Growing Innovation Clusters for American Prosperity: Summary of a Symposium

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Charles W. Wessner, Rapporteur; Committee on Competing in the 21st Century: Best Practice in State and Regional Innovation Initiatives; National Research Council

Growing Innovation Clusters for American Prosperity

Summary of a Symposium

Charles W. Wessner, *Rapporteur*

Committee on Competing in the 21st Century: Best Practice in State and Regional Innovation Initiatives

Board on Science, Technology, and Economic Policy

Policy and Global Affairs

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PREFACE

Responding to the challenges of fostering regional growth and employment in an increasingly competitive global economy, many U.S. states and regions have developed programs to attract and grow companies as well as attract the talent and resources necessary to develop innovation clusters. These state and regionally based initiatives have a broad range of goals and increasingly include significant resources, often with a sectoral focus and often in partnership with foundations and universities. These are being joined by recent initiatives to coordinate and concentrate investments from a variety of federal agencies that provide significant resources to develop regional centers of innovation, business incubators, and other strategies to encourage entrepreneurship and high-tech development.

This has led to renewed interest in understanding the nature of innovation clusters and public policies associated with successful cluster development.

Project Statement of Task

An ad hoc committee, under the auspices of the Board on Science, Technology, and Economic Policy (STEP), is conducting a study of selected state and regional programs in order to identify best practices with regard to their goals, structures, instruments, modes of operation, synergies across private and public programs, funding mechanisms and levels, and evaluation efforts. The committee is reviewing selected state and regional efforts to capitalize on federal and state investments in areas of critical national needs. This review includes both efforts to strengthen existing industries as well as specific new technology focus areas such as nanotechnology, stem cells, and energy in order to better understand program goals, challenges, and accomplishments.

As a part of this review, the committee is convening a series of public workshops and symposia involving responsible local, state, and federal officials and other stakeholders. These meetings and symposia will enable an exchange of views, information, experience, and analysis to identify best practice in the range of programs and incentives adopted.

Drawing from discussions at these symposia, fact-finding meetings, and commissioned analyses of existing state and regional programs and technology focus areas, the committee will subsequently produce a final report with findings and recommendations focused on lessons, issues, and opportunities for complementary U.S. policies created by these state and regional initiatives.

The Context of this Project

Since 1991, the National Research Council, under the auspices of the Board on Science, Technology, and Economic Policy, has undertaken a program of activities to improve policymakers' understandings of the interconnections of science, technology, and economic policy and their importance for the American economy and its international competitive position. The Board's activities have corresponded with increased policy recognition of the importance of knowledge and technology to economic growth.

One important element of STEP's analysis concerns the growth and impact of foreign technology programs.[1] U.S. competitors have launched substantial programs to support new technologies, small firm development, and consortia among large and small firms to strengthen national and regional positions in strategic sectors. Some governments overseas have chosen to provide public support to innovation to overcome the market imperfections apparent in their national innovation systems.[2] They believe that the rising costs and risks associated with new potentially high-payoff technologies, and the growing global dispersal of technical expertise, underscore the need for national R&D programs to support new and existing high-technology firms within their borders.

Similarly, many state and local governments and regional entities in the United States are undertaking a variety of initiatives to enhance local economic development and employment through investment programs designed to attract knowledge-based industries and grow innovation clusters.[3] These state and regional programs and associated policy measures are of great interest for their potential contributions to growth

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[1]National Research Council, *Innovation Policies for the 21st Century*, Charles W. Wessner, ed., Washington, DC: The National Academies Press, 2007.

[2]For example, a number of countries are investing significant funds in the development of research parks. For a review of selected national efforts, see National Research Council, *Understanding Research, Science and Technology Parks: Global Best Practices*, Charles W. Wessner, ed., Washington, DC: The National Academies Press, 2009.

[3]For a scoreboard of state efforts, see Robert Atkinson and Scott Andes, *The 2010 State New Economy Index: Benchmarking Economic Transformation in the States,* Kauffman Foundation and ITIF, November 2010.

and U.S. competitiveness and for the "best practice" lessons they offer for other state and regional programs.

STEP's project on State and Regional Innovation Initiatives is intended to generate a better understanding of the challenges associated with the transition of research into products, the practices associated with successful state and regional programs, and their interaction with federal programs and private initiatives. The study seeks to achieve this goal through a series of complementary assessments of state, regional, and federal initiatives; analyses of specific industries and technologies from the perspective of crafting supportive public policy at all three levels; and outreach to multiple stakeholders. The overall goal is to improve the operation of state and regional programs and, collectively, enhance their impact.

This Summary

The symposium reported in this volume brought together state and federal government officials, leading analysts, congressional staff, and other stakeholders to explore the role of clusters in promoting economic growth, the government's role in stimulating clusters, and the role of universities and foundations in their development. Attention was drawn to specific strategies planned or in place around the country to promote cluster development as well as the challenges faced in growing and sustaining clusters.

This summary captures the presentations and discussions of the 2009 STEP symposium on innovation clusters. It includes an overview highlighting key issues raised at the meeting and a summary of the meeting's presentations. This workshop summary has been prepared by the workshop rapporteur as a factual summary of what occurred at the workshop. The planning committee's role was limited to planning and convening the workshop. The statements made are those of the rapporteur or individual workshop participants and do not necessarily represent the views of all workshop participants, the committee, or the National Academies.

Acknowledgments

On behalf of the National Academies, we express our appreciation and recognition for the insights, experiences, and perspectives made available by the participants of this meeting. We are indebted to Alan Anderson for writing a summary of the meeting and to Sujai Shivakumar of the STEP staff for writing the introduction to this volume.

National Research Council Review

This report has been reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the National Academies' Report Review Committee. The purpose of this independent review is to provide candid and critical comments that will assist the institution in making its published report as sound as possible and to ensure that the report meets institutional standards for quality and objectivity. The review comments and draft manuscript remain confidential to protect the integrity of the process.

We wish to thank the following individuals for their review of this report: Saul Behar, University City Science Center; Joseph Cortright, The Brookings Institution; Daniel Berglund, SSTI; Brian Darmody, University of Maryland; Timothy Franklin, The Pennsylvania State University; and James Gambino, Ben Franklin Technology Partners.

Although the reviewers listed above have provided many constructive comments and suggestions, they were not asked to endorse the content of the report, nor did they see the final draft before its release. Responsibility for the final content of this report rests entirely with the rapporteur and the institution.

Charles W. Wessner Mary L. Good

I
OVERVIEW

GROWING CLUSTERS FOR AMERICAN PROSPERITY OVERVIEW

While competition for innovative technologies and services is increasingly global, the context of innovation—and the benefits it brings in economic growth and high value employment—remains local.[1] Innovation clusters are regional concentrations of large and small companies that develop creative products and services, along with specialized suppliers, service providers, universities, and associated institutions. Ideally, they bring together a critical mass of skills and talent and are characterized by a high level of interaction among these entrepreneurs, researchers, and innovators.[2] The high levels of productivity and innovation found in many clusters are reflected in an intensifying "locational competition" among nations and regions around the world to attract the people, resources, and infrastructure believed necessary to develop clusters in leading-edge technologies.[3]

In the United States, innovation clusters have sometimes developed around a nucleus of government-funded laboratories and universities that interact repetitively with the private sector; one example is the high-technology industries that emerged and grew around the government

[1]Michael Porter has observed that "the enduring competitive advantages in a global economy lie increasingly in local things—knowledge, relationships, motivation—that distant rivals cannot match." See Michael E. Porter, "Clusters and the new economics of competition," *Harvard Business Review*, 76(6):77-90, 1998. For a review of current trends in the globalization of innovation and the nature of locational competition, see Barry Jaruzelski and Kevin Dehoff, "Beyond Borders: The Global Innovation 1000, *Strategy and Business*, 53(Winter), 2008.

