts in the way we approach technology-based economic development. First, while land and leased space will continue to underpin the economics of creating research spaces of all kinds, the real added value will increasingly come not just from providing services (as many parks already do), but from actively managing activities and knowledge creation. Second, as scientific knowledge and tools become available anywhere on-demand, focusing on global domination of any particular industry will lose effectiveness. Growing the regional ecosystem elements that provide the capacity for repeatedly reinventing the cluster will become paramount. Third, all of these dictate a reduced emphasis on real estate development and infrastructure, and more emphasis on creating mechanisms that link local assets to global markets in ways that generate value.

Our understanding of this tool is in its earliest stages, and will require further development. However, our forecasting and scenario-building exercise points toward a crucial need in every technology region, for new governance structures that are broader than a single industry. Acting as a custodian of the regional ecosystem frame, this body could perform several functions. In the short term, new tools are needed for measuring and mapping networks and flows of knowledge, money and ideas. In the medium term, new business models for managing regional assets and creating something that is great than the sum of its parts. In the long-term, the challenge will be leveraging this ecosystem and its many networks to help firms and clusters compete globally—by collectively figuring out where a region fits into global R&D "supply chain". Their goals will be to encourage knowledge creation at the cutting edge and develop the organizational, human and social capital to compete in the global economy. It would build networks that would stretch far beyond the major regional institutions of today to include informal networks of entrepreneurs, investors, professionals and hackers and other communities of mentoring and learning.

[10] Bahrami, Homa; Evans, Stuart. 2005. *Super-flexibility for Knowledge Enterprises*. Ch. 3.

This is where the Institute for the Future and the Research Triangle Foundation find ourselves at the end of this study. This is merely a beginning, however. We will continue to examine the findings of this forecast with our partners and the global network of science parks and technology regions.

We also will be working to develop realistic and implementable execution strategies that respond to the challenges of this forecast. These strategies will be shared in a "field manual" for existing research park and technology-oriented economic development managers—but also a framework for those considering the development of new parks or innovation-focused development programs.

We believe the only way to invent the future will be through systematic futures thinking, risk-taking and experimentation. If the research parks and economic development community does not do it, they will leave it to others to lead.

Part II—Trends Shaping the Future of Technology-led Development

Our forecast research identified fourteen trends that will broadly set the context for technology regions and research parks over the next 5–20 years. They summarize keys global shifts in three domains: economy and society, science and technology, and the models and places for R&D.

Each trend identifies a direction of change and consists of four main elements:

Headline—a title that describes the overall direction of change

Description—what is happening in this trend? What are the key drivers and enablers?

Signals—what early indications of this trend are visible in the world today?

Impacts—how will this trend shape the context for research parks and technology-based economic development?

Economy and Society

The first set of trends examines major global social and economic forces that will set the context for enterprises of every kind.

First, the current global economic crisis will echo for a decade or more, putting governments at the forefront of funding basic science and technology research and constraining big new development projects. Second, new technologies of cooperation will elevate the economic importance of small groups in elation to corporations and individual consumers. This will transform entire industries and reshape the need for collaborative space. Third, as governments and industries work to address global warming through carbon markets and taxes, the measurement of the economic value of ecological processes will be increasingly important.

From Free Markets to Stimulus Capitalism

The economic crisis of 2009 will turn the tables on markets, putting governments at the helm of the global economy for many years to co me. Public investments in basic science and research infrastructure will be used as a primary tool to stimulate both short-term and long-term growth. In the United States, this shift is well underway, and in rising science powers such as the Gulf states and China, recent large public investments in research capacity will at least be are sustained and potentially will expand.

Signals

Harvard University will house Stem Cell Institute in renovated building instead of new science campus [*http://tr.im/l8Wx*]

2009 U.S. economic stimulus provides $100b for science and technology [*http://tr.im/l8Vx*]

Corporate R&D spending holding steady, but real risk of decline in 2009 [*http://tr.im/ilMz · http://tr.im/ilMH · http://tr.im/ilMQ*]

China and Gulf States continue state-led development of R&D capacity and science cities *[http://tr.im/lZOh · http://tr.im/mqC1*]

Impacts

The economic crisis, and governments' massive response through new science funding, will have both short-term and longterm impacts.

An "innovation bottleneck" will form over the next 3–5 years, as companies trim R&D spending and focus on short-term, quick-to-market innovation during the crisis, and before the results of government-funded research projects can be commercialized.

While companies will expand engagement with universities to accelerate technology transfer, there are few short-term solutions.

The supply of venture capital will be constrained, as new funds and less experienced angels who entered the industry in recent years retrench to safer wealth pres-

ervation strategies.[11] In global regions where venture capital markets are lacking or under-developed, the economic situation will slow the development of new funds and investor networks.

The real estate industry will continue to struggle financing new projects and will avoid taking big risks. Real-estate investment trusts that focus on research parks and lab space have been especially hard hit. Even universities acting as developers are not immune to the slowdown, as endowments have suffered in proportion to overall market declines of 30 percent or more. Public universities will face large reductions in government aid, severely limiting their ability to develop new labs and research parks.

Research clusters in developing economies are likely to make significant gains in market share for global R&D spending as they provide lower-cost alternatives to cost-cutting companies.

Finally, existing research parks are likely to see increased tenant demands for flexible lease arrangements, as they plan for greater resilience to future economic shocks.

The Group Economy

New tools for cooperation will drive down the cost of forming groups around any shared interest, identity or activity. New models for creating wealth will emerge at the intersection of the social web and grassroots movements. Existing organizations will be transformed through the adoption of these tools and processes, becoming less hierarchical, more agile and more collaborative.

Signals

Companies adopt of social software as a knowledge management tool—Lotus Connections [*http://tr.im/l972*]

Meetup.com's rapid growth as a platform for organized ad hoc interest groups for face-to-face meetings [*http://www.meetup.com*]

Obama campaign financed largely by small donations made online [*http://tr.im/l97d*]

Science bloggers convention at Research Triangle Park [*http://tr.im/l989*]

Academic studies mapping scientific collaborations [*http://tr.im/l998*]

Impacts

As it spurs the creation of new kinds of ad hoc organizations, and transforms existing ones, the group economy will have major impacts for the kinds of places and spaces that are needed for collaborative innovation.

New kinds of organizations will seek "landing spots" for meetings of various kinds—scheduled daily, weekly or monthly meetups, and ad hoc gatherings around interests, ideas and current events. The space and infrastructure demands for these kinds of activities are dramatically different from those supplied traditional research park—less permanently occupied, private spaces and more think-tank type collaborative spaces. The need for temporary, flexible and even mobile spaces will grow dramatically.

The group economy will change the needs of existing organizations' space as well. Existing tenants will require more meeting and collaboration spaces, and less space for "warehoused" workers. The goal will be to put collaborative activities in spaces that can amplify group economies, and provide opportunities for discovery. As open innovation strategies spread, there will be greater need for co-locating company employees and outsiders within shared spaces.

Finally, the group economy will place new demands on the measurement techniques traditionally applied in economic development and research management. Today, most econometric data looks at outputs and uses existing organizations as its units of analysis—the firm, the research park, the region. However, in the group economy, there is are new needs to measure both the flows between organizations—the "in-between stuff"—as well as the dynamics of small groups forming outside institutional boundaries. How do we measure the substantial impact of organizations without organizations?[12]

Ecological Economics Comes of Age

As governments and industries work to address global warming by developing environmental trading markets, carbon taxes, and other mechanisms, the measurement of the economic value of ecological processes will be increasingly important.

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[11] National Venture Capital Assocation and PricewaterhouseCoopers. *MoneyTree Report* [*https://www.pwcmoneytree.com*]

[12] C. Shirky. 2008. *Here Comes Everybody: The Power of Organizing Without Organizations*. (Penguin Press: New York)

The first major efforts in this area are around carbon. Today, carbon trading is based on estimation more than on the measurement of real systems. Evolving carbon markets from estimation to measurement will generate complex scientific and technical problems requiring transdisciplinary solutions. Figuring out precisely how much carbon is sequestered in a parti cular preserve in Indonesia or Brazil, and how to turn that scientific knowledge into financial instruments will require basic research in botany, ecology, climate science, geology, remote sensing, and even accounting. As a scientific endeavor and information service industry, this will draw upon technological advances in sensing and measurement, simulation and supercomputing.

Signals

Carbon trading markets are growing rapidly, estimated to trade hundreds of billions of dollars of credits worldwide. [*http://tr.im/lZOB*]

Efforts to construct valuation of environmental services (beyond environmental impact studies) [*http://www.iftf.org/node/2789*]

Growth of bilateral trading regimes (*e.g.,* between Northern companies and Southern forest preserves), supporting specific investments or environmental initiatives. [*http://tr.im/mqEt*]

Commercialization of carbon offsets and their widespread adoption by travel agents and travel sites.

Growing availability of personal carbon tracking estimators for travelers. [*http://tr.im/lM3l*]

Impacts

The next decade will see the introduction of a new generation of sustainability-related practices, technologies and services, built less around estimations of the environmental impact of manufacturing, transportation, and resource/energy use, and more on the measurement of actual resource use and pollution.

In this new industry research parks can serve as test-beds for innovative environmental management practices and services. For companies developing these services, fellow research organizations are likely to be valuable beta-testers and early adopters. Research parks located near economically valuable and productive ecosystems could be attractive locations for both researchers developing tools for measuring ecological activity, and entrepreneurs developing instruments for monetizing that activity.

Developing countries seeking to leverage natural resources could turn carbon offsets into a mechanism for technology transfer. By linking investment in science and technology infrastructure to carbon mitigation instruments, they could boost their own capacity for ecoscience at the same time they provide a valuable ecological service to carbon-hungry developed economies.

Science and Technology

Evolving in parallel to trends that will transform the economy and society over the coming decades, the subjects, methods, talent and institutions of scientific research and technological innovation will shift as well.

Five trends will have the greatest impact on technology-based economic development and research parks:

Biology by design will supplant physics as the most scientifically vibrant and economically important field, letting us read and write nature's "source code" at will.

The spread of *ubiquitous computing* will create massive new streams of research data, while simultaneously providing new tools for scientific collaboration in the lab.

Social networks where people and computers work together to make sense of data will enable a shift *from artificial intelligence to hybrid sensemaking*.

New scientists will transform the practice of science by forging transdisciplinary fields, multi-sector careers and bringing new cultural influences to bear.

Science institutions will be transformed as collaborative, open and online models for collaboration and knowledge sharing break through obsolete barriers.

Biology By Design: Nature as Source and Code

From synthetic genomics (which seeks to design micro-organisms that perform useful functions) to stem cell therapy (which seeks to harness the body's own ability to heal itself), biology will become a central source of scientific and technological breakthroughs. Key drivers include global ecological challenges, the health needs of a richer, aging global population and advances in informatics that help decipher the code of life. Biological concepts about how to organize systems and structures will also inspire designs for everything from buildings to organizations to algorithms. Yet many experts believe the biotech industry is structurally unsound—without

change it won't be able to fully realize the commercial potential of these new technologies.

Signals

First synthetic genome created by J. Craig Venter Institute [*http://tr.im/lfHL*]

Scripps Florida biomedical research center opens in Jupiter, Florida, home of the largest chronically diseased population in the world [*http://www.scripps.edu/florida/*]

Massive public investment in biotech at the sub-national level [*http://tr.im/lfMW*]

Transdisciplinary and translational biomedical research centers at Stanford, MIT and UCSF

Google launches venture fund, which will make some investments in biotech "to keep an eye out for disruptive ideas to its core search business that might come from unexpected fields, such as biotech." [*http://tr.im/lZDi*]

Impacts

Biotechnology has not lived up to its economic promises—as Harvard professor Gary Pisano notes, while biotech has attracted more than $300B in capital over the last 30 years, it has produced profitless growth. Synthetic biology may change that, and increase the demand for research space over the coming decades. So-called "white" biotechnology—industrial biotech for producing fuel and materials may just be mundane and scalable enough to produce sustainable profits, unlike earlier generations of "red" (biomedical) and "green" (agricultural) biotechnology.

In the meantime, however, the sector will continue to require massive public investment in basic science to jumpstart economic activity. In the United States, state governments have invested heavily ($500M for California's Institute for Regenerative Medicine, $1B for the Massachusetts Life Sciences Initiative, and $1.2B in North Carolina over the last decade). None of this will change the fundamental structural issues in the industry, which is largely borrowed from Silicon Valley's information technology (IT) industry, and which Pisano argues are stifling innovation. Larger efforts, involving public, private and NGO stakeholders will have to address these on a broader scope.

Biotech will also diverge from the IT industry in the ways and places in which it clusters. First, the translational nature of biomedicine means that researchers are often moving from lab to bedside frequently, requiring them to be located near research hospitals in large population centers, often in the center of large cities (versus a suburban research park). Second, it often involves specimens that cannot be removed from the lab—distributed work is less important since much of the "code" is not portable as in the software world. Third, while IT infrastructure is becoming highly distributed, many of the most advanced biomedical research tools are becoming highly centralized. For instance, the next generation of high resolution MRIs used in brain imaging research weigh dozens of tons and take up an entire building.[13] Finally, biological research will always entail a certain level of public health risk—while many factors cited above point toward centralization, the need to isolate hazardous materials may push in the other direction—some bioresearch will need to be located far from population centers.

The sheer complexity of bioscience will require radically new approaches to designing research organizations. Research at the intersection of biology and informatics, and biology and nanotechnology, for instance, requires bringing together different disciplinary skillsets in the same place or even the same person. Parks and regions that can tap multiple disciplinary centers of excellence, or partner with transdisciplinary organizations and research communities will be well-positioned for biomedical innovation.

Ubiquitous Computing

The spread of ubiquitous computing (ubicomp)—the diffusion of unobtrusive digital sensing, computation and communications technologies into ever-larger parts of man-made and natural environments—will create vast new datasets for scientific research in fields from public health to civil engineering to marine biology. Mobilizing this computational infrastructures will require intensive collaborations between IT specialists, scientists, and engineers. But once in place, ubiquitous computing technologies will also generate very large quantities of information from everyday activities like travel, shopping, and communications. This will have substantial commercial value to companies that can manage and analyze it quickly enough. More im-

[13] Siemens AG. Fall 2008. "Magnetic Mission" *Pictures of the Future*. p.88.

portantly , it will enable new research in social science, public health, and field sciences that will contribute to the further quantification of these fields.

Signals

The growth of environmental sensing research in ubiquitous computing, such as the Living Environments Lab at Carnegie-Mellon [*http://www.livingenvironments.net/*]

Research in "smart dust," cubic millimeter-scale computers that within a few years will allow us to place computing and reactive capabilities in a wide variety of built objects and environments [*http://tr.im/mqIz*]

The growth of low-cost displays, and their diffusion into a variety of use contexts and devices, ranging from cellphones and iPhones to wall-sized digital billboards.

Impacts

Ubiquitous computing will collapse many of the distinctions we take for granted when doing everything from designing scientific research projects to designing research spaces. The distinction between online and offline environments, digital and physical worlds, even between natural and artificial, break down. This does not mean that physical places will become irrelevant: instead, the smart deployment of well-designed digital resources, and the early adoption of new digital technologies, will set smart places ahead of the pack.

On the research front, ubiquitous computing creates opportunities and demands for new forms of cross-disciplinary research. Because ubicomp creates the potential to blend digital resources with a wide variety of materials and environments, research parks could create value by bringing computer scientists and engineers together with sculptors, textile designers, architects, and anthropologists—or with craftsmen and workers from established, mature local industries. It will also create a need for hyper-wired, digitally-mapped, configurable spaces that can be used as test-beds for new technologies.

Ubicomp will also create a need for "living labs" like Seoul Digital Media City or Singapore's Fusionpolis that combine vibrant real-world communities with research and prototyping. Ubicomp is as much about the use of technologies as their deployment; having spaces in which users can realistically interact with prototypes or enhanced spaces can generate valuable experiences and insights for researchers, retailers, and designers.

From Artificial Intelligence to Hybrid Sensemaking

For decades, computer science sought to create artificial systems capable of duplicating and even replacing human reasoning and communications. In the last few years, the excitement around collective intelligence experiments on the Web has established the value of a different approach: the creation of hybrid structures that combine social networks and more limited forms of machine intelligence, to collaboratively filter and extract meaning from data about our environments and ourselves. Such systems allow computers and humans to each do what they're good at, and mix together formal and tacit and social knowledge. More broadly, the growth of these tools reflects a more nuanced view of intelligence as an inherently social and contextual thing, not something reducible to computer cycles or logical statements.

Signals

MIT and NYU trials of workplace infrastructures that mine social interaction data [*http://tr.im/lM8Z*]

Experiments with "artificial artificial intelligence", like Google's Image Search Game and Mechanical Turk, platforms for small tasks are trivial for humans but extremely difficult for computers.

A San Francisco-based startup seeks make scientific distributed computing (made famous by SETI@Home) more accessible by combining a simple computing infrastructure with social networking tools to reach small, rich pools of talent or expertise.