[2]For a review of the literature on the issue of innovation clusters, see J. Cortright, *Making Sense of Clusters: Regional Competitiveness and Economic Development*, Washington, DC: The Brookings Institution, 2006.

[3]See Anne O. Krueger, "Globalization and International Locational Competition; Symposium in Honor of Herbert Giersch." Lecture delivered at the Kiel Institute, May 11, 2006.

laboratories and major universities in the Boston area.[4] In other cases, for example, Silicon Valley in California, multiple private industries interacting with a major university, and irrigated with substantial and sustained federal funding, created powerful developmental synergies.[5] In contrast to the relatively spontaneous emergence of these innovation clusters, a third approach to the development of innovation clusters is through the deliberate co-location of creative activity within the concentrated geographical area, such as through a research park development. The Research Triangle Park in North Carolina is a widely cited example of such a created cluster.[6]

The perceived success of these and other U.S. innovation clusters has led to widespread interest in creating and encouraging the development of new clusters as a means of creating jobs and spurring competitiveness. To this end, local, regional and national governments around the world are implementing programs and policies to create, develop, and strengthen locally focused networks among businesses, universities, research and development organizations, and philanthropic foundations.[7] A recent study by the Brookings Institution documents national cluster

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[4]See National Research Council, *Understanding Research, Science and Technology Research Parks: Global Best Practices*, Charles W. Wessner, ed., Washington, DC: The National Academies Press, 2009.

[5]See AnnaLee Saxenian, *Regional Advantage: Culture and Competition in Silicon Valley and Route 128*, Cambridge, MA: Harvard University Press, 1994, p. 161. See also Martin Kenney, ed., *Understanding Silicon Valley: The Anatomy of an Entrepreneurial Region,* Stanford: Stanford University Press, 2000. See also T. J. Sturgeon, "How Silicon Valley Came to Be" in M. Kenney (ed.), *Understanding Silicon Valley: The Anatomy of an Entrepreneurial Region,* op. cit., pp. 15-47. See also Margaret Pugh O'Hara, *Cities of Knowledge: Cold War Science and the Search for the Next Silicon Valley*, Princeton: Princeton University Press, 2005.

[6]For a comprehensive history of the Research Triangle Cluster, see Albert N. Link, *A Generosity of Spirit: The Early History of the Research Triangle Park*, Research Triangle Park: The Research Triangle Foundation of North Carolina, 1995. For a seminal study of the research parks phenomenon, see, M. I. Luger and H. A. Goldstein, *Technology in the Garden*, Chapel Hill: University of North Carolina Press, 1991, p. 5. For an update of this study, see M. I. Luger and H. A. Goldstein, *Research Parks Redux: The Changing Landscape of the Garden*, Washington, DC: U.S. Economic Development Administration, 2006.

[7]Robert Lucas has long argued that the clustering and density of talented people is a key driver of innovation and economic growth. See Robert Lucas, "On the mechanics of economic development," *Journal of Monetary Economics* 22:38-39. Richard Florida has popularized the characteristics and economic advantages of innovative clusters. See, for example, Richard Florida*, The Rise of the Creative Class*, New York: Basic Books, 2002.

development programs in Japan, the Republic of Korea, and 26 nations in the European Union.[8] National development programs are also underway in the world's emerging economies. China, notably, has recently constructed 54 research parks, many of them on a very large scale, as a part of a coordinated strategy for developing innovation clusters.[9]

> "Silicon Valley is probably the only place on earth not trying to copy Silicon Valley."
>
> Robert Metcalfe, InfoWorld, March 2, 1998

The United States has no similar coordinated national effort underway to build new research parks or develop new innovation clusters.[10] Traditionally, state and local governments and, in some cases, private foundations and other regional organizations have singularly or in combination sought to stimulate the development and growth of clusters. Some of these initiatives, including the development of a nano-technology cluster near Albany, New York, have reported significant

[8]See Karen G. Mills, Elisabeth B. Reynolds, and Andrew Reamer, "Clusters and Competitiveness: A New Federal Role for Stimulating Regional Economies," Washington, DC: Brookings Institution, April 2008.

[9]China's research parks vary in size and mission, but many are very large in scale. For example, the Zhongguancun Science Park in Beijing hosts over 20,000 enterprises, employs nearly a million people, and has earned about $ 124 billion in income in recent years. See National Research Council, *Understanding Research, Science and Technology Parks: Summary of a Symposium,* op. cit. The Chinese government is seeking to develop technology clusters through large investments in research parks. See Justin Tan, "Growth of industry clusters and innovation: Lessons from Beijing Zhongguancun Science Park," *Journal of Business Venturing* 21(6):827-850, November 2006. See also Cheng-Hua Tzeng, "Managing innovation for economic development in greater China: The origins of Hsinchu and Zhongguancun," *Technology in Society* 32(2):110-121, May 2010.

[10]The United States currently has no legislatively authorized programs specifically dedicated to comprehensively supporting cluster initiatives. Many of the Department of Labor's WIRED (Workforce Innovation in Regional Economic Development) projects are cluster-focused, but WIRED is not solely a cluster initiative program. See the Department of Labor WIRED website at <*http://www.doleta.gov/wired/about/*>.

achievements.[11] In many cases, however, state and local efforts lack critical mass in terms of funding and facilities and may also lack the sustained policy support needed for success. To address this apparent gap and to adjust to the changing international competitive environment, some advocates have called for the federal government to play a more active role in supporting the development of local innovation clusters.[12]

Speaking at the National Academies symposium on "Growing Innovation Clusters for American Prosperity," Susan Crawford, then of the White House Office of Science and Technology Policy, said that the Obama Administration is "committed to the idea of regional economic clusters and their role in economic growth and innovation." She noted that innovation "cannot happen top-down alone, or bottom-up alone," suggesting instead that the federal government's role may be to provide a "kind of trellis" that supports the growth of entrepreneurial offshoots in the nation's states and localities.[13]

This volume is based on the National Academies symposium on innovation clusters. The symposium included discussions on the nature of clusters, descriptions of the experiences of several states in cluster development, and views on the role of the federal government in supporting clusters. It also included perspectives on the role that public-private partnerships can play in supporting the growth of robust innovation clusters. This workshop summary has been prepared by the workshop rapporteur as a factual summary of what occurred at the workshop. The planning committee's role was limited to planning and convening the workshop. The statements made are those of the rapporteur or individual workshop participants and do not necessarily represent the views of all workshop participants, the planning committee, or the National Academies.

I. UNDERSTANDING THE CLUSTERING OF INNOVATION

Although there are numerous ongoing efforts around the world to build new innovation clusters, the nature of these clusters and how they evolve remains in many ways an enigma. Clusters have been described

[11]For an account of the role of the state of New York in the creation of this cluster, see the presentation of Pradeep Haldar, in the Summary of Presentations section of this volume.

[12]See Karen G. Mills, Elisabeth B. Reynolds, and Andrew Reamer, op. cit. See also Jonathan Sallet, Ed Paisley, and Justin R. Masterman, "The Geography of Innovation, The Federal Government and the Growth of Regional Innovation Clusters." *Science Progress*, September 1, 2009.

[13]See the presentation by Susan Crawford in the Summary of Presentations section of this volume.

as a "combination of geographically co-located private sector producers of R&D, related manufacturing and services industries, linked or related suppliers and producer services providers, leading research universities and teaching institutions, and government sponsored labs and technology programs."[14] But there is more to the phenomenon of clusters than this static description. Reflecting the non-linear and interactive nature of innovation, successful clusters exhibit a culture of entrepreneurship emerging from dense networks of trust and cooperation that reaches across multiple organizations.[15]

Cooperation, Culture, and Clusters

As Professor Maryann Feldman of the University of North Carolina at Chapel Hill noted at the National Academies symposium, this culture of innovation can emerge when face-to-face interactions enhance localized networks of trust, reciprocity and cooperation.[16] Cooperation improves further when innovators develop a common vocabulary and a grammar to communicate with each other. Professor Feldman noted that this knowledge, and the language associated with it, grows as it is shared within a community. These network effects, in turn, lead to increasing returns and greater productivity from economic activity.

[14]See Edward Feser, "Industry Cluster Concepts in Innovation Policy: A Comparison of U.S. and Latin American Experience," in *Interdisciplinary Studies in Economics and Management,* Volume 4, Vienna: Springer, 2005.

[15]As Tödtling and Trippl note, "innovation should be seen as an evolutionary, non-linear, and interactive process, requiring intensive communication and collaboration between different actors, both within companies as well as between firms and other organizations such as universities, innovation centers, educational institutions, financing institutions, standard setting bodies, industry associations, and government agencies." See Franz Tödtling and Michaela Trippl, "One size fits all? Towards a differentiated regional innovation policy approach," *Research Policy* 34, 2005.

[16]Using controlled laboratory experiments, Elinor Ostrom and her colleagues find that face-to-face communication has a major effect on building trust, reciprocity and cooperation. For a recent review of the findings, see Marco A. Janssen, Robert Holahan, Allen Lee, and Elinor Ostrom, "Lab Experiments for the Study of Social-Ecological Systems," *Science* 328(5978):613-617, April 2010.

> "Cluster formation is a process predicated on the actions of entrepreneurs and their symbiotic relationships with their local environments. The cluster and its characteristics therefore emerge over time from the individual activities of the entrepreneurs and the organizations and institutions that evolve to support them."
>
> Maryann P. Feldman and Johanna L. Francis, "Homegrown Solutions: Fostering Cluster Formation," *Economic Development Quarterly*, 18(2), May 2004

"When we look at firms in that context," Professor Feldman noted, "we realize why they benefit from strategic location. This doesn't mean firms that are attracted to a jurisdiction for a while and then move out. It means that firms have deep roots and deep social connections."[17] In this light, she said, it is logical that cluster formation reflects the local qualities of the place where it forms. Given that clusters are based on interactions rooted in the language and culture of a particular time and place, it also follows that replicating a successful cluster model elsewhere can be highly elusive.

No Simple Formula

While there is no ready formula for recreating an innovation cluster, analysis of the creation of clusters indicates some broader principles at work. Typically, some triggering event, coupled with an entrepreneurial spark, in the context of favorable framework conditions, seem necessary in order for industry clusters to emerge and enter a sustainable growth trajectory. In their review of the genesis of clusters, Feldman and Braunerhjelm note that "clusters are born and develop on the basis of specific combinations of capabilities, incentives, and opportunities." [18] The presence of *capabilities*—including the presence of localized knowledge, a skilled workforce, and the availability of capital—creates *opportunities* for entrepreneurship and collaboration, where these opportunities can be realized in the presence of appropriate *incentives*.

[17]See Pontus Braunerhjelm and Maryann Feldman, *Cluster Genesis: Technology based Industrial Development,* Oxford: Oxford University Press, 2006.
[18]Ibid, p. 5.

A Role for Public Policy

Public policies can play a role in developing the necessary capabilities, opportunities, and incentives for the development of clusters. In the United States, state and local governments have a leading role in supporting the development of clusters. Complementing state and local efforts, the federal government can play an important role in strengthening cooperative linkages within local innovation ecosystems. Public-private partnerships, along with other institutional intermediaries, help shape the incentives needed to foster cooperation among scientists, research administrators, entrepreneurs, financers, and other participants within an innovation cluster.

As we see next, the National Academies symposium examined a variety of initiatives underway among U.S. states to stimulate the emergence and growth of innovation clusters. It also reviewed the role that the federal government and private foundations can play in supporting these efforts.

II. SUPPORTING CLUSTERS: THE ROLE OF THE STATES

In the United States, industry cluster strategies have chiefly been a concern of states, regions, and metropolitan areas. Participants at the National Academies symposium examined how a number of states—New York, Pennsylvania, Virginia, South Carolina, Kansas, Ohio, Washington, California and Arizona—are experimenting with policies to encourage the development of industry clusters.[19] These initiatives can be seen as ongoing experiments that can yield valuable insights on the role and limits of public policy in encouraging cluster-based economic growth and employment. (See Box A.)

Drawing on presentations at the June 2009 symposium on innovation clusters, this overview illustratively contrasts the circumstances associated with the formation of the regenerative medicine cluster in California and the nano-technology cluster New York—two large states with diversified economies—with steps taken by Kansas and South Carolina—two smaller and traditionally rural states—to encourage cluster development.

[19]See the presentations my Michael Crow (Arizona), Pradeep Haldar (New York), Rebecca Bagley (Pennsylvania), Richard Bendis (Kansas and Pennsylvania), John Matheisson (Virginia), Egils Milbergs (Washington), David McNamara (South Carolina), Ed Penhoet (California) and Luis Proenza (Ohio).

Box A
Policy Experimentation in the U.S. Federal System

"There must be power in the states and the nation to remold, through experimentation, our economic practices and institutions to meet changing social and economic needs…It is one of the happy incidents of the federal system that a single courageous state may, if its citizens choose, serve as a laboratory; and try novel social and economic experiments...."

Justice Louis Brandeis' dissent in *New State Ice Company v. Liebmann*, 1932

Clustering in California

Home to Silicon Valley and Hollywood as well as agricultural clusters, California's innovation economy benefits from a strong system of state-supported universities, major research centers, and leading national laboratories. The state is also home to a large pool of talented people and a vibrant entrepreneurial culture. In his remarks Dr. Ed Penhoet observed that "talented people live everywhere, but for innovation, you need people with the courage to start a new business, and an environment that supports this. (See Box B)

Box B
A Key Role of States: Creating a Climate for Entrepreneurial Activity

According to Ed Penhoet, state governments can play a central role in creating a climate for entrepreneurial activity, he said, by following some common-sense guidelines.[a] These may include:

- **Put all the pieces together**. Make R&D investments part of a coordinated innovation strategy.
- **Make the right bets**. Each region has its own strengths, and a regional strategy should build on them. "You do have to choose winners," he affirmed. "But this is not the same as creating them. People often ask how to build a biotech industry, as though there is a secret formula. They fail to understand that what is required is the fertile ground to plant the seed." There has to be a reason to think the business will thrive where you put it."

- **Innovate for the real world—globally and locally**. Research must be relevant to industry and the community. The issue is not so much ownership as where you actually locate economic activity."
- **Invest in collaboration**. Innovation needs partners from universities, industry, and government.
- **Listen to the smart people**. "There are hard decisions in this process, and you will need the best advice. Too many groups have tried to act in isolation."
- **Be consistent while embracing change**. Innovation needs both flexibility and sustained effort.
- **Make sure you get what you want, but be patient**. It will take time to accomplish long-term goals, but measuring short-term gains is critical to getting there.

[a]Excerpt from the remarks made by Ed Penhoet of the STEP Board and summarized in the Summary of Presentations section of this volume.

Dr. Penhoet noted that in addition to what many see as a positive climate for innovation, the State of California also engages in direct efforts to transform its investments in knowledge into commercial products, new firms, and additional employment through large and sustained investments in the research and development of emerging technologies and public-private partnerships.