The Network Oasis in Joensuu, Finland's GLOW system helps managers of an incubator space "manage serendipity" by understanding who is present and their skills and interests [*http://www.globaloasis.fi/glow/*]

Impacts

Artificial intelligence sought to make humans obsolete—as a corollary, it would have made place less relevant. But hybrid intelligence relies on a mix of unique places, strong algorithms, and vibrant human networks. Hybrid intelligences require interesting or unique working spaces, workplaces or other infrastructures that facilitate nonverbal communication.

Not only are there opportunities for research parks to provide rich physical spaces supporting hybrid intelligences. Hybrid intelligence could become a distinguishing feature of highly effective collaborative research spaces. By providing infrastructure and "reality mining" services, parks could distinguish themselves and move up the value chain.

Hybrid intelligences often mobilize around very large, uncertain bodies of information. These are too complex and specialized to be usefully analyzed using commercial-grade Internet connections and servers; the grid computing architecture developed for high-energy physics is likely to be replicated in other fields. Research parks that can provide very fast access to grid-scale computational resources, often in support of groups of scientists or social networks, will have an advantage over less-connected competitors.

The growing popularity of publications like the *Journal of Visualized Experiments* (JoVE) suggest that a new generation of experimental scientists will see the value of systems that allow them to communicate tacit knowledge at a distance. By employing hybrid approaches to map what people are actually doing in research environments, labs can help codify some of the things that were previously craft and technique.

The New Scientists

The next generation of scientists will transform scientific practice, the way scientific careers are constructed and managed, and the sources of knowledge they draw upon and develop in their work. As options outside academia grow, publishing becomes more open, collaborative and real-time, and entrepreneurship gains more legitimacy, the means by which scientists create professional reputation will be transformed. These new scientists will be both transdisciplinary and ultra-specialized, drawing on various disciplines to answer complex, focused questions. The role of amateurs will expand, as both independent researchers and partners of professional science. Scientists from emerging economies will introduce non-Western cultural, ethical and intellectual traditions into the practice of modern science. Science will also provide a pat h for women to achieve gender equality in nations with a high degree of gender segregation.

Signals

Increased competition for academic jobs, as PhD production increases and tenured faculty stay on staff is driving many doctoral graduates into private sector jobs. [*http://tr.im/m20o*]

The Princeton Review and Fortune Small Business now produce annual ratings of the best schools for entrepreneurs—institutions are beginning to see these students as a significant segment of their market.

Reward for entrepreneurship in tenure review is encouraging more young scientists to develop academic-industrial "bricolage" careers, moving back and forth between universities and business.

Universities are responding to student desires for more transdisciplinary education especially around design: Finland's Aalto University (created through the merger of 3 pre-existing universities), Stanford's D.School, and Design London (a joint program of Imperial College and the Royal College of Arts) [*http://tr.im/lmvl*]

"Scientists of the self" are using ubicomp technologies to monitor their own bodies and lives, generating volumes of data and unorthodox research questions. [*http://www.quantifiedself.com/*]

Science is actively engaging many more amateurs, who may go on to science careers or make significant contributions to formal research projects (SETI@Home, Birdsource).

Impacts

New scientists will have dramatically different expectations about career mobility and the ability to pursue independent intellectual interests outside of employment contracts. They will have greater demand for continuing education and learning experiences, and will want work environments where they can maintain connections to their social networks and outside sources of knowledge.

The role of social networks will be extended in other ways that impact econmic development. One of the most important assets being cultivated by large companies are their corporate alumni networks. As research parks and technology regions are increasingly selling community as a highly valuable aspect of location, creating membership-type organizations for "park alumni" might make sense.

Research parks and regions have long marketed themselves as attractive places for companies. As Richard Florida argues, places now need to be attractive to work-

ers as well, if not primarily.[14] However, in between these two layers, parks also need to think about how they appeal to small groups of new scientists—the clubs, mailing lists, and other rich networks that really connect and define innovative communities.

Finally, many of the new scientists will not be professionals, but amateurs. Parks have historically done a terrible job connecting to educational institutions and youth, if they have bothered at all. Connecting to amateurs will entail some of the same challenges, but also reap potentially larger rewards. As volunteer champions of science, amateurs represent a vastly under-utilized resource for parks and their tenants. And the failure to engage them in real world R&D is a lost opportunity to upgrade the region's human capital through experiential learning and training.

Science Institutions Transformed

Experiments with new organizational forms, incentive structures, and rewards will shake the foundations of centuries-old scientific institutions. Scientific publishing is already under full-scale attack, its economics and social conventions completely undermined by cheaper, faster, or more democratic online alternatives and by entirely new forms of publishing like video. Privately funded research centers like the Perimeter Institute, Kavli Institutes, and Jenalia Farms are experimenting new ways of funding and organizing research, and measuring the output of scientists. Scientific challenges like the X Prizes are coalescing into a parallel and competing incentive structure for innovation. Finally, the sheer complexity of the scientific challenges of the 21st century will require massive new global partnerships that cross political and organizational boundaries.

Signals

Prizes and challenges are emerging as a substantial incentive for innovation in sustainability and other global problems. (*http://www.signtific.org/en/signals/technology-prizes-and-challenges-innovations-sustainability-and-global-problems*, *http://www.signtific.org/en/signals/using-prizes-not-patents-support-drug-development-developing-world*)

Hedge funds are partnering with academic mathematicians and physicists to develop new tools of interest to financial engineering and science; others are supporting research in high-energy physics. (*http://www.signtific.org/en/signals/hedgefund-university-partnerships*; *http://www.signtific.org/en/signals/hedgefunds-new-cool-places-basic-science* ; *http://www.signtific.org/en/signals/private-funding-high-energy-physics*)

A wide range of institutions and entrepreneurs are developing alternatives to traditional scientific publishing, which has helped shape professional practices and rewards for decades.

Impacts

The growth of new kinds of scientific institutions may create new clients for research parks: private equity-funded laboratories, institutes created to solve specific high-profile problems. However, while some will be working at a scale and pace similar to companies and academic institutions, others may not, and may be designed to operate for only a few months or a year.

Research parks need to be sites in which virtual networks can coalesce into meetups, conferences, etc. They also need to be places that can support virtual work and new forms of publication. Research parks might also attract new institutions by developing their own science or technology prizes, or partnering with organizations offering prizes.

In some parks and regions, critical science institutions may need new sources of external support, or risk failing entirely. The crisis facing the newspaper industry today may be a particularly illustrative one. Once unthinkable, the failure of a crucial institution that could have massive impacts on local politics and economies, is now a reality in every city. Should parks and institutions struggle to save dying institutions, or help fledgling alternatives grow stronger to take their place?

Models and Places for Research and Development

The final set of trends looks at how organizational structures and business models for research and development are changing, and emerging ideas about how to configure these activities at various scales—the lab, the building, the campus, the region and the globe.

Six trends are shaping the future of R&D:

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[14] R. Florida. 2002. "The Rise of the Creative Class: And How It's Transforming Work, Leisure, Community and Everyday Life" (Basic Books: New York)

A new *global map of science* is emerging, in which smaller countries are playing an increasingly important role, challenging the Western superpowers' centuries-long dominance.

New models of *lightweight innovation* seek to do more, faster with less, and cast a broader net for ideas.

Universities will continue their transformation *from ivory tower to economic engine* and play a greatly expanded role in economic development—in time, it could become their primary function, trumping education.

Economic development practice will shift from trying to copy the success of others to building *sticky know-how*—tacit knowledge that builds on local cultural and industrial resources, and isn't mobile.

Greater attention to the *social life of small research spaces* will create dynamic, transdisciplinary places that bring virtual networks to ground.

Regional knowledge ecosystems will emerge as a new strategic frame, providing scale, efficiency and global platforms for economic development.

New Global Map of Science

If science in the 20th century was a pyramid, with the United States, the United Kingdom, Germany, Russia, and Japan at the apex, science in the 21st century will be more like a network, with multiple, linked centers of excellence. Successful countries and sub-national regions will pursue strategies to blend targeted investments in basic science with local industrial or cultural resources, to create unique and hard-to-reproduce centers of excellence. These centers will be designed to capture critical niches in complex global R&D "supply chains". Meanwhile, the shift from brain drain to brain circulation; the rising capability of moderate Islamic states to support scientific communities; and the growth of new "South-South" collaborative networks mean that these centers of global excellence can develop in a wider range of countries than in the 20th century.

Signals

Growth of South-South research cooperation [*http://tr.im/la34*]

Chinese universities hiring top global talent [*http://tr.im/la6S*]

R&D partnership between The Hamner Institutes for Health Sciences and China Medical City [*http://tr.im/lLZd*]

Fewer doctoral students staying in the U.S. after graduation [*http://tr.im/la6q*]

Globally mobile universities—NYU in Abu Dhabi, JHU in Nanjing, Georgetown in Qatar

"Bamboo ceiling" for Asians in U.S. firms [15]

Impacts

New research clusters in developing countries will capture an increasing share of global R&D investment, and increase the volume and value-added in technology innovations. Some of this will certainly come at the expense of existing industries in developed economies, through offshoring of "routine" R&D functions.

Globally networked science will necessitate a shift from zero-sum competition and efforts to replicate Silicon Valley's broad knowledge ecosystem, in favor of highly focused efforts to develop niches in global technology supply chains. This strategic shift will be pioneered by new clusters in emerging economies, seeking to be globally competitive at the cutting edge in narrow areas of opportunity.

Global science also means greater mobility of talent. As wage differentials shrink, returning home will be more attractive to foreign students—developed countries will need to offer additional value, such as a better business environment or easier access to startup funding. U.S. universities are responding by exporting their "brands" to developed and less-developed countries. We will also see scientists with global mobility that is more complex than simply moving between two countries—they may migrate multiple times to emerging centers of excellence.

Finally, global science will create more demand for "soft landing" zones for foreign companies expanding into new markets and joint ventures, which could provide an additional source of science park tenants, as "soft landing" companies outgrow their incubator space. Innovative regions will need to provide a broad variety of these spaces and market them through existing business networks.

Lightweight Innovation

Over the next decade, new economic realities will increase the pressure to innovate faster and cheaper. New ideas about how to organize the innovation process, combined with dramatically cheaper tools for invention that put advanced research

[15] J. Tang. 1997. "The Model Minority Thesis Revisited: (Counter)Evidence from the Science and Engineering Fields "*The Journal of Applied Behavioral Science*, Vol. 33, No. 3, 291–315

technology in the hands of small firms, will enable new lightweight models fo r commercializing knowledge. More and more of new product and service development will happen outside of existing pipelines. Lightweight innovation will reinforce the strategic shift of innovation activities out of large firms into broadly defined "open innovation" networks.

Signals

Innovations in early-stage investment: BetaWorks,Y! Combinator and AngelSoft

Falling costs of tools of invention—cloud computing, 3–D prototyping and desktop genomics

Crowd-sourcing innovation: Kluster [*http://www.kluster.com*]

Innovation clubs and Fab Labs in Kenya [*http://www.fablab.co.ke/*]

Impacts

Lightweight innovation points toward a growing role for startups in innovation systems at every scale—local, regional, national and by industry. Yet few research parks and economic development agencies are well-equipped to assess and address the needs of startups.

The most important shortcoming is in the area of startup financing. A growing array of smaller startups will seriously challenge traditional venture investing models, which simply cannot produce a profit on small deals. In some areas like biotech, this early-stage funding gap is being filled by corporate strategic venture funds. There will be an increased need for deep local networks of angel investors and small-scale seed funds—but these need to be run by seasoned entrepreneurs. "Dumb money" from investors without expertise or connections, has far less value than "smart money" that does.

The growth of startups, especially very small ones will create a "long tail" market for R&D Space. Instead of a handful of anchor tenants, a long tail is a large collection of very small firms that add up to significant demand. Since existing parks are mostly designed long-term leasing to large companies, a mismatch may emerge.

Incubation of lightweight startups will be a fundamentally new proposition. Just a few years ago, it took millions of dollars of venture capital, dozens of programmers, and a year or more to bring a new software product to market. Today, agile web startups move from idea to implementation without traditional incubation.

Access to "heavy" R&D tools will never disappear completely, except in a very few areas of technology. Research parks can play an important role in aggregating demand and subsidizing costly equipment. Especially in the developing world, where access to equipment is often the greatest obstacle to innovation for micro-financed inventors, this will be critical.

New innovation models are driving new approaches to intellectual property management, which will require managers of research spaces and communities to rethink how they support companies. The traditional focus on helping companies protect their IP, may need to shift to helping them open their IP to potential partners or new communities of innovation.

Universities: From Ivory Tower to Economic Engine

Several interacting forces will expand the modernization of universities' role in the economy. First, increased public investment in basic research will raise public expectations about the social and economic impacts produced by universities. Second, companies will continue to outsource research to university partners, amplifying the need for efficient technology transfer. Third, global competition between universities will foster more entrepreneurial initiatives to secure talent and find new sources of financial support. Finally, developing countries will rely heavily upon universities to jump-start new technology-based clusters.

There is a great degree of uncertainty about this shift. There is still considerable debate about whether "universities should deliberately do more to encourage the development of products or companies."[16] And while the .Edu Impact portal (*http://www.edu-impact.com/*) has cataloged over 90 economic impact studies of universities in the U.S. and worldwide, this is largely a defensive exercise by universities seeking to avoid taxation by local authorities, not a demonstration of university vision or public policy.

Signals

Texas—state officials requested that the words "technology commercialization" and "economic development" be added to university and college mission statements.

[16] *The Future of the Research University: Meeting the Global Challenges of the 21st Century*. 2009. (Ewing Marion Kauffman Foundation: Kansas City, MO)

UK 2015 Research Assessment Exercise will "for the first time examine factors like citation rates and the economic impacts of the research in question." [17]

The number of people employed in the technology transfer offices of U.S. universities more than doubled between 1998 and 2007. [signtific URL TBD]

Harvard University's Technology Accelerator Fund—$1.5m in annual grants for faculty to refine research to attract private capital.

Growth of university-based angel networks in the United States, Canada and Spain.

New technology transfer mechanisms like the Alfred E. Mann Institutes, "proof of concept centers" [*http://tr.im/lZPB*]

Innovation zones, like the Greater Oakland Keystone Innovation Zone, a partnership of Carnegie-Mellon, the University of Pittsburgh, the stat e of Pennsylvania and several non-profit organizations.

Impacts

The most aggressive universities will completely transform their promotion systems, deeply integrating incentives for entrepreneurship. Some universities (such as the University of Iowa and Texas A&M) now identify patents, patent applications and involvement in tech transfer as evidence in tenure review. Some universities are even willing to reward faculty who have proven their effectiveness in economic development as highly as academic stars.[18]

As the share and volume of basic research done at universities rises, technology transfer will either exceed or fail to meet public and corporate expectations. Flaws in prevailing models for managing technology transfer will become more apparent, such as the preference for patents that produce short-term profits over more challenging longterm commercialization projects. The backlog of research generated by stimulus funding may skew incentives even further in the wrong direction, and leave many promising technologies languishing in the lab.

On the other hand, greater competition between universities will encourage more experimentation by universities in technology transfer and IP management. More universities will develop strategies and resources for supporting other means of promoting commercialization and entrepreneurship than only patent licensing.[19] Others will create internal competition—putting outside agents on equal footing to compete with their own technology licensing office. Still others will partner to create multi-university offices that can achieve a more efficient and effective scale.

The role of research parks, incubators and other facilities for technology transfer will change rapidly. As expectations for technology transfer grow, universities will diversify their strategies for spin-off spaces. This will mean shifting from a single research park model to investing in entire "innovation zones". In this model, rather than merely developing an urban research campus, universities act as long-term participants in the ongoing revitalization of urban neighborhoods or districts. These districts are mixed-use, combining both academic and commercial research activities with residential, office, retail, and cultural uses. The goal is to create an en vironment that helps attract, nurture and retain talent, and to encourage innovation across a wide range of other enterprises as well. Extending this strategy, more incubation spaces may be inserted directly into campuses and university buildings.

Entrepreneurial universities are not without their critics. Gary Pisano argues that aggressive commercialization of university bioscience research is actually limiting the industry's development by reducing the pool of shared scientific knowledge. His solution: "[t]hey should focus primarily on maximizing their contributions to the scientific community, not maximizing their licensing revenues and equity returns." [20] And there is a clear impact on the academic environment in entrepreneurial universities—when research parks are close by, the curriculum tends to shift from basic to applied research.[21]

Some universities will be unwilling or unable adopt a new model, and will produce limited economic benefits. We are also likely to see the emergence of new universities where economic development, not education, is the primary mission. Most will fall in the middle. As one study summarized the future: "In our view, universities

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[17] "Peer pressure" *SEED*, April 2009, p. 20.

[18] For example, Alain Kaloyeros, who attracted more than $2.4 billion in Federal, state and corporate funding to make the University at Albany a center of nanotechnology and semiconductor research, was paid a salary of $696,000 in 2008.

[19] R. E. Litan, L. Mitchell, and E. J. Reedy, "The University As Innovator: Bumps In The Road", *Issues in Science and Technology*, Summer 2007.

[20] Pisano G. 2006. "Can science be a business? Lessons from biotech" *Harvard Business Review*.

[21] A. N. Link, J. T. Scott. "U.S. science parks: the diffusion of an innovation and its effects on the academic missions of universities" *International Journal of Industrial Organization*.

. . . increasingly have no choice whether to be entrepreneurial, although like for-profit firms, they do have a choice about how they go about doing so."[22]

From Knowledge Diffusion to Sticky Know-How

Advocates of innovation economies often see knowledge as both infinitely mobile and disconnected from its origins. Knowledge can be produced anywhere, this thinking goes, and high value-added, knowledge-intensive activities can be decoupled entirely from manufacturing. Both are wrong.

Many bench scientists can't take their work home, and some can't work outside one-ofa-kind facilities. Innovation often has a geographical or social "stickiness" to it because it can draw on combinations of scientific knowledge, technical skill and tacit knowledge that are place-specific. Nor is innovation so easily distinguished from manufacturing: many high-tech innovations have emerged while solving manufacturing problems, and contrary to popular perception, making things—especially innovative new products—is a highly complex, creative activity. Indeed, future industries, like the translational research paradigm emerging in the biomedical world, are likely to place a higher value on the tacit knowledge required to move new scientific discoveries from the laboratory to store shelves, doctors' offices, and living rooms.

Signals

Zaha Hadid's Central Building for BM's Leipzig plant deliberately seeks to mix white-collar and blue-collar workforce as a spur to innovation [*http://tr.im/lZT5*]

Rise of "guild" workspaces, such as Pixar in Emeryville, Calif. where large freelance contractor work forces are co-located with corporate customers during production.[23]

Venture capitalists are being recognized as tacit knowledge brokers who acquire and create intelligence about industries, market conditions, entrepreneurs and companies through a constant process of interaction and observation. This knowledge is then used to select promising industries, find good firms, and assist portfolio companies.[24]

Venture capitalists' are the center of a tacit knowledge exchange system that gives them lots of exclusive know-how. They are also able to speed this process to provide their portfolio companies an advantage.

Trade fairs are "temporary clusters" that provide mechanisms to share tacit knowledge exchange over long distances.[25]

Intel "Copy Exactly" in which Intel copies successful factories, right dow n to the paint colors, on the theory that they don't always know what makes a factory successful, so just copy everything. [*http://tr.im/lZXh*]

Impacts

Partnering or providing space for groups that have skills very different from conventional R&D, but can contribute to the development of innovative products or services—arts or cultural groups, human factors or ethnographic researchers, even financial engineering firms—may encourage unique cross-fertilizations that forms the basis of competitive advantage.

Some research parks will be able to maintain their viability if they can both attract interesting people, and co-locate near useful industries or important markets.

Boutique parks designed to bring together highly specialized clusters of existing tacit knowledge could incubate new technologies and innovations. For example, these could support creative work combining older industrial knowledge with new high-tech expertise.

For innovations in "brownfield" industries, critical challenges aren't just technological, but also regulatory, legal and financial. Research parks specializing in areas like cleantech, environmental remediation, alternative energy, and sustainable development would be smart to attract experts in finance, law, and technology policy.

Manufacturers who want to move up the value chain could be a target for new R&D parks.

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[22] (Kauffman p. 124).

[23] Myerson J. 2006. *Radical Office Design*. (Abbeville: New York)

[24] Zook, M. A. 2005. *The Geography of the Internet Industry: Venture Capital, Dot-coms and Local Knowledge.* (Blackwell: New York)

[25] Bathelt, H. and Schuldt, N. A. 2008. "Between Luminaires and Meat Grinders: International Trade Fairs as Temporary Clusters". *Regional Studies*. 42:853–868.

The Social Life of Small Research Spaces[26]

Traditional business incubators will fade away, replaced by new kinds of spaces for entrepreneurship and collaborative research. Pop-up labs, co-working hubs, mobile incubators and disposable research parks will provide flexible physical spaces for R&D. Rather than warehousing workers, they will meet a need for communal collaborative meeting space in a world of increased mobility within and between workplaces. They will be neutral places where networks of investors, entrepreneurs, hackers and customers converge for collaborative knowledge creation and trust-building, cementing relationships initiated and cultivated online. Overlaid grids of social software will enhance serendipitous discovery inside these spaces and knit them together in local, regional and global networks of collaboration.

Signals

The rise of coworking and communal rent-a-desk and drop-in offices—[*http://tr.im/lkjQ*]

Kitchen Budapest, a "pop-up" media lab [*http://www.kibu.hu/en*]

Angel network in residence at Cambridge Innovation Center [*http://tr.im/lkke*]

Throw-away research parks—Phase Z.Ro in Singapore [*http://tr.im/lkkt*]

Oklahoma City's mobile biotech incubator—relocate the incubator instead of the growing company [*http://tr.im/lklf*]

The Hub's global network of social enterprise incubators [*http://the-hub.net*]

Charge-by-the-hour incubator space [*http://www.globaloasis.fi/*]

Impacts

The collaborative magic of small research places depends heavily upon the ability of managers to "produce" and "direct" the space like a "show" on a daily basis. This involves coordinating events, both formal and informal, ensuring a steady flow of new people and ideas through the space, and making connections between participants. This is a very different set of skills than the typical research park manager or economic developer today. The shift from managing land use and real estate to managing activity (or both) will require a fundamental shift in perspective.

Small research spaces are the physical side of lightweight innovation, allowing big companies and their smaller partners to come into direct contact. As architect Frank Duffy writes, "Conventional office developments exclude or marginalize workspace at lower rental levels and thus diminish the possibility of mutually beneficial interactions between large, mature businesses and smaller, growing enterprises." Simply moving small bits of the company out of the main campus (like Corning, Yahoo! and Intel have done in recent years) will not be enough. Corporations and startups will need to co-locate within the same buildings, forming "coalitions of interest".[27]

Small research spaces, because they lack the scale of research parks, are heavily dependent upon social networks to extend their reach and connect to external resources. Social networks are the demand generators for these spaces, as online communities develop needs for ad hoc, temporary or on-demand meetings, these spaces will need to develop business models to meet those needs.

The new leasing arrangements of small research spaces—monthly, weekly, daily, and even hourly rate structures—will overturn the supply chain for commercial real estate, which evolved around long-term leases of 10 years or more. As Duffy points out, conventional leases block feedback from users in the design and construction business. By providing direct daily feedback to property managers, research "hotels" might introduce end-user innovation to architecture for the first time in a century.

Many of these small spaces are driven by more than just business objectives. A growing number seek to further social goals by incubating social ventures (Front Seat Software in Seattle, The Hub in London) or by gathering disparate firms and communities in just-emerging sectors like sustainable design (Treehouse Brooklyn).

Finally, small research spaces present an opportunity to make R&D more transparent—engaging not only partners, customers and suppliers, but also a broader public as well. Already, we see many firms engaging lead users through beta tests and iterative design processes—it is only a matter of time before the physical organization of research adapts to support these activities.

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[26] The title of this section is a reference to Willam "Holly" White's pioneering videographic studies of how people use public spaces, conducted in New York City in the late 1970s, and presented in a film and book titled *The Social Life of Small Urban Spaces*. [*http://www.pps.org/info/products/Books_Videos/social_life*]

[27] F. Duffy. 2009. *Work and the City.* (Black Dog: London)

From Research Parks to Regional Knowledge Ecosystems

Translational research—science that transcends basic and applied research—and successful commercialization of the resulting technology, will grow increasingly complex. To succeed, these efforts will require coordinated investments at the regional level, because no single organization will have the capacity to perform all of many steps between lab and market. Because of this, we will see an expansion of new institutions and governance structures operating at the regional level whose goal will be to encourage knowledge creation at the cutting edge and develop the organizational, human and social capital at the scale needed to compete globally. These institutions will stretch far beyond the regional networks of today to include not just university and corporate leaders but also entrepreneurs, investors, professionals and amateurs. By their very nature, regional knowledge ecosystems will transcend traditional industry boundaries, seeking to create capacity to quickly re-invest resources and re-invent industries in response to global shifts.

Signals

East Bay Green Corridor in California—coordinated regional approach to growing and attracting cleantech industries. [*http://tr.im/m250*]

North Carolina Research Parks Network pooling marketing and long-term strategic planning resources.

Øresund IT, a regional body in Denmark and Sweden, expansive mission includes identifying and initiating R&D projects. *[http://www.oresundit.com/?id=41*]

World Bank infoDev project global incubator network [*http://infodev.org/en/Publication.6.html*]

Impacts

The risk-spreading logic behind a regional approach to technology-led development is parallel to the innovation zone strategy of universities. In their seminal study of U.S. research parks, Luger and Goldstein concluded "one of the few generalizations we can make about the net benefits of research parks is that they are far from certain." By scattering investments across a number of real estate, infrastructure, venture and human capital investments regions have more chances of success, albeit on a smaller scale, than a single bet on a research park.

Spreading risk may also improve resilience and agility in periods of economic turbulence or great technological change. The strength of regional knowledge ecosystems is that they can adapt faster than national systems, which are dictated by national politics, and they can scale up successful enterprises much more effectively that individual research parks or municipalities. In fact, one of the best models for future regional alliances may be the regional readiness partnerships pioneered by the disaster management community, which are wholly voluntary , but flexible and effective.[28]

For these reasons, it is likely that regions will become the new default starting point for formulating technology -based development strategies, with the pressure to do so coming both from the top-down and the bottom-up. National governments will increasingly delegate research funding decisions to regional networks, while a constellation of small, local players will require greater assistance in leveraging regional assets. Regional strategies that anticipate obsolescence and disruption will permit resources to support the continuous learning of the workforce and upgrading of research infrastructure.[29]

For firms, there are many potential gains from public stewardship at the regional level. The need to tap regional and global knowledge pools, research infrastructure and talent are at odds with economic development strategies that focus on particular parcels of land, campuses or local jurisdictions. Recent research on the dynamics of technology clusters points toward two important flows of knowledge that play different roles. "Local buzz" is the dialogue of rumors, knowledge and other information within a geographic cluster. "Global pipelines" are the flows of more codified kinds of knowledge that firms obtain through business relationships with distant firms. Regional knowledge ecosystems could become mechanisms that improve both functions—speeding the flow of knowledge in a regional cluster, but also making it easier for firms to import knowledge and amplify the spillover benefits to other firms in the region.[30]

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[28] S. T. Ganyard. May 18, 2009. "All Disasters Are Local" *New York Times*. Opinion/editorial.

[29] M. Joroff, W. Porter, Feinberg, C. Kukla. *Enabling Work Practice* (Cambridge, MA. MIT School of Architecture and Planning, 2008)

[30] Bathelt, H., Mamlberg, A. and Maskell, P. 2002. "Clusters and knowledge: Global buzz, local pipelines and the process of knowledge creation". [*http://ideas.repec.org/p/aal/abbswp/02–12.html*]

Regional approaches to technology-based economic development are not without their critics however. By spreading risk, regional approaches may spread government research support too thinly across many institutions, preventing the formation of a critical mass that can achieve breakthroughs. Some innovation economists also argue that regional approaches distract policymakers from the needs of firms—and that it is individual companies that are "competitive" not regions or clusters.[31]

As regional knowledge institutions develop, and innovation zones and small research spaces proliferate, it is entirely likely that the term "research park" or "science park" will gradually fade from the vocabulary of economic development. For existing parks, the rise of regional ecosystems will require a major reinvention. It means expanding the range of workplaces they connect to and manage—in fact this will be a major value proposition for them. Park managers can play a role in helping tenants build bridges between core centrally owned space and non-core spaces like homes, cafes and airports—all the other places where people actually work. Buildings need to transform into platforms that are resilient enough to enable disruptive reconfiguration.

Part III—Three Scenarios of the Future

Trends are valuable for understanding directions of change in areas that will help shape the future. But the future is a complex and messy place, and will be shaped by many trends acting in combination. If we only look at individual trends in isolation, we will miss the big picture.

Scenarios are a tool for thinking about the future in all its complexity. While it is highly unlikely that any scenario we envision in the present will come true in its entirety, parts of scenarios might, and the discipline of thinking systematically about the future allows us to prepare for better decision-making in the present and near future. Some places may confront one of these scenarios more than others. Some may confront all three and have to make choices about which direction they want to go. Others may find these irrelevant but the process of systematically thinking through how they would react to them develops future thinking literacy and skills.

Four external trends were pivotal in shaping these scenarios, because of their broad importance in setting the background for technology-based economic development. They are also have a high degree of uncertainty, and may play out in a variety ways. These highly uncertain trends are:

Universities. Some universities will embrace entrepreneurialism while others reject a larger role in the economy. But all will face challenges navigating the conflicting demands and increased strains of a shifting economic and intellectual role. (see "Universities: From Ivory Tower to Economic Engine", page 25).

New science institutions. Professional societies, journals and other institutions that set the basic rules of who can call themselves a scientist, and how they should conduct research and share results, will come under tremendous strain. Something will replace these institutions, but how will it connect to existing and new places in the future? (see "Institutional Transformation", page 21)

Sustainability. The cost of energy will drive business and policy decisions across the board. How will R&D ecosystems react to different energy frameworks, and the scientific and technological challenges of battling global warming? (see "Ecological Economics Comes of Age", page 13)

The bio-industrial complex. Bioscience will supplant physics as the source of great breakthroughs, but will the fundamental flaws in systems for commercializing those discoveries be fixed, and what role will places play, if any? (see "Biology: Nature As Source and Code", page 15)

By combining plausible hypotheses about how these factors might play out in combination, we developed three scenarios for the future of research parks set around the year 2025, that are intended not to be a prediction of what will happen, but what could happen, with the goal of provoking strategic thinking about what we can do today to get ready, build resilience, and develop the ability to think systematically about the future:

Scenario 1—Science and Technology Parks 3.0

Incremental Change Adds Up

A time-traveler from 2009 would still recognize the research parks that are being built in this scenario, all over the world, at roughly the same level as today. But looking deeper inside them, he will see that these parks are upgraded versions of their predecessors—faster, more efficient and with more features. They are starting

[31] "The fading lustre of clusters". Oct. 1, 2007. *The Economist*.

to bring conventional tenants together with new kinds of collaborative networks, and leveraging the intellectual resources of universities more effectively than today. Put simply, they are doing some things right, but some opportunities have been passed over due to the risk involved.

Parks have developed deeper formal ties to universities and companies alike, but technology transfer is still a long, inefficient and uncertain process, and parks still play a limited role. Regional partnerships are helping to pool marketing resources and create global brands, but are not actively managing ecosystems of knowledge, talent and investment. New science networks overlap and occasionally connect to parks and campuses, but they still form and grow mostly outside the sphere of parks' influence. The most successful parks are almost exclusively housing or incubating biotechnology and biomedical R&D, and investing significant resources in bridging some of the industry's structural obstacles to innovation—though progress is incremental.

Universities as Catalysts

Part of why parks haven't changed much is because universities have changed a lot. Many of the commercial and entrepreneurial functions of parks are now seamlessly integrated into campuses and curricula. Both faculty and students are supported and rewarded for entrepreneurial activity. The humanities shrink in relation to business and professional training. There has been a lot of innovation in how universities manage intellectual property and technology transfer. With private research institutions stealing away the best faculty, they really had no choice.

Parks as "Living Labs" for Sustainability

One area that research parks have made a calculated gamble is in sustainability. The economy is still going through a managed transition new energy regime, but it has been expensive and difficult. Early on, research parks seized the opportunity to distinguish themselves as centers of experimentation in sensing, energy and resource management. A select group has pioneered its own performance standards that go far beyond LEED—they are carbon-negative and are now global centers for innovation in the booming business around managing carbon.

Bringing Biotech and Big Pharma Closer Together

The Bio Economy hasn't truly blossomed yet, due to continuing structural deficiencies in the industry's structure. But one outcome of the Great Recession of 2009 was a vastly expanded role of big pharma's strategic venture funds in financing early-stage startups.[32] In this scenario, parks have positioned themselves as strategic sites for big pharma and biotech startups to co-locate. Parks provide flexible space for both short- and long-term collaborative research projects. Parks that accommodate a wider range of R&D and manufacturing are attractive to more vertically-integrated biocompanies. The most successful parks are positioned as key nodes for translation between biology lab and the marketplace (and back). They have also diversified connections between science parks and universities, so that life sciences are more strongly linked than today.

A Spur on the Science 2.0 Highway

New science networks and institutions are blossoming online, and research parks and their partners are listening to and participating in these activities. But parks are not the primary places where these networks are "coming in for a landing" in the real world but not leading. The main highways of Science 2.0 pass by parks, but not directly through them. The result is that its harder for tenants to really connect to these vital communities of innovation.

Scenario 2—The Rise of Research Clouds

Disruptive Competition from Outside

On a sunny morning in 2015, ScienceSpaces.com went live. Targeted at everyone from angel investors to corporate real estate managers, ScienceSpaces provides a real-time global directory of available research space at small, independent incubators and pop-up labs around the world. These spaces are distributed, agile and lightweight. They pop—up overnight as needs change, and disappear when their usefulness has run out. Many are tenant-owned cooperatives.