In addition, California has created a number of large innovation funds including the University of California Discovery Grants, which offers seed grants to move projects out of the university laboratory and into early-stage development. The California Institutes for Science and Innovation provide another means to spur partnerships between university research interests and private industry that could expand the state economy into new industries and markets and "speed the movement of innovation from the laboratory into peoples' daily lives."[20] These institutes have received a total state investment of $1.2 billion, equally distributed among the four research centers.

Dr. Penhoet, who also serves as a vice chair of the California Institute of Regenerative Medicine, described a state initiative to develop a new medical cluster in the state. This story began, he said, when California voters approved Proposition 71 in 2004 to establish the California Institute of Regenerative Medicine to regulate and fund stem cell research. This proposition was passed at a time when the federal government did not support stem cell research. The measure was paid for by issuing $3 billion in state general obligation bonds, which was the

[20]State of California, Governor's Budget summary 2001-2002.

first time a state has raised that much money for a specific kind of research.

Proposition 71 had two explicit goals. One was to find cures for disease using stem cells as a therapy or tool. The second was to enhance California's competitive position as the world's leading biotech region. Taking advantage of the hiatus in federal funding for stem cell research, funding for the state's stem cell initiative has established in California the most robust regenerative medicine program in the world, he said, attracting numerous scientists from within and outside the United States. "So it has had a positive effect."

New York's Nano Initiative

Dr. Haldar, of the New York Energy and Environmental Technology Applications Center, described the rapid evolution of a high-technology cluster near Albany that is reversing the economic fortunes of the region. The effort began in the 1990s, when much of upstate New York was in an "economic shambles." Manufacturing jobs were disappearing from every region: steel mills from Buffalo, high-tech Xerox and Kodak jobs from Rochester, the gas turbine division of General Electric from the capital. Traditional industries, such as textiles, shoes, and typewriters had long since moved offshore.

The State Government Role. This situation began to change in the 1990s, said Dr. Haldar, as a result of energetic state leadership. Governor George Pataki assembled a diverse group of stakeholders to develop a strategy to revive the economic fortunes of the Upstate region. Subsequently, the state of New York provided grants, tax breaks, and other subsidies of more than $1 billion to encourage big-company investments and foster the birth of small start-ups. To sustain the momentum towards the development of a high-technology cluster, the state also sought to integrate research and development, education, and business strategy around Centers of Excellence, anchored by the State University of New York.

Technology Focus. New York's strategy identified nanotechnology as a main area of focus, launching in 1993 a Center for Advanced Technology. This was joined in 1997 by a NanoFab facility, and the following year the Semiconductor Industry Association (SIA) chose the site for a National Focus Center Consortium. Accelerating this trend, IBM in 2001 decided to build its new Nanoelectronics Center of Excellence in Albany, along with a consortium of partners. This news was followed in 2002 by the announcement that SEMATECH would establish a new research center there, called International SEMATECH North. In 2002 a TEL R&D Center was added, and in 2003 a NanoFab 300S, and in 2005 an ASML R&D Center.

University Research and Workforce Development. These new enterprises all needed a highly trained workforce. At the time, the Albany campus of the State University of New York had no engineering department. Starting from scratch, the state established a College for Nanoscale Science and Engineering (CNSE) in 2004, which has since seen remarkable growth. By 2007, *Small Times Magazine* ranked CNSE as the number one college in the world for nanotechnology. Today CNSE has 48 faculty members and 150 graduate students. An undergraduate program is scheduled to begin in 2010.

The Kansas Experience

States like Kansas have also adopted focused strategies, albeit drawing on more limited budgets but leveraging existing capacities and strengths to develop industries deemed to have the highest potential for growth. Richard Bendis, a former president and chief executive officer of the Kansas Technology Enterprise Corporation (KTEC), described efforts in Kansas to develop high-technology clusters.

The State Government Role. The state of Kansas established KTEC as a public-private partnership to promote the state's technology-based economic development. With funding determined yearly by the state legislature, KTEC manages a portfolio of programs, investments, subsidiaries, and affiliates that support the development and commercialization of new technologies developed by Kansas entrepreneurs and technology companies.

Mr. Bendis noted that KTEC's plan recognizes that Kansas is a "flyover state," which means that Kansas cannot expect to benefit at the outset from top-tier research institutions or the presence of a large venture capital community. To overcome these limitations, Mr. Bendis underscored that "we had to link our strategic plan to local and national opportunities that matched the capacities in the region." "We developed a Strategic Assessment Framework to see how Kansas ranked against national and global opportunities, based on the capacities it had at the local level." The assessment found that Kansas had high capacity ratings in four areas: human biosciences, agriculture and agricultural biotechnology, information and communications technology, and aviation.

Technology Focus. KTEC decided, in consultation with the state's four major universities, that biotech and biosciences sectors were the strongest candidates for the development of innovation clusters, followed by information and communications technology sector. Interestingly, while the state has a significant agricultural sector, it was not seen to have the potential for strong future growth. Likewise, based on long-term

Box C
Shifting State Perspectives: Innovation-based Economic Development

Richard Bendis contended that over the past decade, there has been a migration away from the concept of "technology-based economic development" (TBED) toward one of "innovation-based economic development" (IBED). While the goals of TBED tended to focus on natural resources and brick-and-mortar projects, the goals of IBED focus on clusters, networks, innovation, and technology products "intervening at the margins of the private sector."

projections of industry data and the state of the Kansas economy, KTEC judged that the state's aviation sector did not offer sufficient growth potential.[21] Recognizing that "each state, country, or region must adjust and prioritize policies according to its individual context," KTEC decided not to compete with emerging nanotechnology clusters like Albany, New York, because the state did not have the means to build new, large-scale infrastructure. Instead, he said, "we chose to build on existing capacity and strengths."

The Kansas Economic Growth Act of 2004 "led to the creation of the Kansas Bioscience Authority [KBA], a statewide bioscience initiative that guides the state's investment in the biosciences. The act provided an innovative funding mechanism for the KBA based on the growth of state income-tax withholdings from employees of bioscience-related companies. State taxes that exceed the base-year measurement accrue to the authority for investment in additional bioscience growth." Funding is estimated to reach more than $580 million over 15 years."[22] The launch of a $600 million National Bio and Agro Defense Facility at Kansas State University has further strengthened the state's Human, Animal and Plant Bio-Sciences industry.[23]

[21]Wichita, often called the "Aircraft Capital of the World," is the manufacturing base of Cessna, Hawker Beechcraft, Bombardier Learjet, Spirit AeroSystems, and Boeing Integrated Defense Systems. See <*http://www.wingsoverkansas.com/about/*>. Given that the Wichita Aviation industry is dependent on small personal aircraft or corporate fleet sales, the performance of this sector has been cyclical, following macroeconomic cycles.
[22]See <*http://www.kansasbioauthority.org*>.
[23]Ibid.

Building the South Carolina Innovation Ecosystem

In his presentation, David McNamara of the South Carolina Research Authority described his state's approach towards developing successful innovation clusters.

The State Government Role. Mr. McNamara said that South Carolina, a traditionally rural state, had come in recent years to emphasize the importance of knowledge-based economic development. The state legislature took the first step in 2002 when it funded the Endowed Chairs Act to attract high-quality academic researchers. In 2003, the legislature followed this with the Research Infrastructure Act to provide the facilities and equipment for academic research. The state has also sought to provide tax credits for private investment companies offering equity, near-equity, or seed capital for companies in the state that are emerging, expanding, relocating, or restructuring.