A year later, ScienceSpaces added a rich set of collaboration and innovation management tools, providing tenants with new ways to coordinate leasing and research projects across a "research cloud" of small facilities. This model combined the scale

[32] P. Mitchell. 2009. "Corporate venture funds chase early-stage deals". *Nature Biotechnology*. 27(5):403–404

efficiencies of traditional research parks with the diversity and dynamism of small, social collaborative research spaces.

Research parks everywhere scrambled to respond to this new competitive threat.

An Oort Cloud Around Universities

Like the Oort cloud of comets that surrounds the solar system, invisible but carrying the chemical seeds of life, the research cloud is an almost invisible, but crucial mass orbiting research universities. Some universities find ways to leverage this, but many don't.

The universities that don't get it fail to see that they are losing their dominance as hubs in regional knowledge ecosystems. Their stodgy IP frameworks and huge cost overhead make them very uncompetitive for anything other than teaching. Their research parks are trying to re-invent themselves into the cloud, and are disconnecting from the university partners that now present more of a liability than an asset. Academic institutions remain useful as sources of labor.

Ironically, it is universities with the smallest endowments that embrace the cloud most tightly, as they are priced out of large-scale expansion. They are aggressively shifting away from the "research campus" model, and toward an "innovation zone" model. By engaging with cloud players, they can spread the risk of spin-off activities among multiple participants. Development is more incremental, with less master planning and more evolution. Extensive reuse of existing buildings will also reduce costs of housing the cloud.

A Crucible for New Institutions and Networks

The research cloud isn't just a hub for new science and technology institutions—it is a platform for creating them. Since the cost of forming groups is basically zero, new groups are forming all the time around emerging fields of research, particularly challenging problems and new business models.

In the beginning, because it was outside the traditional system, the cloud had to invent new structures on the fly, and developed new platforms for reputation and rewards. These workplaces ar e peppered with sensors that "mine reality", helping the inhabitants be more effective and engineering meaningful chance encounters. But the sensors also help record people's contributions to the collaborative community. A sensor-rich environment could automagically note the 15 minutes you spent mentoring a young entrepreneur by the water cooler and credit your reputation account.

A small but growing number of research parks are injecting pieces of the cloud into their campuses, sites and buildings. These spaces are playing the role of the coffee houses of the 17th century. They are a place of open discourse among people from business, academia, startups, craftsmen, policy people, users, amateurs, etc.

Parks Hobbled High-energy Infrastructure Puts Parks at a Disadvantage

Parks and universities are at a competitive disadvantage to clouds, because they have lots of legacy infrastructure, underused real estate, and are big targets for regulation and citizen watchdogs. Bioteaming becomes a popular approach for managing clouds. Research parks that are connected to manufacturing are quickly adopting industrial ecology strategies or facing public scorn.

Lightweight Approaches Push Biotech R&D in Productive New Directions

While many critics thought biotech needed vertical integration, fewer networks and longer investment horizons, research clouds are showing that going in the other direction, hard and fast, can actually produce new industry structures capable of major scientific and technical breakthroughs.

Probably the biggest gain has come from the freedom clouds gain in how they manage intellectual property due to their lack of institutional legacy. Clouds make major contributions to knowledge commons like the Registry of Standard Biological Parts, and because so much of what they know is tacit, patents don't really matter that much. When knowledge leaves the cloud, it still has to be translated into something consumable by more traditional partners, but within the cloud many of those bottlenecks to knowledge circulation, that serve as barriers to innovation elsewhere, are gone.

Scenario 3—Dematerialized Innovation

Research Parks in Decline

In 2011, the number of research parks worldwide peaks and then begins to decline. The beginning of the end was the Great Recession of 2009, which devastated the commercial real estate industry and decimated university endowments, cutting off two of the main sources of funding for research parks. But what really spelled the end for capital-intensive parks was the Energy Shock of 2012, when a renewed

global economy picked up where it left off in terms of resource demand. Virtual R&D networks made big gains during these crises, allowing companies to maintain an innovation pipeline in times of austerity, while gaining greater flexibility and lower fixed costs. During each successive crisis, this beachhead of dematerialization has expanded, and today half of all innovations come from research teams that are highly virtualized—only in the last few steps of development does any real face-to-face collaboration happen.

There are many possible triggers acting alone or in concert—high energy costs, falling R&D productivity, or a protracted global recession. Since technology just isn't solving economic, social and environmental problems, the few remaining productive research enterprises become highly virtualized to cut costs. Existing parks fail to provide value to virtual networks, and don't create local and regional systems to create sticky know-how. Research parks are obsolete, mere office parks.

Universities Retreat to the Ivory Tower

Universities have become nothing more than very expensive coffee shops. Much of what they provide can be replicated in other places, or online through new platforms. Distance learning, which took off during the years after the recession, is now serving a large swath of the student population. DIY and peer-produced education is easy to assemble from vast learning resources online. People create and share curricula as pages of hyperlinks to archived lectures, documents and simulated learning environments.

Parks as Event Spaces

While demand for traditional, long-term leased private space is shrinking, the rise of distributed teams does not mean that teams never gather. On the contrary, there is a rapidly growing need for spaces that can house teams and other gatherings for a few hours, days or weeks. Some parks are reinventing themselves as event destinations, or extended-stay research "hotels".

Costly Energy Pushes R&D into Cyberspace

Among the many benefits of dematerialization is its much lower measureable sustainability impact. While some argue that virtualized research networks merely shift energy consumption from offices to home and from organizations to their employees, rather than reduce it, it's very difficult to prove this. Parks are at a severe disadvantage, because they are geographically contained big targets for ecological audits.

Biotechnology Stagnates

Parks and universities were probably the best possible sites for housing the kind of translational bench-to-bedside research that was needed to prime the biomedical industry for rapid innovation-based growth. The failure of both to compete effectively head-on with virtual R&D models means that few places exist that are well suited for translational research. Virtual networks are more suited to incremental innovation upon existing technologies. Too much dependence on virtual networks has also stifled cross-disciplinary conversations as communities of interest wall themselves off online, like radical political groups. It turns out that too much of a good thing can stifle innovation.

Part IV—Strategic Implications

This forecast has sought to identify the trends that will shape the future for technology-based economic development generally, and research parks specifically. Throughout Part II we highlighted tactical impacts of each of fourteen emerging trends.

In Part III, we brought these trends together to describe three scenarios for the future of research parks and technology regions. Here we highlight some broader strategic takeaways that arise from these scenarios.

Building Biomedical Places: From Silicon Valley to Biopolis

Too many assumptions about how technology-led development works are based on lessons learned from the Silicon Valley experience. However, these successes have not only proven incredibly difficult to duplicate but are unlikely to be a good model for successfully growing biomedical and biotechnology industries.

More and more we are beginning to understand the fundamentally different nature of biomedical R&D, the current and optimal industry structure, and the needs of growing firms. While a place like Biopolis in Singapore has literally reframed our thinking about how to build a "city of biology", it has by no means perfected the model. Bio-industrial regions will cluster along very different rules than IT hardware and software did. We have identified several driving forces in this study, but

more focused research is needed to understand how location decisions happen in these future growth sectors.

Building Responsive Universities

As universities become bigger players in R&D and economic development, their relationship with research parks and regions needs to be carefully rethought. On some level, the very notion of a university as solely a center of research and teaching needs to be re-examined.

In our scenarios, universities are among the least adaptive institutions. While universities do routinely respond to market and economic shifts, they do so over very long periods of time. Today, economic development often responds to the needs of universities. For regional knowledge ecosystems to become more resilient, they will need to encourage universities that are responsive to well-articulated regional needs. Structuring these engagements around mechanisms that produce tangible benefits for the universities will be crucial.

Future Business Models: from Products to Services

Each of our scenarios point toward a need to develop new business models for technology-led economic development efforts. The first-generation and second—generation models in use today are mainly driven by revenue from real estate development, sales and leasing and government subsidy. Potential new models are more likely to be built on venture investments, knowledge brokering and event management. The overall shift will continue to evolve rapidly from products (buildings, sites, infrastructure) to services (research "hotels", incubation, technology transfer, knowledge commons).

Rewards for Grand Visions

While the Great Recession may mean the end of big real estate projects, it does not mean the end of grand visions. In fact, it is during the downtime of a recession that the window for long-term strategic planning opens most widely.

Conflicts in large-scale efforts almost always arise from a failure to reach consensus or develop a shared vision early on. So, as a point of beginning, regions need to frame and embed a grand strategy in their thinking. For example, Research Triangle Park served as a primary mechanism for sustaining a m uch broader grand vision of re-inventing North Carolina's economy to stem the "brain drain" of young talent leaving for other parts of the country. The park's business model, and the grand strategy of developing the Triangle region worked together over a period of several decades.

Making Know-How Sticky

That original grand strategy for the Research Triangle sought to address that generation's challenge of a mobile work force—the "brain drain" migration of educated workers out of the South. But regions and places today face a different kind of mobility—of talent, but also of knowledge.

Figuring out how to create and maintain "sticky know-how" as an immobile asset will be a central challenge for technology regions and research parks. The first step is simply to assess what your "know how" assets are? What tacit knowledge is locked up in local manufacturing firms? How can strategic discussions be focused around core competence that can be upgraded and transformed rather than replaced?

Working at the Very Large and Very Small Scale Simultaneously

As they develop grand visions, and align interests behind them, successful regions are going to need to work simultaneously at the very small scale—unlocking the secrets of small research spaces and finding new ways to scale them quickly and coherently. Understanding the research cloud requires understanding its overall mass and shape, but also the diversity of its many fine-grained parts.

The first step in mapping this cloud will be engaging it. Identifying various elements and players in the cloud will be challenging, but we have identified many new players, groups and elements here—science bloggers, coworking spaces, angel investor networks. These can be the foundation upon which to begin discovery of the truly off-the-radar assets. The challenge will be creating venues and opportunities to bring the cloud out into the open so you can engage them.

Cultivating a Regional Knowledge Ecosystem

Beyond visioning, there are also several possible drivers of new institutions that take on the role of knowledge ecosystem managers at a regional level. As we discussed earlier, in highly successful regions, this role is played by venture capitalists—the ultimate brokers of tacit knowledge in technology-based economies.

In aspiring regions, future ecosystem managers might:

—Support and coordinate research across a network of "boutique" research facilities

—Coordinate research among universities across a region, acting as a broker for national research funding streams

—Funding and making available major technology commercialization infrastructure (*e.g.,* wind tunnels, supercomputing centers, etc)

—Rather than operate venture funds, invest in capacity for entrepreneurship broadly to develop the talent and high-quality startups that will attract private capital as a natural development.

Leadership for the "Long Now"

Regions need a leadership structure that can prepare for the "long now"—an extended view of how today's actions connect to future outcomes. Just like the massive science projects it will support, building and supporting regional knowledge ecosystems will require sustained, coordinated effort over many years. This is not something that will be accomplished overnight or under the influence or control of any one leadership group. This structure will need to bring about trans-generational hand off of stewardship over the grand vision, to avoid the zigs and zags that kill most plans. It won't happen accidentally, so it needs to be "designed in" from the beginning.

From Managing Dirt to Managing Activity

As research spaces become more collaborative, and the boundaries between firms, between institutions and between individuals will need to be re-designed. Places like the Network Oasis in Joensuu, Finland, are beginning to develop the tools and skills for "serendipity management". The notion of planning for chance encounters is counter intuitive, but that is exactly why it is important and why it works. Creating spaces where firms, individuals and small groups can develop new trusted relationships will be an enormous source of value creation.

Re-assessing Assessment Tools

There is a pressing need across all aspects of the economic development profession to develop better ways of measuring assets and outcomes, and re-thinking just what it is that needs to be measured. As we shift toward more open innovation networks and regional knowledge ecosystems, the most important things to understand will be what happens *between* institutions. But most assessment tools measure what happens *inside* institutions. In addition to understanding the scope of institutional activity, we need to map the pipelines of people, ideas and money moving through regions. The goal is to develop a vocabulary for talking about networks in detailed and specific ways, rather than the vague ways we do today.

Developing Brands

Because regional knowledge ecosystems will grow increasingly complex and multi-institutional, brands will become more important, not only in marketing to outsiders but in describing just what people and organizations are doing and inspiring them to new achievements.

Today, not many regions do a good job at brand management. In the future, building a brand as an identity that can describe and communicate the unique value of a knowledge ecosystem will require active cultivation on an ongoing basis. The "grand strategy" discussed earlier can be a powerful tool in testing and maintaining consistent and effective brands.

Brands will be crucially important in attracting globally mobile talent and earning reputation in new group economies.

Senator PRYOR. Thank you, Dr. Townsend.

Let me go ahead and dive into some questions, here. And then I'm going to try to keep my question period short, if I can, and let Senator Begich ask questions. And I may have a few follow-ups.

But, Dr. Wessner, let me start with you. You've shown this graphic, up here, about the—China's 54, I guess, state-level and technology parks and, you know, how they've been able to utilize those and help them invent, really, their industrial base in things like electronics, information technology, materials, biotechnology, et cetera, et cetera. You alluded to this in your opening statement,

but if you could tell the Committee here, really, how the United States compares with China when it comes to this type of innovation and this type of commitment to innovation.

Dr. WESSNER. Well, thank you, Senator. And I can be very brief.

We don't compare, sir. We don't compare at all. What we're good at is—we're very strong on the military side. We watch very carefully what goes on in the world. In the agricultural sector, we're very strong. We know what's happening in trade. But, if you're looking at the level of investment in parks, I think my colleagues here would—at least most of them—would agree with me that we don't begin to compare. We have small parks, some of which are highly effective, but we don't have the type of industrial-scale parks that they have.

And we—I think Brian Darmody made an important point. In our efforts to make sure that the public and private sectors retain their respective roles appropriately, we have sometimes passed conflict of interest—and this is a personal opinion, I would stress; I'm not speaking on behalf of National Academies—but, the Chinese excel in very close and seamless cooperation between their public institutions and the private sector. And I think we need to weigh how we approach these things more carefully.

I mentioned a note of optimism. Since we're being out-invested, the question is, What tools would be appropriate to invest? And I think what you've identified is part of the path. I don't work on behalf of EDA. They do sponsor some of our work, along with about 12 other government agencies. But, I would stress that their budget, in my view, needs to be very substantially increased, both for grants, but particularly where we can get massive leverage through loan guarantees. Other agencies may have to provide loans.

I'd like to stress the point that was made about leveraging other agencies' programs so that you get a more integrated approach.

But, I would also caution that we not spend all our time trying to integrate everybody. You know, it's easy to say we're going to knock down the walls between agencies. Well, you and I are both old enough to remember how the Department of Energy smoothed out all the differences there, and, of course, Homeland Security's been complete success. I think we have to be cautious about how much time we spend on that, and spend more time—one of your colleagues, Senator Begich here mentioned, I think importantly, speed. All of us—or, not all of us; some exceptions—are beginning to get a little gray hair. And if we're going to give our children and grandchildren the type environment that they need to grow in and to prosper in, we need to move much more quickly than we have in the past. And we need to move on scale.

I have a number of other points. The other point I'd just like—is tax tools that was mentioned; that's exceedingly important. We act like we're so good that the industry will just stay there, because there's no place to go. Well, that might have been true in the 1950s and 1960s, but that is sure as certain not true now. And I think Craig Barrett, the former CEO of Intel, has spoken eloquently, you know, "How do I explain to my stockholders that I'm going to take a billion-dollar less—or, a billion dollars higher in taxes in order to invest in New Jersey rather than outside of Shanghai or outside of Dresden?" The equity investments made in Dresden for the AMD

facility, the loan guarantees, the loans put together a package of 900 million Euros. And that's why Jerry Sanders put AMD's lab, Fab, there.

Now, we just have to get in the game. And we also have to remember that our orthodox economists may have very good insights, certainly not in anticipating economic downturns or economic upturns. As John Kenneth Galbraith once said, "The main purpose of economic forecasting is to make astrology look good." But, the issue is that the rest of the world is not playing by the same rules. They're playing a different game. It's not wrong, morally, it's just the way they're playing the game. And we need to have effective tools, and your bill is an important step forward.

Senator PRYOR. Thank you.

Senator Begich?

Senator BEGICH. Thank you, Mr. Chairman.

I do have a 4 o'clock, but I want to, if I can, just do a couple questions. But, your statements—and all four of you have—I appreciate.

I've been in small business since the age of 16, so I have had those great successes, and also those great failures that go along with them. I'm my own incubator and risk-taker.

[Laughter.].

Senator BEGICH. And my wife is an entrepreneur, owns four shops in Alaska, and a variety of businesses. And so, everything you're talking about rings true to what I'm—what I've been around most of my life.