Leveraging University Research. South Carolina businesses can also receive a 100 percent tax credit for contributions to a fund that is used to promote the commercialization of research discoveries at the state's three major research universities—the University of South Carolina, the Medical University of South Carolina, and Clemson University. In addition, the 2005 Innovation Centers Act established Research Innovation Centers at each of these universities. The Industry Partners Act of 2006 established the Industry Partners Fund, which provides revenue to be used by the South Carolina Research Authority (SCRA), whose mandate is to focus on the knowledge being produced by South Carolina's research universities and build an innovation system to commercialize that knowledge.

Technology Focus. The 2005 Innovation Centers Act created SC Launch, a state program focused on developing technology sectors that have good commercialization potential and some strength in the state—primarily advanced materials and fibers, alternative energy, automotive technology, energy and chemicals, life sciences/biotechnology, and related information technology and software. Among these, the automotive cluster, Mr. McNamara said, is growing rapidly with research facilities supported by BMW, Toyota, and Timken. Clemson University's motor sport center and hydrogen fuel cell program complement this agglomeration.[24] He concluded that while SC Launch was not charged explicitly with the mission of forming clusters, "they seem to be forming on their own."

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[24]For a description of the Clemson University International Center for Automotive Research, see the keynote address by James Barker, President of Clemson University summarized in National Research Council, *Understanding Research, Science and Technology Parks: Global Best Practices: Summary of a Symposium*, op. cit.

Box D
Examples of State Government Role in Fostering Innovation Clusters

Symposium participants listed a number of practices undertaken by state governments to encourage the development of innovative clusters.

- **Provide and sustain high-level attention**. In his presentation, Pradeep Haldar noted that in the 1990s, then-Governor Pataki gathered a diverse group of stakeholders to develop a strategy to revive the economic fortunes of Upstate New York. David McNamara of the South Carolina Research Authority noted that the legislature and state leaders have been active in passing legislation and funding SC Launch to stimulate innovation-based economic development in the state.
- **Pick winners**. Several speakers noted the importance of focusing on specific industries based on their existing potentials as well as future promise. Richard Bendis noted that as a first step in expanding innovation in Kansas, the Kansas Technology Enterprise Corporation conducted an assessment that found that the state had high capacity ratings in human bio-sciences, agriculture, and agricultural biotechnology, information technologies, and aviation. Based on consultations with research universities in the state, they determined the strongest sectors going forward would be in the biosciences, followed by information technologies. As John Mathison noted in his discussion of the strategy adopted by the Commonwealth of Virginia, the states resources are limited, "so you really do have to pick winners." Pradeep Haldar noted that New York made just such a choice in picking nanotechnology as their focus technology.
- **Strengthen universities and colleges**. Pradeep Haldar noted that attracting new enterprises to Upstate New York would not be sustainable without a highly trained workforce. The planners decided in 2004 to build from scratch the College for Nanoscale Science and Engineering (CNSE) at SUNY-Albany. Today, CNSE is a top-ranked college in this field, he said, with 48 faculty members and 150 graduates.
- **Support Technology Investment Offices**. Rebecca Bagley, then of the Pennsylvania Department of Community and Economic Development, noted that the state's Technology Investment Office served as a catalyst for growth and competitiveness by taking an active role in fostering university-

industry collaboration and by supporting companies at every stage.

- **Create a regional brand**. Richard Bendis emphasized the need for regional branding and marketing. "You need to market your strengths," he said, "so people know what your strengths are doing." Rebecca Bagley noted that Pennsylvania focused on biotechnology as a way of branding the region and enabling the state to address the issues of the biotech sector with a cohesive voice.
- **Seed private investment with public investment**. Pradeep Haldar noted that in the last six years, about $4.5 billion has been invested by industry, seeded by less than $800 million in state investment. David McNamara noted that SC-Launch, with a budget of only about $6 million, had helped start about 130 companies within three years. Despite the organization's youth, he said, this public investment has brought to the state about $65 million in follow-on funding secured by the launched companies.
- **Build synergies with federal funding**. Richard Bendis noted that the Kansas Technology Enterprise Corporation leveraged its portfolio heavily with federal SBIR and business assistance programs. Rebecca Bagley noted that Pennsylvania drew on federal Manufacturing Extension Program centers to help support manufacturing clusters in the state.

III. SUPPORTING CLUSTERS—THE FEDERAL ROLE

National programs and regional and state programs can play complementary roles in supporting the growth of innovation clusters. As Andrew Reamer of the Brookings Institution noted in his symposium presentation, sub-national programs are "on site" and are better positioned to promote local synergies. A national program can complement sub-national programs by creating public goods, including knowledge about global and national best practices and supplementary financial resources, which then can be shared across the nation.

Some Principles of Federal Participation

Given that "national competitiveness is a function of regional competitiveness," and that "regional competitiveness in turn is largely a function of cluster competitiveness," Dr. Reamer recommended that it is time for the federal government "to enter this space for purpose of a

stronger national economy."[25] Drawing from a paper coauthored with Karen Mills and Elisabeth Reynolds, he suggested three principles to guide federal participation:

- **Bottom-up**. First, federal programs should be flexible, bottom-up, and collaboration-oriented, rather than top-down, prescriptive, and input-focused.
- **Incentive-based**. Second, the government should use a kit of diverse tools to improve market information and incentivize entrepreneurship though the selective use of grants.
- **Appropriately funded**. Third, a federal effort should be funded at a level appropriate to need.

Dr. Reamer concluded by saying that the federal effort should build and rely on the capacity of state and regional organizations so they can serve as effective local catalysts. Federal policy should also link, leverage, and align existing federal programs that support regional economic development.

Box E
Making Cluster Support a Federal Priority

"Who's going to create the good-paying jobs here in America? They're going to be innovation-driven companies that grow to be our new foundation for competitiveness. We have to think, "Where in the federal government is that initiative going to live?" The answer is that it is going to live in multiple places, so we need to create an umbrella structure that will make that a priority. That initiative is now in formation."

Karen Mills, SBA Administrator

Putting $100 Million to Work for Clusters

Jonathan Sallet of the Glover Park Group stated in his symposium presentation that clusters are part of national competitiveness strategies in most countries except for the United States. This, however, is changing. In the FY 2010 budget, President Obama has requested $100 million in appropriations to support regional clusters and associated business incubators.

[25]See Karen G. Mills, Elisabeth B. Reynolds, and Andrew Reamer, "Clusters and Competitiveness: A New Federal Role for Stimulating Regional Economies," op. cit.

To use this budget successfully, Mr. Sallet suggested that the federal government deploy its existing mechanisms more effectively. As a first step, he suggested a more explicit involvement of the Economic Development Administration (EDA) with cluster development. Because the EDA is in the Department of Commerce, he observed, it is well positioned to complement other relevant Commerce programs, including the Technology Innovation Program, Manufacturing Extension Partnership, export assistance from the International Trade Administration, and infrastructure funding from National Telecommunications and Information Administration and NOAA.

He suggested that a federal program to support clusters should have three key features: competitive grants, a program of information exchange, and coordinated delivery of expert assistance. The grants program, he said, should be competition-based and flexible to maximize efficiency and should be matched by industry contributions. These grants could be used for business incubators, training programs at universities, and technology transfer for small and medium-sized firms. States have little or no money available for such programs now.

The federal government can also provide data on cluster formation, performance, and composition from a national information center. Participants within the cluster can benefit by knowing what businesses are located there, or have filed patent applications, which suggests the level of expertise. Also, clusters have much to teach other clusters, which "is a fundamental aspect of what we ought to be trying to achieve here."

Finally, Mr. Sallet noted that the delivery of federal assistance could also be facilitated by a "one stop" delivery mechanism that draws together the expertise from existing Department of Commerce programs related to infrastructure, trade, and technology; programs of the Small Business Administration; the WIRED[26] program of the Department of Labor; and other business-generating efforts with a regional focus.

IV. PARTNERSHIPS AND THE INNOVATION ECOSYSTEM

Public-private partnerships can play an instrumental role in fostering technology clusters. They encourage collaboration among industry, government, universities, and foundations in research and development

[26]The Department of Labor's Workforce Innovation in Regional Economic Development (WIRED), was initiated in 2005. According to its website, it "goes beyond traditional strategies for worker preparation by bringing together state, local and federal entities; academic institutions (including K-12, community colleges and universities); investment groups; foundations; and business and industry to address the challenges associated with building a globally competitive and prepared workforce." <*http://www.doleta.gov/wired/*>.

and provide the positive incentives necessary for entrepreneurship, thus helping to foster a robust innovation ecosystem.

In a comprehensive study of federal innovation partnerships, the National Research Council found that appropriately structured partnerships contribute to national missions in health, energy, the environment, and national defense, as well as to the nation's ability to capitalize on substantial R&D investments.[27] Successful partnerships tend to be industry initiated and led, with public commitments limited in time and defined in scope. At the same time, partnerships are not a panacea; the high-risk, high-payoff nature of innovation research and development assures that not all partnerships will be successful.

Participants at the National Academies symposium discussed the role of federal innovation awards and S&T research parks—two important types of partnerships—in the development of innovation clusters and the role universities and foundations play in encouraging the development of clusters.

The Role of Innovation Awards—The Technology Innovation Program

"Imperfections in capital markets can sometimes pose major challenges to small firms seeking to bring their innovations to market."[28] Programs like the Technology Innovation Program (TIP) of the Department of Commerce provide competitively awarded grants that can help innovative firms secure early-stage funding.

Marc Stanley, then the program's director, described TIP's three key features. First, it emphasizes societal challenges that are not being addressed and that have potential benefits that extend significantly beyond the proposed project. Second, because of its location at NIST, the program has exceptional scientific and technical ability to review and support high-risk, high-reward research. Third, the program has strong potential to advance research, contribute to the U.S. science and technology base, and help the nation deal with major societal challenges. "What I'm interested in," he said, "is investing in disruptive technologies." In particular, Mr. Stanley noted that the TIP program is focused on early-stage basic research and investment in areas of critical national needs. Only small and medium-size companies were eligible to

[27]For a review of best practices among federal partnerships, see National Research Council, *Government-Industry Partnerships for the Development of New Technologies,* Charles W. Wessner, ed., Washington, DC: The National Academies Press, 2003.

[28]National Research Council, *Government-Industry Partnerships for the Development of New Technologies*, op. cit., p. 11.

participate, and the majority of joint ventures are being led by universities.[29]

He said that the TIP looks for ways to support clusters and other state programs that share this spirit of adventure. TIP could do so, he said, by bringing federal R&D dollars and helping retain or develop high-tech industries located in different parts of the country. This has the effect of bringing and maintaining high-tech jobs to those regions, increasing local revenues.

The Role of Research Parks

"Research parks are a type of public-private partnership that fosters knowledge flows—often between park firms and universities and among park firms—and contributes to regional economic growth and development. These partnerships enhance both formally and informally, the efficiency of innovation within park firms, universities, and national laboratories." [30]

Speaking at the symposium, William Kittredge of the Economic Development Administration cited a recent example from Fargo, North Dakota. Recognizing that its competitive advantage lay in the high number of students graduating from its engineering school, North Dakota State University (NDSU) drew the University of North Dakota, along with the EDA, state and county governments, entrepreneurs, and people from the community, together to form a successful technology park adjacent to the NDSU campus. "This is not a traditional place, or a Silicon Valley," Dr. Kittredge said. "It started with existing assets, brought everyone together, and came out of ideas on how a local competitive advantage might be exploited."

Science and technology research parks are seen increasingly as a "proven tool to create successful new companies, sustain them, attract new ones—especially in the high-technology sector—and make existing companies more successful using R&D. Today, countries as diverse as China, Singapore, Mexico, and France are among those undertaking substantial national efforts to develop research parks of significant scale and scientific and innovative potential. In many cases, these research parks are expected to generate benefits that go beyond regional development and job creation. Indeed, to the extent that research parks and the clusters they engender are effective, they have the potential to

[29]Large companies may participate as joint venture members that fully fund their participation, as contractors, or as informal collaborators.

[30]See National Research Council, *Understanding Research, Science and Technology Parks: Global Best Practices,* op. cit., pp. 11-12.

shift the terms of global competition, not least in leading technological sectors."[31]

The Changing Role of Universities

The role of universities has evolved tremendously over the past two decades. In today's knowledge economy, universities are recognized increasingly not only as centers of learning but also as focal points of regional growth and employment.[32]

Today's science-driven industry increasingly draws upon university research for new ideas for improved products and processes, while university researchers frequently draw ideas from commercial trends to explore new veins of scientific inquiry.[33] Support of university research by industry is also a common source of funds for equipment and research assistance for university laboratories.[34] Such partnering between university and industry contributes to innovation and growth in the United States and is expected to remain an indispensable element for future economic growth.[35] This recognition, in turn, is focusing new policy attention to strategies that grow new technology-based companies and growth clusters and the role that universities can play in this regard.[36]

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[31]For a review of selected national and local investments around the world to develop research parks, see National Research Council, *Understanding Research, Science and Technology Parks: Global Best Practices,* op. cit.

[32]See Roger L. Geiger and Creso M. Sá, *Tapping the Riches of Science: Universities and the Promise of Economic Growth,* Cambridge MA: Harvard University Press, 2009. See also Federal Reserve of Chicago, "Can Higher Education Foster Economic Growth?—A Conference Summary," *Chicago Fed Letter* March 2007.

[33]Rosenberg and Nelson have argued that university research enhances and stimulates R&D in industry, while Pavitt (1998) describes such research as "augmenting the capacity of business to solve complex problems." See N. Rosenberg, and R. R. Nelson, "American universities and technical advance in industry," *Research Policy* 23:323-348, 1994. See also K. Pavitt, "The Social Shaping of the National Science Base," *Research Policy* 27:793-805, 1998.

[34]Y. S. Lee, "The Sustainability of University-Industry Research Collaboration," *Journal of Technology Transf*er 25(2), 2000.

[35]Bronwyn Hall, "University-Industry Research Partnerships in the United States," Kansai Symposium Paper, February 2004.

[36]Some analysts point out, however, that not all universities are structured and funded in ways that encourage commercialization. They point to university technology transfer offices (TTOs) that are often faced with conflicting demands of generating revenues while managing the high volume of early-stage innovations resident and available for potential commercialization See Robert E. Litan, Lesa Mitchell and E. J. Reedy, "The University as Innovator: Bumps in

> "It is hard to overstate the importance of a university in a cluster."
> Ed Penhoet, STEP Board

In their presentations, the presidents of Arizona State University (ASU) and the University of Akron described how their institutions have successfully taken on the challenge of research commercialization and regional development. Describing the experience of Arizona State University, Michael Crow said that his institution is taking steps to grow and adapt with the changing needs of the rapidly growing Phoenix region by becoming a center of knowledge creation, knowledge discovery, and commercialization. This task, he noted, began with a restructuring of the university seven years ago. The university's goal, he said, was to become a "central node of an integrated knowledge discovery and commercialization network." To this end, ASU has developed its own approach to innovation, rather than following models developed elsewhere.

This approach includes engaging with the aerospace and other extant industries in Phoenix to reinforce existing technology clusters as well as developing new clusters by working with the Army on flexible display technologies and with the EPA on renewable energy technologies.