But, the last comment was very interesting. And it goes to my point, when the Assistant Secretary was here. My biggest worry with some of the work we do here—and I 100-percent support what the Chairman is doing, because I think it is good to get some more tools out there, and I'm going to ask you a second question, in a second, on, collectively, something—an idea I have, sitting here. But, the Federal Government is so slow. And that's why China is so successful. And I understood, when the Assistant Secretary made the comment that we're not—we're kind of falling a little bit, but not behind. And I—you know, I would disagree with that. I agree with your statement. We are behind. Energy technology is one area we're falling quickly behind, because we spend more time talking about it—talking about percentages of what we should have for climate change, and all these other things, which I'm a big supporter of—but, we're not doing anything. You know, there are little pockets, as mentioned in Senator Pryor's home State, of the wind energy—wind—the company making turbines. You know, great. One. You know? I could talk about one in Seattle that's doing some stuff, one in Michigan. But, it's not a collective. And I think we lack, in some ways, the capacity, from a Federal Government standpoint, to say, "Get to it," because the majority of the Federal Government are not entrepreneurs. They never walked on the edge and understood risk, and understood that you have to take a calculated risk that may not be as calculated as you like. But, it might jump off and end up in a great opportunity. That, to me, is the biggest systematic problem we have.

I mean, I'm going to support this bill, because I think it's the right thing to do. I like some of your ideas. I'm going to ask you,

collectively, to think about this. As we move forward—Senator Pryor, myself and others—as we move into January, we're going to be very aggressive about more job opportunities in this country. More job opportunities. The largest and fastest growth area is small business. That's where we can create some opportunity.

I'm not sure we're going to create the right tools, to be frank with you. We, marginally, did it in the stimulus bill. I say, "marginally," with quotations around it. We have to be aggressive.

And so, I would look to you on some ideas, especially as we move into the beginning of the first of the year, working, obviously, with the Chairman here—and I'd be happy to work with you on four or five very targeted collective ideas that we can do to help spur the entrepreneur capacity in this country. I just——

So, I look to that. Your questions and your statements made me really just want to make a comment, and I'm happy to have you respond. But, I think our biggest challenge is, you know, doing what we should be doing, and that's leading, and not get in the way. We have a habit of leading and then getting in the way. And I can give you example after example, as you can with universities, where they are great incubators. You know, we have the Alaska Small Business Development Center. Fantastic. I just saw a letter from someone, that was given to me about a small business, who wants to start-up, but she's struggling to figure out how to do that.

And so, if you can give me just some quick commentary, then I—I apologize, I have to leave. But, I'd be very interested in the second half—and I'm assuming Senator Pryor would, too—and that is, help us, as we move forward as the U.S. Senate—after healthcare, we're going to move forward on an America Works Project bill that's going to be about creating new jobs and looking to the future. And some of these ideas, the bonding issue—I know exactly what you're talking about. And I can list off some ideas there, and that's why I was very intrigued.

So, let me, first, just end there, see if there's any commentary. My time is limited. But, please, anyone want to respond?

Mr. SALLET. Could I offer one thought——

Senator BEGICH. Sure.

Mr. SALLET.—Senator?

It's exactly right. The paradigm ought to be local leadership, businesses, educational institutions, governments, NGO's, working together. So, it has a business focus and immediately reflects the insights of the local business sector. And then, the Federal Government needs to align itself in support of strategies that are created at the regional level. That would take a lot of doing. There are something like 200 Federal programs that have been identified.

Senator BEGICH. Yes.

Mr. SALLET. What they need to do is to think about themselves as supporting this kind of regionally-led strategies. Now, that will require coordination across agencies. It will require that some programs be changed some, in their emphasis, to make sure that they are always aligned tightly with regional economic strategies. But, if we do that, then we will know that the leadership is coming from where the leadership needs to come from, but that the support exists at the national level, because all of the Nation benefits from the total output of the regional economic strategies.

Mr. DARMODY. And, Senator, you know, earlier was mentioned Sandia Park, and Los Alamos, as well, in New Mexico. And those parks are Federal, but they're managed by the private sector. And so, they have a lot more flexibility; government is not in the way as much as it is for other Federal labs that are government-owned and government-operated. And we're not going to, you know, suddenly make all of our Federal labs privately managed. That, you know——

Senator BEGICH. Right.

Mr. DARMODY.—that's more complicated than the healthcare bill. [Laughter.].

Mr. DARMODY. But, you could take—you know, reduce the friction by doing what universities have done. They've created foundations and other organizations to help the business of tech commercialization. Take that piece. I mean, we're investing $25 billion right now, every year, in Federal labs. And so, if you gave them more opportunities, through a sort of a foundation—I mean, the Henry Jackson Foundation that—Congress created that; that's at the Uniform Health Services University—very effective in tech commercialization. But, it was a foundation created by Congress. But, it's not governmentwide; it's for one particular agency.

So, some of those ideas—I think there are best practices out there. Making them more across the board for the Federal Government, as well as for universities—some of these ideas about, you know, helping build the commercialization funding strategy in our research and development funding programs, which currently doesn't exist—I mean, we passed Bayh-Dole, but then we thought, you know, the royalty checks were going to roll in. It doesn't happen that way. It's a much more complicated commercialization process. And we need that—OMB and others to recognize that there's cost in the initial stages of tech commercialization.

So, there are a number of programs that could be done administratively, wouldn't even necessarily need significant legislation.

Senator BEGICH. Thank you.

I hate to do this. My time was exceeded, so I don't want to burn up the Chairman's time. But, I thank you for that. I would—and I will probably follow up with some of you in regards to some ideas. But, I just—it's frustrating. I set up a development corporation when I was a mayor, because I didn't want us messing it up. And, to be honest with you—and we took a hazardous wastesite, as one example, and turned it into a $70-million development, using a BEDI grant and a few other pieces. But, the private sector did the show. And we used a development corporation to really be the instrument, and kept us out of it. I still have, I think, local city council members mad at me because I got—cut them out of the process. But, we got it done in 14 months. So, it's all about how to do it, not just sit there and debate it all the time.

But, again, thank you very much.

Thank you, Mr. Chairman, for allowing me a little flexibility there.

Senator PRYOR. Thank you.

Dr. Townsend, let me, if I may, ask you a question. I believe you used the term "research clouds." Tell me what that means.

Dr. TOWNSEND. Well, I just want to start out by reminding everyone this is a forecast and not a prediction. It's sort of difficult to understand how many different trends that are shaping the future will intersect 10, 20 years out. But, I think what we see are a lot of signals in the marketplace that this traditional model of, kind of, drawing a line around a piece of land and saying, "Everyone that does science and technology, get inside that box," is something that's going by the wayside.

What it is being replaced by are districts, zones, geographic clusters of facilities, labs, shared workspaces, university facilities, and private-sector speculative lab-space developments that are all tied together by the Internet, basically; by shared social networks, by Facebook, by scientific communities that form online.

What we think is going to happen down the road is that someone is going to try to organize that and formalize that. And the way that might work out in the future is that, rather than going to a research park to get 10,000 square feet of space, a company might tap a network and say, "I need 10,000 square feet of space. I want some of it to be private, some collaborative, and I want it to be sort of in the same area." And that can be provisioned very rapidly and very efficiently.

This model would have lots of advantages. It would probably be more efficient, in its use of space. It would probably reduce the risk for everybody involved, because you'd go from long-term leases to temporary leases. And it would foster collaboration, because it would also include a lot more shared space.

Now, this is something we see already happening, naturally, in places like the—part of Cambridge, Massachusetts, around MIT. It's also something that's starting to become part of university-driven economic development strategy. So, if you look at the greater Oakland Keystone Innovation zone, around Carnegie-Mellon in Pittsburgh, they're not doing a single-park expansion of the campus. They're scattering investments, engaging lots of partners, and doing things in a very organic, evolutionary fashion.

And so, we think that's a very compelling middle ground between the model, that we have continuing for 20 years, and research parks basically going into decline.

Senator PRYOR. OK.

Mr. Darmody, let me ask you. Apparently, the University of Maryland research park, M Square——

Mr. DARMODY. Yes.

Senator PRYOR.—is that what they call it?

Mr. DARMODY. Yes.

Senator PRYOR. Could you tell us a little bit about that, and, kind of, what they're doing there, and what makes them stand out?

Mr. DARMODY. Well, because we're located inside the Beltway, we have three focus areas, kind of building partnerships among the university, the Federal Government, and the private sector. And among the Federal Government—I mean, we've talked about stovepipes here. So, for example, in food safety and food security, we have the FDA, the food safety part of the FDA, headquartered in our park. We also do—we have part of USDA. So, you know, the way we regulate food safety in the United States, we have USDA, a piece of it; FDA, another piece of it. We've brought them together.

We've been the intermediary, as well as the university. And now we're bringing in private-sector people. And we're doing training, for example. So, you know, 40 percent of all of our food is imported, is now a commodity. So, if the food isn't grown safely and tested in other countries, that's an issue for the U.S. So, we are doing international training. We're setting up both regulatory and toxicology training so that other countries are going to adopt U.S. standards in food safety and food security, and that will help us. It helps build better science, because, really, science parks and research parks need to be thought of a communities of innovation. And, given our location, we've leveraged a—Federal, private sector, and the academic sector for that.

And we're doing something similar with global climate change, where we have Department of Energy, NOAA, and NASA. We put them all together in the same place. Again, the Federal Government has some global climate change in each of those three departments.

We've been the intermediary. And I think that's a good model. And even the private sector is looking at that, because insurance companies are—you know, have risk related to global climate change. They want to know what the proper models are.

So, that has been our experience. But, then other parks across the United States have had more of a small business—trying to build innovative companies out of—technologies out of universities.

So, as the saying goes, "If you've seen one research park, you've seen one research park." Because, frankly, they are very, very dissimilar, but they all add value and create new innovations for the country.

Senator PRYOR. Right. Well, thank you.

Mr. Sallet, let me ask you. In the bill, in the Building a Stronger America Act, it requires the planning grants to be awarded on a competitive basis and to consider geographic diversity. Are those the right two criteria? I mean, does that make sense to you?

Mr. SALLET. It does. The—having a competitive process is very important, for two reasons. One, the nature of competition will create the right incentives for local places to create real strategies. Knowing that they will have to compete for the money, it will help bring businesses together with the other parts of the community, to have a really thought-through strategy.

The second thing it will do is help to ensure the efficiency of Federal spending, which is very important, in times of necessary fiscal restraint, by putting money to where it will have the biggest impact while, frankly, giving people, even who don't win a competition, the chance to learn from the experience and do a better job next time.

At the—the provision on geographic dispersion is also very important. We have a tendency to think about clusters in innovation as if they're urban phenomenon. They're not. I mean, there's a lot of manufacturing in rural America that people don't take enough account of, for example. And we've seen, in the last year, a sharp decline in that kind of manufacturing employment. Automobiles, an obvious area. But, that's not just big cities in the Midwest; it's rural locations, as well. We've seen a decline in apparel, textiles, and paper products.

And so, it's very important that we understand that the advantage of geographically concentrated innovation will work in rural America. And by emphasizing geographic dispersion in the bill, you've made people focus on that.

Here's one reason why rural America has advantages. We know that rural America, when it comes to converting patents of well-established technologies, is just as good at it, has just as many patents as urban America. We know there are advantages in costs. For example, in advanced manufacturing, these days, we used to think of manufacturing as something that can't be done in the United States because wage costs are too high. But, as we get, particularly in the area of semi-conductors, in the world of advanced manufacturing, labor costs actually shrink. What companies need is to be in a nexus of innovation in places where community colleges are training workers for those kinds of advanced manufacturing. What rural economies have a good base for manufacturing—good wages that provide those kinds of opportunities. So, we need to keep our emphasis on rural America.

Indeed, if I could just say, Mr. Chairman, I know that you've been very busy, of late. And the healthcare debate is a critical one. It—I think we're all appreciative of the fact that you've taken a moment out of that healthcare debate to focus on this, because this isn't the front-page story that healthcare was this morning, and will be tomorrow. But, actually, if we're going to have the new building blocks of American competitiveness, it's fundamentally important. And so, it's—we're all very appreciative that you've taken the time to focus on it.

Senator PRYOR. Well, thank you.

And thank you all for being here. And I really appreciate your participation today, and your very thoughtful comments.

And I know that you've helped my staff, and other staff on the Committee and other member staffs, to help us make this Building a Stronger America Act even better. And we're going to continue to improve it. So, if—we're working with Senators on both sides of the isle, here, to try to really have a good piece of legislation that we can get very broad bipartisan support for, and your assistance on this has been invaluable. And I hope we'll continue to discuss this as we go through the process.

We're going to leave the record open, here, for just a week, maybe 4 or 5—let's say 5 business days. We're going to possibly get some questions from some of the members who either had to leave early or who—not able to be here today. So, if you get questions from the Committee, please try to get those back ASAP.

I really appreciate your thoughtfulness and your time in trying to help us do something good for this country, and help us get back in the innovation business in a way that our global economy wants us to do this right now.

Thank you very much for being here.

And the Committee is adjourned.

[Whereupon, at 4:21 p.m., the hearing was adjourned.]

A P P E N D I X

PREPARED STATEMENT OF HON. OLYMPIA J. SNOWE, U.S. SENATOR FROM MAINE

Thank you, Senator Pryor, for holding this hearing today on the crucial issue of strengthening America's economic competitiveness by enhancing U.S.-based science research parks. Indeed, this hearing is truly timely as our Nation's economy hints at a tenuous comeback. With a high, 10 percent, unemployment rate and millions of jobless Americans, it is imperative that we continue to focus our efforts on economic revitalization and job creation. It is therefore critical that we follow President Ronald Reagan's inspirational message from his Second Inaugural address that, "We must think anew and move with a new boldness, so every American who seeks work can find work; so the least among us shall have an equal chance to achieve the greatest things. . . ." And, the best and most proven way to accomplish this mission is by investing in American innovation.

In furtherance of that goal, we are here today to explore and recognize the nexus between science research parks, regional innovation clusters, business incubators, and the creation of jobs for the 21st century. Science parks promote an essential culture of innovation, collaboration and economic competitiveness among universities, research laboratories, and small businesses—working within close quarters or networking through "virtual" parks where technologies cluster—to move research from "mind to marketplace." They are a vital part of our Nation's economy, employing more than 300,000 scientists and engineers. Significantly, every single job in a research park generates 2.57 jobs outside the park. That is more than three quarters of a million (770,000) American jobs!

To echo the message of President Obama at the recent jobs summit, we must take "every responsible step to accelerate job creation" and get the "biggest bang for the buck." Science parks can help us realize both of these goals.

As Ranking Member of the Senate Committee on Small Business and Entrepreneurship and a senior member of the Senate Commerce Committee, I *enthusiastically* encourage increased investment in science parks and regional industry clusters. That is why Senator Pryor and I introduced the "Building a Stronger America Act" (S. 583), to provide grants and loan guarantees for the planning, development and construction of science parks throughout the United States. This bipartisan legislation would drive innovation and regional entrepreneurship by enabling existing parks to make needed renovations while also encouraging rural and urban states to undertake studies on developing their own successful regional science clusters. Our legislation would allow the Secretary of Commerce to guarantee up to 80 percent of loans exceeding $10 million for the construction of science parks. Additionally, the bill would provide grants for the development of feasibility studies and plans for the construction or expansion of science parks. Notably, our legislation exemplifies the need to think of science parks as more than just the traditional "mortar and bricks"—and leverage the networks of people and knowledge and clusters—if we are going to meet the economic development needs of the 21st century.

In my home state of Maine, traditional science parks currently do not exist; and, yet, Maine is a national leader in providing business "incubation" services. These incubators are critical to the success of new companies. To help start-up entrepreneurs in Maine, incubation centers around the state provide business support tailored to companies in their regional innovation clusters. The benefit of Maine's seven technology incubator centers has been nothing short of monumental, as a remarkable 87 percent of all businesses graduating from these incubators are still in business and creating new jobs. Under the "Building a Stronger America Act," business incubators as well as science parks will be eligible for vital assistance that will hopefully lead to similarly successful results in other states.

More than simply stimulating job creation and strengthening U.S. competitiveness, this legislation can also help benefit military bases affected by the base realignment and closure (BRAC) rounds. Specifically, we can utilize this opportunity to help BRAC communities' redevelopment efforts and stem enormous job losses. For instance, with the closure of Naval Air Station Brunswick (NASB) in my home

state of Maine, the Midcoast region is estimated to lose 6,500 jobs and $140 million in annual income. Sadly, the closing will also leave behind a complex of buildings, state-of-the-art facilities and idle real estate property. It is essential that we do everything in our purview to lessen these negative impacts. This is why I plan to work with you, Senator Pryor, and our colleagues to ensure that one factor to consider when awarding grants under S. 583 is whether the award would assist in the transformation of military bases shuttered by the BRAC rounds into vibrant science parks.

By resourcefully and adequately investing in American science and technology, we expand opportunities and build on a foundation for a better tomorrow. We must continue to encourage all avenues for advancing science and technology if America is to remain at the forefront of scientific and technology development for decades to come.

In conclusion, thank you again, Senator Pryor, for scheduling this vital hearing today and for your invaluable and longstanding leadership on behalf of advancing innovative technology in our economy.

PREPARED STATEMENT OF HON. DAVID VITTER, U.S. SENATOR FROM LOUISIANA

I want to thank the Chairman for scheduling this important hearing. Discussing ways the United States can maintain its crucial leading edge in scientific research and technological development is obviously of the utmost importance.

I certainly understand and agree with the great value scientific research parks and consortiums can have, both for achieving scientific breakthroughs and fostering economic development. In my home state of Louisiana, I helped form the Stennis-Michoud Aerospace Alliance to promote the growth of the aerospace industry in the region between NASA's Stennis Space Center in Mississippi and Michoud Assembly Facility in New Orleans, as a means to both foster job creation as well as further scientific and technological breakthroughs in aerospace engineering and design. And in Shreveport, we have the burgeoning Intertech Science Park—home of the LSU Health Sciences Center, as well as private companies—dedicated to research in the biomedical field.

More and more, we hear that America is falling behind—or the rest of the world catching up—in scientific research and development. As I noted, I have personally seen in my own state the immense value research parks and consortiums and cooperation and engagement between public educational institutions and private companies can have in terms of scientific research and job creation and economic growth.

Research parks can be a useful tool for maintaining and improving America's role as the world's scientific and technological leader, as well as helping to grow local, state, and regional economies, and we should look for ways to encourage their development.

I'd like to thank Dr. Wessner for his testimony and I look forward to continuing to discuss ways we can continue to foster scientific research and the job creation and economic growth that comes with it.

PREPARED STATEMENT OF RUSS LORINCE, DIRECTOR, RESEARCH AND ECONOMIC DEVELOPMENT OFFICE, WEST VIRGINIA UNIVERSITY

Science and Research Parks Promote Innovation

The West Virginia University Research and Economic Development Office submits this testimony in support of S. 583 and the prospect of developing and constructing science and research parks to promote the Innovation Economy. Such facilities are essential to the United States' ability to maintain its competitive edge in the global market place.

Competing in an Innovative World

For the United States to remain a world leader in innovation and to compete effectively in the global economy, it is critical that infrastructure be in place to advance science and engineering education, research, technology transfer and commercialization. In recent years, alarming statistics indicate that the U.S. is falling further behind competitors in terms of the number of students engaged in science and technology fields. While American universities retain their standing as the world's leading institutions for post-graduate education, the trend is disturbing.

The innovation continuum constructed around higher education has been a primary reason that the Nation has continued to move new discoveries and technologies to the market place and to realize the economic benefits of that work. That structure has provided a positive environment that has assured a competitive ad-

vantage with the rest of the world and has brought top researchers from around the world to American campuses. The Bayh-Dole Act, SBIR/STTR grants, business incubators and accelerators, industry collaborations and commercialization programs are among the innovation elements which have allowed the U.S. to lead the world in productive use of intellectual property.

Important Role of Science and Research Parks

University research parks have earned their own status as vital components in advancing technology's role in economic growth. Over the past 50 years, an increasing number of U.S. institutions of higher education have added research parks to the innovation continuum, often as the last needed piece of physical infrastructure. After talented faculty researchers, world class laboratories, research support, technology transfer and business incubators have been put in place, parks add another essential dimension.

Though they are physical places, the value of research parks comes from the unique economic ecosystem they create. These facilities supply a fertile environment for higher education, government and industry to collaborate and partner in ways which have yielded great returns. All three parties realize benefits from the proximity and regular interactions which spring from parks, in part from good fortune and in part from careful planning and management. It is the real estate element of a park which is most visible, but the true value is derived from programming which drives opportunities for tenants and visitors to define common goals, explore partnership options and experience scientific and economic success.

Support for Science Parks in Other Nations

Recognizing the significant output from research parks in the U.S., competitors around the world have undertaken their own projects. Reflective of different economic systems, national governments elsewhere have been instrumental in building parks in and around their academic and scientific assets.

European nations have longstanding parks which provide similar benefits to their U.S. counterparts. New facilities and expansions of existing parks are springing up across the continent.

But it is in Asia where governments are investing huge sums in research parks with scale and scope which are difficult to grasp. In one extreme example, a single park in China contains 20,000 companies and 950,000 employees. Of course, the central government funds these projects in pursuit of economic growth and a greatly enhanced competitive position.

In contrast, funding for research parks in the U.S. has come from the state and local level and through private partnership. 5583 provides a new avenue through which the Federal Government can partner to promote further prosperity and improve return on the public investment made in research.

WVU Research Park

The WVU Research Park was announced a decade ago and since that time Phase I has slowly been developed, now offering 24 acres served by roads and utilities and prepared for construction. One tenant has taken occupancy of a privately-finance building in the park, creating some activity and energy. Funding for the facility, which has come through the WVU Research Corporation, has been sporadic as the State of West Virginia and local governments have been limited partners.

With the first tenant in place and important agreements and financing elements pending, the park is at a critical crossroads. The type of support which would be available through the programs in S. 583 could be crucial to advancing the project. Funding for planning grants, including a current and more useful version of a 2002 consultant's report, would reaffirm the concept of the park and its market potential and possibly attract corporate collaborators to create a public-private partnership. The prospect of loan guarantees could be of great importance in finalizing a financing plan for the construction of WVU's first building in the park, which would serve as an Innovation Center to support entrepreneurs and start-up firms spun from the WVU research effort.

While some states have been able to provide significant financial support for such projects, that hasn't been the case at WVU. Lacking that backing, the opportunity to compete for Federal planning grants and loan guarantees would provide wonderful new opportunities to advance the WVU Research Park.

Conclusion

As the U.S. reassesses its competitive position in the global marketplace, it becomes clear that we must focus on sustaining and building the innovation infrastructure. Having the Federal Government partner with state and local investment

in constructing university research and science parks is a sound strategy to build economic strength and S583 provides a reasonable means to that end.

Thank you for considering our testimony.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. MARK WARNER TO HON. JOHN R. FERNANDEZ

Question 1. Infrastructure is obviously the first step in the development of a research park and is addressed in S. 583. However, early stage high-tech companies quickly hit a source of funds roadblock. What should the Federal Government's role, if any, be in facilitating the flow of investment funds to emerging companies in research parks?

Answer. EDA recognizes that the funding roadblocks are a major impediment to the full realization of the potential of the early stage companies that are an important source of employment growth. One study estimated that companies once backed by venture capitalists accounted for nearly 17 percent of America's GDP and 9 percent of private-sector employment (Economist, March 2009). Venture capital is also known to be important to innovation more generally. Since $1 in venture capital yields as many patent applications as $3 in R&D, venture funding is critical to research park success (Kortum and Lerner, 1998).

Venture capital investment in the U.S. is down 51 percent since last year (*Economist*, October 3, 2009). However, some industry commentators believe venture capital was too prevalent and should become smaller based on low average returns over the last decade and the risk inherent in normal venture projects (Kauffman Foundation, June 10, 2009). The Kauffman report concludes, "the venture business should shrink . . . possibly by as much as 50 percent". EDA believes that increased capitalization of its Revolving Loan Fund ("RLF") program specifically targeted to supporting the commercialization of innovative new technologies particularly in markets that "will continue to grow . . . including clean technology" (Kauffman 2009) might be as useful as a recovery strategy and is currently attempting to estimate if an unmet need exists in this area.

Question 2. Universities can play an enabling role in the creation of intellectual property that could form the foundation of companies that could benefit from a research park environment. How would you recommend that the universities, especially the land grants, become incentivized to be more engaged in economic development throughout the states—especially supporting research parks that might not be adjacent to them like at Virginia Tech?

Answer. The land grant universities already possess the outreach tools, such as Extension Service Agents, that will support activities remote from the university campus. EDA is currently sharing its "Know Your Region" curriculum and web-based local decisionmaking support tools with our colleagues at USDA Rural Development, who will be adapting its regional innovation systems core to their environment. (For example, see EDA's *www.statsamerica.org/innovation*). EDA is also collaborating with the Appalachian Regional Commission in a similar way to adapt these intellectual property transfer mechanisms to that region. These collaborations could be enhanced through closer coordination of EDA's University Center program and programs of our sister agencies. Outreach programs, such as the University of Oregon's Resource Assistance for Rural Environments (RARE), which provides students with practical work experience and partial support for their educational expenses if they work for rural governments and non-profits, could be supported via competitive University Center grants, and could significantly increase contact with appropriate tech-transfer and other science park services. Other models, such as the Idaho Virtual Incubator, have also shown successful results. Taken together, EDA believes that successful models and best practices, appropriately adapted to regional conditions, are a critical component of university enabled company formation and broad based benefits of intellectual property creation.

Question 3. I understand that the President's budget requested $50 million in EDA funds for regional innovation clusters, and that a recent EDA report on regional competitiveness also touted the benefits of thinking regionally when engaging in economic development. However, I'm curious how that will work when the "region" crosses state lines. As the former Governor of Virginia, I know how Governors compete with each other to attract projects and employers—including new science parks that are likely to create high-paying technology parks down the road—to their state. How can you create incentives for multi-state regions to cooperate when each state involved wants to know that they are getting a return for their share of the investment?

Answer. All of us who had the privilege of serving as elected officials understand the competition between political jurisdictions seeking to attract projects and employers to locate within their boundaries. We seek elected office to improve the lives of our constituents. This includes promoting their economic well-being and the tax base that allows us to provide the schools that educate their children, public safety programs that protect their lives and property, and the amenities that make their community or state a desirable place to live and work.

These goals are not inconsistent with a regional approach to economic development that acknowledges the realities of economic interdependence and economic spillovers. EDA believes that the higher probability of improved economic outcomes that arises from a regional economic development approach is the best incentive, consistent with bottom-up economic development.

The economic spillovers from the Virginia Tech Institute for Advanced Learning and Research are a prime example. Its location in Danville, Virginia is directly adjacent to several North Carolina communities. While EDA has not attempted to measure the spillovers, it is difficult to believe the benefits stop at a border that is only a few highway miles away.

EDA encourages regional thinking because it produces better economic development outcomes. EDA has developed and deployed a "Know Your Region" economic development curriculum that embodies this thinking. EDA develops and deploys web-based analytical tools that support the regional approach. Both have been very well received. USDA Rural Development adopted the EDA "Know Your Region" curriculum and several other agencies are employing or evaluating our regional economic development analytical tools.

EDA's educational outreach and the demonstrated economic development benefits are among the factors driving jurisdictions to embrace regional economic development collaboration. EDA believes that the critical path lies in the bottom up approach informed by the best information we can provide to state and local economic development policymakers. EDA is beginning to receive more requests that are rooted in this regional approach.

For instance, EDA is funding a 12-partner collaborative initiative that involves three universities, three technical (community) colleges, several nonprofit economic development organizations, and several government jurisdictions. The members of this collaborative come from six counties: four in Wisconsin and two in Illinois.

EDA recently designated an Economic Development District that includes cities and counties in Oregon and Washington. The planning activities EDA is funding are targeted at developing economic opportunities for this multi-jurisdiction, two state region.

Other examples exist, such as Mobilize Maine. At Governor Baldacci's direction, the Economic Development Districts are collaborating with FairPoint Communications, the State of Maine, and collaborative investors to develop regional capacity throughout the State that will build a strong, growing and sustainable knowledge-based economy for all of Maine.

EDA believes that focusing on the dissemination of information and best practices that inform state and local government economic development policymaking is the appropriate role for the Federal Government and supports improved bottom-up economic development decision-making.

Question 4. How would the regional economic development model work within EDA's current structure, for example with EDA-designated economic development districts? Would they have to be redrawn accordingly, or dispensed with all together?

Answer. The regional economic development model is already successfully utilized in many parts of America. Some initiatives are driven by existing EDDs, while others arose from the work of local partners independent of any EDD involvement.

EDA continues to support the EDDs as the fulcrum of its planning activities. They are, and should remain, locally determined. EDA, through its program of practitioner accessible research, web based data access and local decision-maker support tools, and "Know Your Region" training outreach continues to foster regional perspectives because the regional perspective increases the probability of better economic outcomes. Considerable progress is being made. For instance, EDA recently designated an EDD serving Portland, OR and Vancouver, WA that includes 5 adjoining counties on both sides of the state line.

In another example, EDA recently funded a complex collaborative regional innovation cluster planning process involving three universities, a liberal arts college, three technical colleges (community colleges), and a number of not-for-profit economic development organizations. The members of this collaborative cluster cover six counties, four in Wisconsin and two in Illinois. What makes this an interesting

endeavor is the division of labor within a framework that crosses town, city, county and state lines.

EDA does not know if local decisionmakers will formally ask to have EDD boundaries redrawn or otherwise re-structure themselves. What is clear is that the regional perspective and the importance of innovation and industry clusters to sustainable long-term economic growth is being understood and implemented across the Nation. EDA believes that its continued support of grassroots decisionmakers will continue this positive trend.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. OLYMPIA J. SNOWE TO HON. JOHN R. FERNANDEZ

Question 1. In order to reverse the present tide of economic stagnation, America must invest in the creation, development, and promotion of homegrown technologies. A 2007 National Academy of Sciences study found that science parks drive regional economic development and enhance American competiveness by promoting technology and innovation, pooling local talent, and encouraging the exchange of ideas.

The "Building a Stronger America Act" (S. 583), which Senator Pryor and I introduced, will provide grants and loan guarantees for the planning, development and construction of science parks throughout the United States. This legislation will not only stimulate job creation and strengthen U.S. competitiveness; it can also help benefit military bases affected by base realignment and closure (BRAC) rounds. That is why I pledge to work with Senator Pryor to ensure that one factor to consider when selecting awards under S. 583 is whether the grant would help the transformation of military bases shuttered by the BRAC rounds into vibrant science parks.

Your testimony mentions that EDA's investments create conditions in which jobs are created, often in the midst of economic hardship or adjustment. What role could EDA play in assisting BRAC-affected communities under this legislation?

Answer. EDA's commitment to constructive reuse of BRAC facilities to transition the economies of affected communities and regions will not change under this legislation. EDA will continue to support local decisionmakers as they seek to exploit their region's competitive advantages, including those offered by science parks, to create jobs for their citizens and a tax base that adequately supports local government services.

EDA has a long and successful partnership with DoD's Office of Economic Adjustment (OEA). The current OEA deputy director and a member of his staff are EDA alumni and continue to work closely with EDA to plan and implement BRAC recovery strategies. Typically, OEA focused on reuse planning, and EDA funded implemention activities, typically public works projects. The two agencies have always employed a regional approach to constructive reuse of BRAC facilities and, when appropriate assets are in place or can be developed, leverage regional competitive advantages to create science parks.

The additional funding for BRAC communities and the science park focus can be expected to produce significant results as part of EDA's regional innovation clusters approach to economic development.

Question 2. A recent Brookings report, *Clusters and Competitiveness: A New Federal Role for Stimulating Regional Economies*, co-authored by now Small Business Administrator Karen Mills, asserts that regional industry clusters—geographic concentrations of interconnected firms and supporting organizations—represent a potent source of productivity at a moment of national vulnerability to global economic competition. To compete in technology development, a region or state must differentiate itself and cultivate and sustain areas of expertise where it can be a world leader. As a result, it has become more common for science parks to focus on identified technology areas or industry clusters. However, the Brookings report also asserts that this Nation's network of cluster initiatives remains thin and uneven.

Given EDA's longstanding tradition of supporting regional innovation clusters, what can be done to make U.S. industry clusters more competitive? What can be done to catalyze growth producing collaboration in key industry clusters and help them realize their full potential?

Answer. EDA's leading role in the implementation of the regional innovation clusters approach to economic development focuses on the competitiveness of U.S. industry clusters though its support of methodologically rigorous practitioner accessible research, web based decision support tools, practitioner training, and strategic planning and implementation investments. Many of EDA's research reports, tools, and training products have been cited or adopted by other agencies. EDA believes these form a solid base upon which to build more competitive U.S. industry clusters and assist them to achieve their full potential.

While continuing to implement and update these activities, EDA's policy recognizes the importance of the Brookings critique. EDA's 2010 budget initiates a cluster identification and mapping project designed to strengthen the network of clusters, disseminate best practices, and integrate across the cluster spectrum from fostering network linkages beyond the direct supply chain partners to include cluster specialized banking, consulting, and legal services, universities, and community colleges.

EDA's 2010 budget includes funding for the initial steps toward a comprehensive cluster network mapping project that will extend beyond the European Clusters Observatory (ECO) model mentioned in the Brookings report. Based on the existing clusters definitions used by ECO and others, EDA's multi-year project will incorporate workforce skill set layers, as identified by Labor's Standard Occupation Codes (SOC), and important network relationships based on secondary and tertiary relationships. Phased project roll out will provide rapid access to initial cluster network information and support continuous, client informed, product improvement, so that the product evolves in the same manner as EDA's tool and training curriculum projects.

EDA's partnerships with other agencies, including our Labor Department and Appalachian Regional Commission colleagues, are producing strong results and more needs to be done. EDA is collaborating with SBA, Education, Labor, USDA and other Federal partners to develop more coordinated regional investment strategies. Additionally, EDA recognizes the need to integrate private sector actors driving growing and emerging clusters more tightly into the planning and implementation processes.