Describing the experience of the University of Akron, Luis Proenza said that his institution has focused on opportunities, beginning with underutilized assets and the greater flexibility of the new economic environment. "We began," said Dr. Proenza, "with the realization that the university was nearing its 130th birthday. The college opened the first rubber chemistry program in 1909, and, along with the major tire

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the Road," *Issues in Science and Technology* Summer 2007, pp. 57-66. Others note that universities generally do not do not have the financial resources to provide early-stage capital, specialized support services to the inventors, entrepreneurs, and start ups, and a physical infrastructure and organization that allows their research faculty and students to network with corporate partners, investors, service providers and other entrepreneurs to help build and grow cluster capabilities. See Diane Palmintera, "Accelerating Economic Development through University Technology Transfer," Innovation Associates, February 2005. This makes it harder for university based entrepreneurs to secure outside early-stage capital, even as angels and venture capital funds shift their focus to larger and later stage investments. See Bo Fishback, Christine A. Gulbranson, Robert E. Litan, Lesa Mitchell and Marisa Porzig, "Finding Business "Idols": A New Model to Accelerate Start- Ups," Kauffman Foundation Report, 4, 2007.

companies located in Akron, developed what is today the "largest polymer program in the world."

Akron also formed its own research foundation in 2001 to build on its historical record of research. "This record is very complex and comprehensive," he said. "A university's impact on its region through its own technology and outreach is far broader than we'd recognized." The university began by looking at local knowledge assets. Many companies were downsizing and could no longer manage their technical libraries. Some of them donated their libraries to the university where they could be managed at much lower cost. They took advantage of available space to work more actively on industry research projects. The Ohio Research Foundation was developed expressly to offer university services to other institutions.

More broadly, the university began to transform itself and the region in fundamental ways. It found that 7,000 of its 23,000 students were not living on campus because housing had been neglected for so long. The neighborhood around the campus had little vitality. In response, the university launched an initiative that resulted in a virtual rebuilding of the campus and improvements to a 40-block area around it. "The goal is to make the whole area a nice place to live, learn, work, shop, and play," said Dr. Proenza.

Under President Proenza's leadership, the University of Akron has also launched partnerships with other industries in northern Ohio. At the request of Proctor & Gamble, headquartered in Cincinnati, the university also started a series of Open Innovation Seminars. Their purpose was to promote outreach and networking among companies—to transform corporate culture from an inward-looking, isolated model to one of open innovation in which firms are receptive to the ideas of partners.

Another initiative undertaken by the University of Akron is the Bioinnovation Institute, which grew out of existing local strength in polymers. "The human body, when you take away the water and the calcium, is basically polymeric stuff. So the concept of biomaterials becomes an exceptional opportunity to deepen the relationship between materials science and biomedicine. We asked the three major hospitals in Akron, as well as a regional public medical school, to join in forming this new entity. They agreed, and it was catalyzed by another grant from the Knight Foundation. This initiative is dedicated to making Akron the #1 biomaterials and orthopedic research program in the world."

The Catalytic Role of Foundations

Private foundations can play a catalytic role in the development of local innovation clusters. In his presentation, Dr. Bo-Linn of the Gordon and Betty Moore Foundation described three unique roles played by foundations. First, he said, foundations can identify "possible pockets of

innovation and inflection points. We are not encumbered by an existing bureaucracy. In many cases the founders are businessmen and entrepreneurs who have long personal experience in finding and supporting those pockets of innovation and inflection points."

Second, he said, foundations are able to provide seed money outside the traditional funding process. This differs from the venture capital approach in that foundations can take longer to examine a project, pursue a deeper due diligence examination, and support more capacity building. With its flexibility and stature, a foundation can take risks, act quickly, and catalyze consensus. He noted that the tradition of philanthropy was being enriched by "a whole array of Silicon Valley entrepreneurs who have been enormously successful, and who are putting their money into foundations. The difference is that the living founders play a key role in their foundations. They want to know that something's happening, that innovation is occurring."

Third, the stability, resources, and freedom from political pressures allow a foundation to stay with a project for the long run. Gordon Moore, he said, believed that success takes about 10 years measure. "He feels that if you want to see change, then you have to commit to it." Once the Moore Foundation has done its due diligence, which takes about 18 to 24 months, it usually commits several hundred million dollars for 10 to 15 years.

Foundations often focus their resources on particular localities and themes. For the Moore Foundation, 58 percent of the foundation's grants from 2000 to 2009 were awarded to recipients in California ($810 million, in 938 grants) and 42 percent outside California ($981 million, in 677 grants). Similarly, the Heinz Endowments focuses its efforts on a geographical area—Southwestern Pennsylvania, including the city of Pittsburgh. Christina Gabriel described how Heinz and other foundations have joined with community development organizations and the state to integrate the city's dilapidated Hill District with more prosperous adjacent zones into a new Pittsburgh Central Keystone Innovation Zone. Dr. Gabriel foresaw that this "KIZ" would feature "direct and deliberate bridges" to connect the Hill to the surrounding high-tech clusters.

Philanthropic foundations also often reflect a founder's personal history and interest. Reflecting Betty Moore's interest in nursing, the Moore foundation provides funds for the Betty Irene Moore Nursing Initiative and the Betty Irene Moore School of Nursing, thereby addressing a major need for the health care system. The primary theme of these investments is workforce development, which is shaped by the foundation's conviction that more and better nursing education and training are essential to keeping the quality of health care high and the costs low.

Clusters and Institutional Diversity

These symposium presentations on public-private partnerships, research parks, universities, and foundations provide examples of how these entities can each contribute to the creation of dense localized networks of trust, reciprocity, and cooperation associated with robust innovation clusters. Federal partnership programs like the Technology Innovation Program provide competitively awarded grants that help innovative firms to secure early-stage funding, while bringing federal R&D dollars to help develop and retain high-technology companies located in different parts of the country. As Marc Stanley noted, this has the effect of creating and sustaining high-value employment in the nation's regions while increasing local revenues.

Research parks facilitate knowledge flows between firms and universities—where firms can draw from university research and students benefit from a local market for their knowledge and skills—while helping regions develop a well-recognized brand name. For their part, many universities are restructuring to become centers of knowledge creation, knowledge discovery, and commercialization. As Michael Crow of ASU and Luis Proenza of the University of Akron pointed out at the symposium, 21st century universities are actively seeking to develop complementarities between their own assets and expertise and the needs of regional companies.

Lastly, as George Bo-Linn of the Moore Foundation and Christina Gabriel of the Heinz Endowments noted, private foundations can often leverage the strong personal interest and extensive business experience of their benefactors to provide the leadership, resources, flexibility, and stability needed to address missing gaps and connect firms and universities to neighborhoods.

As Professor Feldman noted in her presentation, this institutional diversity—partnerships, research parks, universities, and foundations, together with state, regional, and national governments—helps create the localized networks of trust and collaboration we call innovation clusters.

V. IN CLOSING

As knowledge-based competition intensifies, countries around the world are making major investments in creating and encouraging the development of new clusters as a means of creating jobs and spurring competitiveness. Until recently, the United States had no similar national effort underway although, as described in this report, a number of states and regions have launched major programs to stimulate cluster development.

However, as Jonathan Sallet noted in his presentation, recent federal and state initiatives provide significant resources to develop regional

centers of innovation, business incubators, and other strategies to encourage entrepreneurship and high-tech development. This has led to renewed interest in understanding the nature of innovation clusters and public policies associated with successful cluster development.

This STEP symposium addressed this policy interest. The deliberations, summarized in the next chapter, brought together senior officials from the White House and other federal agencies, representatives of leading state and university programs, congressional staff and other policymakers to explore current knowledge on the role of clusters in promoting economic growth, the state and federal governments' role in stimulating clusters, and the contributions of universities and foundations to their development.