Question 3. Small businesses are the engines that drive job growth and they will lead us out of the current recession. I am deeply committed to ensuring that they succeed, not only because I am Ranking Member of the Small Business Committee, but because I truly believe in the power of small businesses to lift us out of our economic troubles. The "Building a Stronger America Act" (S. 583) is one of many efforts I have undertaken to encourage small business growth. Science parks provide small businesses numerous advantages, such as access to a range of management, marketing, and financial skills and services. At its heart, a science park provides an organized link to local research centers or universities, providing small firms with constant access to the expertise, knowledge, and technology they need to prosper. A recent Battelle report on science parks found that for each job in a science park, 2.57 *additional* jobs are created on average as a direct result.

What do you foresee as the effects of the "Building a Stronger America Act" on job creation in the short- and long-term? How can investment in science park creation and redevelopment help lead us out this recession?

Answer. EDA is not in a position to empirically estimate the effects of the pending legislation. EDA does note that studies by leading innovation policy authorities with whom it works closely, such as those at the National Academy of Sciences and OECD, repeatedly find countries around the world are adopting the parks model. The model is characterized by substantial public investments in infrastructure, new organizational approaches (*e.g.,* Belgium's IMEC semiconductor facility), and public-private research collaboration (*e.g.,* France's MINATEC).

EDA's direct experience is also telling, especially in the area of small business development and growth. For instance, EDA's long-term partnership with state and local officials in the Fargo, ND area fostered the North Dakota State University Research and Technology Park, where many of the best practices, including co-location of private and public research teams, venture capital funding, and business advising services, continues to produce outstanding results. The Park's services include the Entrepreneur Program, co-led by University business school faculty and successful entrepreneurs. The Park's reach is extended through its Virtual Incubator program, which connects to even the most rural areas of North Dakota, and beyond.

Question 4. In order to drive innovation, and encourage the clustering of advanced industries in specific areas, the "Building a Stronger America Act" (S. 583) that Senator Pryor and I have introduced provides grants and loan guarantees to promote the planning, development and construction of science, research, and technology parks. Science parks help drive innovation and regional entrepreneurship by promoting technology and innovation. In my home State of Maine, we presently do not have any traditional science parks. That said, Maine is a national leader in providing business "incubation" services that are tailored to companies in their region. Incubators, like science parks, nurture the development of entrepreneurial companies, providing business support and helping them survive and grow during the start-up period, when they are most vulnerable. The benefit of Maine's seven technology incubator centers has been nothing short of monumental, as a remarkable

87 percent of all businesses graduating from these incubators are still in business and creating new jobs. Many other rural areas in Maine and throughout the Nation would benefit from this type of targeted economic development. Can you elaborate on the critical nature of encouraging innovation in rural areas where populations are not very dense while simultaneously encouraging the development of science parks in population centers? What more can we do to strengthen and grow business incubators?

Answer. EDA's regional innovation clusters approach is best understood as including rather than excluding. Innovation is too often defined in such a way that excludes rural areas and regions are often thought to require an urban center. EDA's definitions, approach, and experience is not consistent with such exclusionary outcomes. Innovation, broadly considered, is not equivalent to 'high tech' or even 'new products'. Innovation is the spirit of America. It is embodied in everything we are, an innovative society that experiments with new ideas.

For instance, employing EDA's regional innovation clusters approach, Minot State University's Bottineau campus is addressing a unique situation in an incubator-like fashion. Small farmers, unable to earn sufficient income, were leaving the land, although they preferred to stay. EDA provided funding that created a low-tech approach to extending the vegetable growing season, which created market potential. However, the local groceries, fearful of being dropped by distributors, refused to buy the produce.

The EDA grantee and local vegetable farmers organized to gain access to the supply chain via the distributors. As a result of assessing regional competitive advantages, being innovative both in growing and entering the distribution chain, the extremely rural area is fostering an emerging cluster focused on locally grown produce.

Question 5. We live in an increasingly globalized world. Science parks reflect the needs of a high-tech, innovative, and global marketplace. Science parks have helped lead the technological revolution. Our Nation's capacity to innovate is essential to ensure future economic growth. Ideas by innovative Americans in the private and public sector have paid enormous dividends, improving the lives of millions throughout the world. We must continue to encourage the advancement of this vital sector if America is to compete at the forefront of innovation. There was a lot of discussion at the hearing about the need to transform existing parks into more modern, collaborative environments primed for innovation in the 21st century. However, we cannot be blind to the technology challenges facing our Nation. For example, U.S. private corporate research centers are greatly downsized or, in some instances, no longer exist. Corporate and Federal support for R&D at universities is declining. And, science and technology are now global commodities.

How can we better encourage the redevelopment of existing science parks in ways that will help them compete in a globalized economy? What specific measures can be taken to ensure that American science parks are evolving for the 21st century? How critical is it that a science park be physically located close to a university given that so much business is now done through networks and virtual environments?

Answer. The National Academies of Science's recent report "Understanding Research S&T Parks" identifies several conditions for creating successful 21st Century research parks. Perhaps one of the most important factors is the presence and involvement of a large research university or laboratory supporting a critical mass of knowledge workers. Also key is the availability of funding over a sustained period, and a strong and committed leadership guiding the development of the park's physical infrastructure and quality-of-life amenities. Finally, and not least, a successful park needs skilled entrepreneurs and managers. Talented and motivated individuals and teams in the private sector are needed to commercialize the knowledge generated. The benefits of a successful park are realized over the long-term, but short term benefits, such as architecture/engineering jobs in the design phase, and construction jobs and associated purchases, should not be overlooked in any evaluation of the park investments.

Question 6. One of the most beneficial incentives in the tax code is the Research and Development Tax Credit. This credit enables small businesses to develop new technologies and create additional jobs. Unfortunately, Congress is not allowing the R&D Credit to realize its full potential. According to the Organization of Economic Cooperation and Development (OECD), the U.S. ranked first in research and development tax generosity in 1990, but has fallen to 17th since then. This is unconscionable at a time when our economy has shed 7.3 million jobs since December 2007. First and foremost, we must make this credit permanent, as Senate Finance Committee Chairman Max Baucus and I have attempted to do in "Grow Research Opportunities with Taxcredits' Help Act" (S. 1203). How can the research and develop-

ment tax credit help science parks grow and generate innovation? How specifically would science parks and small businesses therein benefit and grow as a result of making this tax credit permanent?

Answer. Small and large firms make up an important part of a park's innovation ecosystem. Tax credits increase the R&D engagement at the firm level, leading to additional innovation output. Recent research shows that recipients of R&D tax credits show significantly better scores on most performance indicators. Especially at a time of slower economic growth and stagnant employment, it is important to renew the R&D tax credit. Moreover, making the tax credit permanent will reduce uncertainty and promote business growth in an otherwise challenging environment.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. DAVID VITTER TO DR. CHARLES WESSNER

Question 1. You said that the "potential of research parks appears to be less widely understood in the United States." To what extent, in your estimation, has the U.S. fallen behind the curve the rest of the world is setting in developing and investing in science research parks?

Answer. Success of U.S. Parks Has Led to Their Emulation Abroad.

The United States created the idea of a science and technology park in the early 1950s. The Silicon Valley clusters—sometimes described as a large park—and the successful Research Triangle Park in North Carolina have inspired many governments to believe that they can create growth and jobs through the geographic colocation of resources.

As documented in a recent report by the National Academies, *Understanding Research, Science, and Technology Parks: Global Best Practices*, countries as diverse as China, Singapore, India, Mexico, and France arc among those undertaking substantial national efforts to develop research parks of significant scale and scientific and innovative potential. Foreign efforts to build research parks often involve integrating research institutes, large and small companies and, often, universities, with first-class infrastructure. These ingredients are often complemented by substantial tax advantages and other direct incentives.

Comparative Scale of Foreign and U.S. Parks

Currently, one can argue that U.S. parks, in comparison to its major competitors, lack scale, lack resources, and lack the infrastructure and facilities needed to compete in the global economy.

On the issue of scale, Figure 1 below compares the size of the average North American Research Park (at 358 thousand acres) with that of the average Chinese research park (at over 10 million acres.)

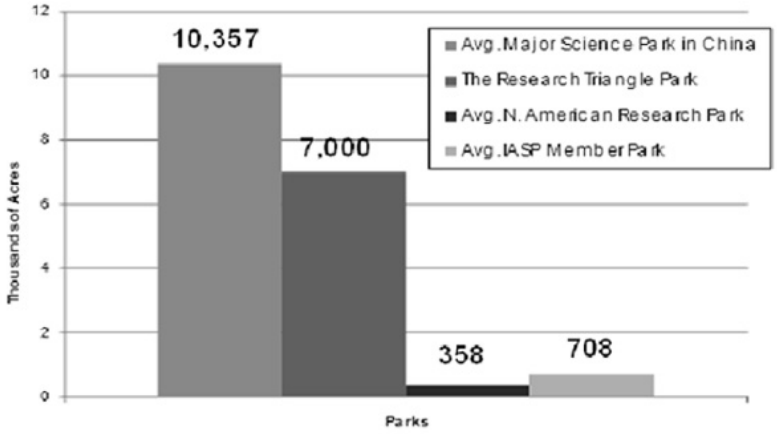

Figure 1: Research Parks in Comparative Perspective—an Issue of Scale [1]

[1] "Average North American Research Park" data are from "Characteristics and Trends in North American Research Parks: 21st Century Directions," commissioned by AURP and prepared by Battelle, October 2007; "Average IASP Member Park" data are from the International Association of Science Parks annual survey, published in the 2005–2006 International Association of Science Parks directory.

The Chinese parks are large, in some cases with numerous top-tier multinationals, and benefit from significant political authority. In short, our Chinese colleagues have taken the park concept and put it on steroids.

The scale of China's investments in research parks might well be compared to the massive efforts undertaken in the United States during the Cold War in building national laboratories. To the extent that these more commercially oriented investments are successful, they may give a significant boost the competitive position of Chinese industry.

Singapore and France provide two additional points of comparison in terms of financial support for the development of research parks. Singapore, with population of 4.5 million, has allocated a 5-year budget of $10 billion over 5 years to strengthen its research and development base, especially in the area of biotechnology. Both the Biopolis and the Fusionopolis urban research parks arc key features of Singapore's competitiveness strategy. These parks are well staffed, include international scholars, and benefit from the latest equipment and close proximity to major universities and the airport. France is reinventing its innovation system through the development of competitive clusters, called "pôles de croissance," with a budget of $2.2 billion for a country of 65 million, over 3 years. By comparison, S583 proposes $500 million over 5 years for the United States, a country of over 300 million.

What Will Be the Impact of the Growth of Parks Around the World?

The substantial investments that the world's leading nations are making to grow research parks reflect an appreciation of their capacity to spur knowledge-based growth and enhance technological competitiveness through innovations that are supported by government infrastructure, government research, government finance and, in some cases, assured national procurement markets. These research parks arc expected to generate very significant benefits to regional development and job creation. Indeed, to the extent that foreign research parks are effective, they have the potential to help shift the terms of global competition, not least in leading technological sectors.

What must the United States Do?

The acceleration in the pace of planning and development of research parks around the world shows that research parks are widely seen as a key tool to improve economic competitiveness through accelerating innovation. To stay in the game, the United States need to make commensurate investments basic and applied research, in growing research parks, and in creating other incentives to encourage the transition of research to the market. In addition, we need to learn from the experiences of others and adopt and adapt those lessons to U.S. circumstances just as other countries are adapting what they see as positive lessons from the U.S. experience.

Good S&T research parks are not a panacea, but they are an effective tool to help U.S. firms and American citizens compete in the global economy. Currently, with regard to parks, we lack the enabling legislation and resources to compete effectively in the 21" Century.

Question 2. You said that there are "challenges of getting these research parks off the ground and integrating them with their universities' missions." Can you provide examples of the specific challenges research parks face in their initial development that makes Federal financial support so important to their creation? In your opinion, is state funding simply not enough to foster their growth and help them clear these initial challenges?

Answer. U.S. Research Parks Receive Most of Their Support from State and Local Governments.

As noted above, science parks now exist in most parts of the world; they are seen as a proven policy tool to spur economic growth and enhance technological competitiveness. They benefit from significant financial and policy support from national and state governments.

The United States remains an exception in this regard, where support for research parks is principally undertaken by state and local governments with only limited participation by the Federal Government. While some state governments are experimenting with technology zones to support research parks and technology incubators, and to increase technology-led economic development clusters, others have lagged behind.

Challenges Facing State and Local Governments in Supporting Research Parks

The National Academies report, *Understanding Research, Silence, and Technology Parks: Global Best Practices*, identifies the availability of significant levels of fund-

ing and policy support over a sustained period as key to the successful development of a research park. This requires a policy environment that is patient, adaptable and focused on commercialization.

Some states like North Carolina have been able to provide the resources and far-sighted leadership needed to grow a successful park. The state's approach to the development of Research Triangle Park is particularly commendable in that it recognized the importance of "patient" support, especially through the first 10 years of its existence when the park made little tangible progress.

Other states face balanced budget requirements and/or other fiscal and political exigencies that preclude the scale and consistency of support necessary for the development of successful parks. Many local governments lack the fiscal base to make the scale of investments necessary to support globally competitive research parks. The paradox is that the Federal and state governments make substantial investments in education and research, yet the early-stage investment to commercialize this research in not readily available.

How Can the Federal Government Help?

While recognizing the traditional role of state and local governments in local economic development, the Federal Government can play an important role in providing incentives for states and regions to undertake significant, long-term investments in research parks, and by supplementing these investments when merited.

State and local governments can also take advantage of Federal programs, like the Small Business Innovation Research (SBIR) Program, to encourage the development of innovation networks between universities and small firms and to provide seed capital for small business entrepreneurship. Other partnership programs can help states and localities leverage the substantial investments the Federal Government is already making in universities, national laboratories, and other research facilities around the country.

This can be a win-win proposition for the Federal and state governments, as the case of Sandia Park illustrates. Here, Sandia National Laboratories gains from the research park through the retention of the needed skills base near the Laboratory, while the community benefits from the commercialization of knowledge and the jobs and growth made possible by the Laboratory's presence.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. OLYMPIA J. SNOWE TO BRIAN DARMODY

Question 1. Ever since the cluster concept was introduced, it has rapidly attracted attention as a means to enhance the capability for innovative conversion of science and technology into products, services, and new business growth. Nowadays, clusters of existing and emerging science-based activities have been shown to be crucial factors in shaping the economic winners and losers of the first half of the 21st century. What are some best practices and successful models of knowledge transfer in science based clusters? What are the necessary conditions for success and issues of sustainability of clusters?

Answer. First, regional leadership and buy-in by local stakeholders in the business and academic communities are critical factors. Second, technologies do not know in which political jurisdiction they are being developed. Strategies to break down competing political jurisdictions' natural inclination to control and instead allow initiatives to grow on a regional basis must be develop, such as establishing a regional authority. Finally, cluster development can help grow a region but unless there is some core technology base, declaring a region a cluster will not help regional technology led economic development. You need the core technology to grow the regional cluster.

Question 2. In order to drive innovation, and encourage the clustering of advanced industries in specific areas, the "Building a Stronger America Act" (S. 583) that Senator Pryor and I have introduced provides grants and loan guarantees to promote the planning, development and construction of science, research, and technology parks. Science parks help drive innovation and regional entrepreneurship by promoting technology and innovation. In my home State of Maine, we presently do not have any traditional science parks. That said, Maine is a national leader in providing business "incubation" services that are tailored to companies in their region. Incubators, like science parks, nurture the development of entrepreneurial companies, providing business support and helping them survive and grow during the start-up period, when they are most vulnerable. The benefit of Maine's seven technology incubator centers has been nothing short of monumental, as a remarkable 87 percent of all businesses graduating from these incubators are still in business

and creating new jobs. Many other rural areas in Maine and throughout the Nation would benefit from this type of targeted economic development. Can you elaborate on the critical nature of encouraging innovation in rural areas where populations are not very dense while simultaneously encouraging the development of science parks in population centers? What more can we do to strengthen and grow business incubators?

Answer. Technology incubators are a key element of any regional technology strategy. The 'Building a Stronger America Act' does recognize the role of technology incubators in growing small businesses in the United States, and includes startup incubators in the definition of 'science parks.' Many university research parks have an incubator in or (as in the case at the University of Maryland) on the campus that work together, and many startup companies are located in research parks. Indeed the Bayh-Dole Act is encouraging universities to create startup companies, and technology incubators are critical in filling this role. The Association of University Research Parks works very closely with the National Business Incubation Association (NBIA) on programs and legislative initiatives such as programs to support technology infrastructure and technology led economic development.

Question 3. We live in an increasingly globalized world. Science parks reflect the needs of a high-tech, innovative, and global marketplace. Science parks have helped lead the technological revolution. Our Nation's capacity to innovate is essential to ensure future economic growth. Ideas by innovative Americans in the private and public sector have paid enormous dividends, improving the lives of millions throughout the world. We must continue to encourage the advancement of this vital sector if America is to compete at the forefront of innovation. There was a lot of discussion at the hearing about the need to transform existing parks into more modern, collaborative environments primed for innovation in the 21st century. However, we cannot be blind to the technology challenges facing our Nation. For example, U.S., private corporate research centers are greatly downsized or no longer exist. Corporate and Federal support for R&D at universities is declining. And, science and technology are now global commodities. How can we better encourage the redevelopment of existing science parks in ways that will help them compete in a globalized economy? What specific measures can be taken to ensure that American science parks are evolving for the 21st century? How critical is it that a science park be physically located close to a university given that so much business is now done through networks and virtual environments?

Answer. Providing infrastructure support, as provided in 'Building A Stronger America Act', is a necessary, but not sufficient response to encourage innovation and cluster development. My written testimony amplifies some other ideas and they are further explored in 'The Power of Place, A National Strategy for Building America's Communities of Innovation, *http://aurp.net/meet/The_Power_of_Place.pdf*. A number of Senators at the hearing asked about the role of Federal labs, and I have provided some policy ideas below related to Federal, private and academic sectors to encourage cluster development:

Use Federal Labs and Lab Spin Outs as Anchors in Cluster Development:

Over $25 billion a year in internal research and development spending (nearly as much as is spent at colleges and universities) and tens of thousands of brilliant researchers are employed at Federal labs, but much of the talent and technology remains inside, and the Federal labs are not often integrated into the community where they reside:

- Create local technology companies from Federal intramural research: Create Congressionally-chartered Federal commercialization intermediary organization, based on best practices of technology commercialization intermediary models found at leading research universities (WARF at U. Wisconsin), in states (TEDCO in Maryland) and individual Federal labs (for example, the Congressionally-chartered Jackson Foundation at Uniform Health Science University), through expanding the funding, authority, venture staffing, and venture acceleration capacity of the Federal Lab Consortium established in 15 U.S.C. sec. 3710. Just as when Congress wanted to improve Pennsylvania Avenue, it chartered the Penn Ave Development Authority to take on business of redevelopment, a Federal technology commercialization authority needs to be chartered by Congress to take on business of tech transfer and to create technology spin outs to locate near the Federal labs and improve the communities where Federal labs are located.
- Connect Federal researchers with private companies: The Administration has called on Federal researchers to be more involved with private sector companies (See, *e.g.,* August 4 2009 OMB/OSTP directive to heads of Executive Agencies). No comprehensive agency-wide program exists, however, to allow Federal re-

search assignments with private sector companies. Issue a Presidential Executive Order on Federal lab technology commercialization and private sector partnerships (See, *e.g.,* EO 12591) based on the NASA Innovation Ambassadors Program. *www.nasa/gov/office/innovation__incubator/*

- Connect fed labs to local communities: Embed regional economic development mission into all fed labs missions; currently Department of Energy labs have this mission; will help spur Administration's regional cluster initiatives.
- Create more private sector involvement near Federal labs in urban areas: Expand Enhanced Use Lease (EUL) authority (which allows leasing of fed land and equipment) to all Federal agencies, not just DOD agencies. See, 10 U.S.C. 2667.
- Create culture of Entrepreneurship: Create entrepreneurial leave programs to encourage Federal researchers to take temporary assignments with private sector technology firms, and protect their positions in the fed labs upon their return. Encourage 'entrepreneur in residence' (EIR) programs as all fed labs and create programs to encourage Federal researchers to create companies and mentor the process through the EIR program.
- Create regional clusters: Issue GSA/Army Corps of Engineers policy encouraging fed labs to build and lease in area near innovation assets, such as research parks, health science centers, other fed labs, private research centers and colleges and universities.

Research Universities and Commercialization

Improve University Commercialization in the U.S. by imbedding commercialization in U.S. grant and contract funding model: The U.S. created the Bayh-Dole Act that spurred university technology commercialization around the world but now lags the UK in tech commercialization since Federal grant and contract policies provide no funding for tech transfer office or initial proof of concept funding to make them attractive for follow on investment. Reform OMB A–21 restrictions on overhead to increase by 1 percent overhead negotiated rates with cognizant Federal agency for cost reimbursement for patent expenses and seed commercialization fund at universities to bridge first 'valley of death' consistent with the Bayh-Dole Act to create more companies and jobs in U.S. This can be done without new Federal legislation, or Federal agency, and can be implemented quickly, without a new bureaucracy.

Private Sector

R and D Tax Credit: To keep more R and D at home, develop an enhanced corporate R and D tax credit for projects undertaken in partnership with college and universities.

Keep more Corporate R and D in U.S.: Remove Federal IRS restrictions on private use in tax exempt research facilities by corporations sponsoring research by removing tests related to IP licensing. IRS Revenue Procedure 97–14 needs to be reformed to allow corporations to keep more of the IP they sponsor; otherwise they will continue to ship R and D to universities overseas.

Education

From 'STEM' to 'ESTEEM': Move from focus on 'STEM' (Science, Technology, Engineering and Math) issues to 'ESTEEM' (Encouraging Science, Technology, Engineering, Entrepreneurship, and Math) skills since job creation will be dependent on new startup companies.

Entrepreneurship Programs at Department of Education and NSF: Develop new U.S. Department of Education program, joint with NSF, to encourage university based partnerships for innovation and dormitories for entrepreneurs and living learning centers to encourage study of entrepreneurships and new company formation as basis for economic growth in the U.S.

Question 4. One of the most beneficial incentives in the tax code is the Research and Development Tax Credit. This credit enables small businesses to develop new technologies and create additional jobs. Unfortunately, Congress is not allowing the R&D Credit to realize its full potential. According to the Organization of Economic Cooperation and Development (OECD), the U.S. ranked first in research and development tax generosity in 1990, but has fallen to 17th since then. This is unconscionable at a time when our economy has shed 7.3 million jobs since December 2007. First and foremost, we must make this credit permanent. Senate Finance Committee Chairman Baucus introduced the "Grow research Opportunities with Taxcredits' Help Act" (S. 1203), which I cosponsored, to make the credit permanent. How is a research and development tax credit essential for the growth of science parks and generating innovation? How specifically would science parks and small

businesses therein benefit and grow as a result of making this tax credit permanent?

Answer. Many of the larger companies in university science parks avail themselves of the Federal tax credit and making the tax credit permanent and expanded would be of great help. A program to give an enhanced credit to corporations doing joint R and D with universities would help keep more R &D in the United States. Additionally, we need to focus on the needs of the smaller technology companies, many of whom may not qualify for the Federal R and D tax credit due to their size or their tax status. A Federal program to provide a tax credit to angel investors, who have invested in the startup company, would help spur more investment in smaller companies.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. OLYMPIA J. SNOWE TO JONATHAN SALLET

Question 1. You noted during the hearing that "some of our strongest international competitors, including Japan, South Korea, and many European countries, have invested in significant national cluster initiatives, directing great amounts of money and resources toward making innovation clusters the main focus of their economic and innovation policies." And, you pointed out an irony that while foreign innovation policymakers have studied our successes and consulted with our experts, "the United States has conspicuously failed to embrace cluster initiatives as an explicit part of its own innovation policy." What are some of the crucial factors in shaping our Nation's economic winners and losers? What are some best practices and successful models of knowledge transfer in science based clusters? What are the necessary conditions for success and issues of sustainability of clusters?

Answer. In our paper from the Center for American Progress referenced in my testimony, we explain why the critical components of a national economy are strong regional economies. As we have looked at the lessons of successful regional economic strategies, we see key lessons that include:

- *Place Matters.* Not every location can do everything. Boatbuilding is better suited for Maine than for states far from the coast, for example. So a key step is for a region to understand its real and prospective competitive advantages. Important in the success of a "place" is, of course, leadership from local educational institutions, a supply of capital, and well-trained workers.
- *Networks of Collaboration.* A region will be successful because it is competitive and because it hosts businesses that are fiercely competitive, often with each other. But collaboration at the pre-competitive is very important as well. Consider, for example, information processing businesses that work together to incent local community colleges to offer education in their field, creating a supply of talented workers from which all can draw.
- *Local Leadership.* Regional economies are built from the ground up. Our examination of successful clusters reveals a high sense of leadership, incorporating the private sector, universities, local government and civic organizations. And, equally importantly, that leadership inevitably needs to look beyond local political boundaries—often to regional economies that cross state lines.

Question 2. In order to drive innovation, and encourage the clustering of advanced industries in specific areas, the "Building a Stronger America Act" (S. 583) that Senator Pryor and I have introduced provides grants and loan guarantees to promote the planning, development and construction of science, research, and technology parks. Science parks help drive innovation and regional entrepreneurship by promoting technology and innovation. In my home State of Maine, we presently do not have any traditional science parks. That said, Maine is a national leader in providing business "incubation" services that are tailored to companies in their region. Incubators, like science parks, nurture the development of entrepreneurial companies, providing business support and helping them survive and grow during the start-up period, when they are most vulnerable. The benefit of Maine's seven technology incubator centers has been nothing short of monumental, as a remarkable 87 percent of all businesses graduating from these incubators are still in business and creating new jobs. Many other rural areas in Maine and throughout the Nation would benefit from this type of targeted economic development. Can you elaborate on the critical nature of encouraging innovation in rural areas where populations are not very dense while simultaneously encouraging the development of science parks in population centers? What more can we do to strengthen and grow business incubators?

Answer. As a resident of the Eastern Shore of Maryland, which continues its agricultural base, I see this problem first hand. That's why I believe that any Federal efforts should be sure to reach beyond metropolitan areas to include rural AmericAnswer. And why I believe that local economies should have flexibility to use Federal support in the ways that they believe will work for them. I have suggested, therefore, that the science parks initiative, very important on its own, would be even stronger if it were part of a larger effort that includes business incubators and other tools of growth. With the kind of record of success show in Maine, and experience around the nation, it is clear that business incubators are critical.

Question 3. We live in an increasingly globalized world. Science parks reflect the needs of a high-tech, innovative, and global marketplace. Science parks have helped lead the technological revolution. Our Nation's capacity to innovate is essential to ensure future economic growth. Ideas by innovative Americans in the private and public sector have paid enormous dividends, improving the lives of millions throughout the world. We must continue to encourage the advancement of this vital sector if America is to compete at the forefront of innovation. There was a lot of discussion at the hearing about the need to transform existing parks into more modern, collaborative environments primed for innovation in the 21st century.

However, we cannot be blind to the technology challenges facing our Nation. For example, U.S., private corporate research centers are greatly downsized or no longer exist. Corporate and Federal support for R&D at universities is declining. And, science and technology are now global commodities.

How can we better encourage the redevelopment of existing science parks in ways that will help them compete in a globalized economy? What specific measures can be taken to ensure that American science parks are evolving for the 21st century? How critical is it that a science park be physically located close to a university given that so much business is now done through networks and virtual environments?

Answer. Collaboration with universities is very important. Although we may not want to enact a Federal requirement of particular geographic proximity, we certainly want to ensure that science parks, along with other tools of regional economic growth, are part of a well-considered, strategic plan for the region. Ensuring the presence of a strategic plan is a critical—perhaps the critical—step in ensuring that Federal monies are well-spent and that local efforts are really tied to areas of current or prospective economic advantage. And a critical part of any strategic plan is the inclusion of local institutions of higher learning. As we write in our CAP paper:

Innovative companies were once innovative ideas, many of which came from the scientists, professors, and engineers that work at universities, corporate R&D facilities, and government laboratories. The "spillover" of ideas from these knowledge-creation institutions (and their intellectual property practices) to the local community and network of entrepreneurs is the central process that takes place in fertile innovation clusters. As more and more ideas move from labs to eager individuals and their business partners, scores of innovative businesses are started, feeding an auspicious cycle.

Science parks would be a leading beneficiary of this approach.

Question 4. One of the most beneficial incentives in the tax code is the Research and Development Tax Credit. This credit enables small businesses to develop new technologies and create additional jobs. Unfortunately, Congress is not allowing the R&D Credit to realize its full potential. According to the Organization of Economic Cooperation and Development (OECD), the U.S. ranked first in research and development tax generosity in 1990, but has fallen to 17th since then. This is unconscionable at a time when our economy has shed 7.3 million jobs since December 2007. First and foremost, we must make this credit permanent. Senate Finance Committee Chairman Baucus introduced the "Grow research Opportunities with Taxcredits' Help Act" (S. 1203), which I cosponsored, to make the credit permanent. How is a research and development tax credit essential for the growth of science parks and generating innovation? How specifically would science parks and small businesses therein benefit and grow as a result of making this tax credit permanent?

Answer. Business strategy and investment is always aided by certainty. The quest to make the R&D tax credit permanent has gone on for too long. Passage of your legislation is very important.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. OLYMPIA J. SNOWE TO DR. ANTHONY TOWNSEND

Question 1. What are the trends shaping the plausible future for science parks? What will happen if we maintain the status quo and who do you see as the early adopters and the resisters of these scenarios?

Answer. The Institute for the Future identified fourteen external trends that will shape the future for science parks. Four of these will play a special role, as their future direction of change has a high degree of uncertainty, and may play out in a variety ways. These highly uncertain trends are:

- *The Economic Role of Universities*—Some universities will embrace entrepreneurialism while others reject a larger role in the economy. But all will face challenges navigating the conflicting demands and increased strains of a shifting economic and intellectual role. As the major developer of science parks today, the future role of universities is a critical variable. Realizing the full potential of universities to drive growth will probably require a painful and extended overhaul of intellectual property management and technology transfer frameworks.
- *Growth of New Science Institutions*—Scientific societies, journals and other institutions that set the basic rules of who can call themselves a scientist, and how they should conduct research and share results, will come under tremendous strain. New science networks are forming, organized via the Internet and social software, but their future role and their connection to centers of science could play out in many different ways.
- *Sustainability*—The cost of energy will drive business and policy decisions across the board. How will R&D ecosystems react to different energy frameworks, and the scientific and technological challenges of battling global warming? We expect this will reinforce the desire to cluster some research and development activities in science parks, but also create forces that favor virtualization and dispersion.
- *The Bio-industrial Complex*—Bioscience is supplanting physics as the source of great breakthroughs, but there are fundamental flaws in systems for commercializing those discoveries. It is unclear how to fix the many problems in the "bio-industrial complex", the role of the public sector, and whether science parks will be able to create environments that address any of the structural challenges, and accelerate innovation and commercialization.

Question 2. Can you elaborate on the critical nature of encouraging innovation in rural areas where populations are not very dense while simultaneously encouraging the development of science parks in population centers? What more can we do to strengthen and grow business incubators?

Answer. New technologies for computing and communication, as well as changes in the nature of scientific collaboration are creating new opportunities to extend the science park model from its traditional base in population centers to rural areas. First, many of the tools and instruments of both basic science and technological development are now networked and can be accessed remotely. Cloud computing technologies allow anyone with an Internet connection to access almost infinite computing capacity on-demand for simulation, data analysis and visualization and modeling. Second, the practice science and technology are becoming more global and distributed, reducing the cultural, organizational and logistical obstacles to participation in collaborative R&D for researchers in rural locations. Third, we must note that many colleges and universities are indeed located in rural communities. As these institutions seek to play a more important role in economic development they are well-positioned to provide support for rural scientists and engineers to participate in global R&D networks. Finally, there are great opportunites to connect networks of metropolitan and rural science parks in mutually beneficial ways. For instance, the North Carolina Research Parks network combines the global brand and appeal of the Research Triangle Park with potentially lower cost alternatives of the state's seven other science parks. The network can market a wide range of assets to potential tenants, that combine benefits of rural or more metropolitan locations.

Question 3. How can we better encourage the redevelopment of existing science parks in ways that will help them compete in a globalized economy? What specific measures can be taken to ensure that American science parks are evolving for the 21st century? How critical is it that a science park be physically located close to a university given that so much business is now done through networks and virtual environments?

Answer. The most important way to redevelop existing science parks is to recognize that their management needs to be upgraded for the 21st century. Managing science parks effectively over the coming decades will mean a greater focus on managing activity than managing buildings and land. This requires as different kind of manager and developer, different relationships with tenants, and different tenants themselves. While large companies will continue to be an important part of the tenant mix in science parks, small and medium-sized companies will play a growing role in driving technological innovation. Science parks will need to learn how to market to them, how to attract them, how to serve them and help them grow, and how to maximize their local economic impact.

Specifically, I recommend that the Federal Government support upgrading and expanding the "software" of science parks at the same time it supports the "hardware" of science parks in S. 583. Science parks could use this funding to expand staff focused on social capital development—creating new business networks, engaging and cultivating venture investors and angels, and other kinds of activity that characterize successful technology clusters like Silicon Valley.

Question 4. How is a research and development tax credit essential for the growth of science parks and generating innovation? How specifically would science parks and small businesses therein benefit and grow as a result of making this tax credit permanent?

Answer. Making the R&D tax credit permanent would expand the market for science parks by expanding the overall expenditure on R&D in the U.S. economy. Creative science park managers and developers could package advisory services on the R&D tax credit with their leasing programs to help small and medium-sized companies plan for long-term growth and expansion. This would create a virtuous cycle of investment supporting the overall business model for new and expanded science parks.

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