II
SUMMARY OF PRESENTATIONS

WELCOME

Charles Wessner
The National Academies

In welcoming the conference participants to the National Academies, Dr. Wessner noted that while many that recognize clusters are a means of accelerating innovation, advancing the nation's competitiveness, and providing jobs and growth, few understand what clusters are, how they form, or how they develop. Hence, a key goal of the symposium is to improve our understanding of clusters and enhance our knowledge of how public policies can foster their growth.[1]

Under the leadership of Lawrence Summers, Dale Jorgensen, and Ed Penhoet, the National Academies' Board on Science, Technology, and Economic Policy (STEP) has studied how public-private partnerships can support and accelerate innovation. STEP has reviewed several major U.S. efforts to promote innovation, including the Small Business Innovation Research (SBIR) program, the SEMATECH consortium that contributed to the resurgence of the semiconductor industry, the Advanced Technology Program, and the role of Science and Technology Parks. Together, these programs have made vital contributions to accelerating innovation in the United States. [2]

A Global Perspective

STEP has also looked at examples of partnership programs in other countries. Dr. Wessner called the international interest "relatively unusual" in Washington, but one that is essential to understand the

[1]Regional industry clusters are defined as "geographic concentrations of interconnected firms and supporting organizations" in Karen G. Mills, Elisabeth B. Reynolds, and Andrew Reamer, "Clusters and Competitiveness: A New Federal Role for Stimulating Regional Economies," Washington, DC: Brookings Institution, April 2008.

[2]See National Research Council, *Government-Industry Partnerships for the Development of New Technologies,* Charles W. Wessner, ed., Washington, DC: The National Academies Press, 2003.

features of the global economy.[3] "A lot of countries are working extremely hard," he said, "at making good the deficiencies in their innovation systems. And those efforts are of course shaping the international competitive environment." He noted that a representative of IMEC, a consortium in Flanders, Belgium, that supported industry-government-university partnerships of many kinds, would address the symposium.[4]

A key finding of the STEP research, he said, is that partnerships—and the clusters in which they are embedded—are "sound in principle and effective in practice" when properly structured, funded, and managed." They succeed by helping capitalize on a nation's R&D investments through the accelerated commercialization of new technologies, he said. This process also contributes to national missions in health, energy, defense, and the environment.

Dr. Wessner noted that the Small Business Innovation Research Program (SBIR) is one example of an effective partnership. He noted that a recent assessment by the National Research Council found that the SBIR program stimulates firm creation. Over 20 percent of respondents to the NRC survey of firms with SBIR Phase II projects attributed the founding of their firm to a prospective SBIR award.[5] The SBIR program also encourages collaboration between small firms and universities, he said, and brings innovative technologies to market. One such company is the A123 Systems that has developed an innovative advanced technology lithium-ion battery that may well power the next generation of electric vehicles.[6]

A sister program to SBIR is the Technology Innovation Program (TIP), formed when Congress modified the Advanced Technology

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[3]See National Research Council, *Innovation Policies for the 21st Century*, Charles W. Wessner, ed., Washington, DC: The National Academies Press, 2007.

[4]See National Research Council, *Innovative Flanders: Innovation Policies for the 21st Century*, Charles W. Wessner, ed., Washington, DC: The National Academies Press, 2008.

[5]See National Research Council, *An Assessment of the SBIR Program*, Charles W. Wessner, ed., Washington, DC: The National Academies Press, 2008. In this volume, see Appendix A for the NRC Phase II survey methodology as well as the survey form.

[6]National Research Council, *Building the U.S. Battery Industry for Electric Drive Vehicles: Progress, Challenges, and Opportunities,* Charles W. Wessner, rapporteur, Washington, DC: The National Academies Press, forthcoming.

Program to add universities as lead partners.[7] TIP is structured to address specific national needs, including energy, infrastructure, and health.

An R&D consortium that coordinates pre-competitive research is another form of partnership that adds value to the economy. Such a consortium is based on the willingness of competing firms to collaborate on questions that do not involve proprietary topics but that are of sufficient complexity and importance to benefit from industry-wide attention. The United States has long experience in such successful consortia, he said, beginning with the SEMATECH partnership that helped revive the U.S. semiconductor industry in the 1990s. The Semiconductor Research Corporation's Focus Centers continue to provide a model for forming teams of universities to conduct exploratory research needed for next-generation technologies.

Dr. Wessner noted that effective university-industry linkages help drive local growth and national competitiveness. "We need innovative universities to keep and improve our standard of living," he said. "A variety of new incentives and new initiatives are needed, and we shall hear about some of the activities underway later today" from the presidents of the University of Akron and Arizona State University.

Key Questions

Dr. Wessner introduced the topic of the symposium with a series of related questions: How can the United States keep industry here? How can the country capture the benefits of the recent Recovery Act[8] and its consequent increases in R&D budgets for the U.S. economy? How can the United States address the locational competition for investment in industries of national importance, both today and tomorrow?

A broad approach, he said, which has been successful generally, is "to use what you have, and to use what is known to work." He recommended that the United States should fund proven innovation partnerships that invest in U.S.-based firms and U.S.-based clusters. "Innovation is not just a high-technology, science-based phenomenon," he said. "Support for innovation means supporting the small and large companies that will provide tomorrow's growth and employment, and from a national security perspective, one that will provide procurement officers with greater choice and greater speed of delivery."

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[7]See National Research Council, *The Advanced Technology Program: Assessing Outcomes,* Charles W. Wessner, ed., Washington, D.C.: National Academy Press, 2001.

[8]The $787 billion American Recovery and Investment Act was passed by Congress in 2009 "to create and save jobs, jumpstart our economy, and build the foundation for long-term economic growth." <*http://www.recovery.gov/*>.

This approach, he suggested, should be part of a broader range of efforts, many of which were on the symposium agenda. In light of that recommendation, he described the meeting as "a key part of STEP's work on best practices in state and regional innovation policies." He said that the objectives of the symposium were to:

- Highlight the role of clusters in promoting economic growth.
- Examine the government's role in stimulating clusters.
- Explore the role of universities and foundations in developing clusters.
- Learn of specific strategies in place around the country.
- Identify institutions and programs that can be leveraged to grow and sustain clusters.

He concluded by thanking the sponsors of the symposium: the Heinz Endowments, the National Institute for Standards and Technology (NIST), the U.S. Department of Energy, the Economic Development Administration (EDA), Acciona Energy, and SkyFuel.

OPENING REMARKS

Susan Crawford
National Economic Council
The White House

Ms. Crawford said that the Obama administration was "committed to the idea of regional economic clusters and their role in economic growth and innovation." Together with colleagues at the Office for Science and Technology Policy, she said she had worked to initiate an interagency innovation group. The meetings had been attended by many representatives of key federal agencies, especially the Department of Commerce, and marked by bilateral discussions about how best to advance the administration's innovation agenda. She praised the new Commerce secretary, Gary Locke, for whom "innovation is a core pursuit." It is, however, "a lot to get your arms around, because it's nothing in particular and everything at once," and would require a great deal of work.

In her remarks, she said, she would examine the role of clusters and the role that federal policies can play to support them. Innovation, she said, "cannot happen top-down alone, or bottom-up alone." The government's role, she suggested, may be to provide a kind of trellis, adding that "biological and gardening metaphors come up all the time in discussing clusters." She supported the use of evaluation metrics, saying that these might be considered both fertilizer and "a kind of goal. What kinds of outcomes do we want to see from these clusters?" she asked. "It's all extraordinarily difficult, the idea of providing targeted strategic funding that leads to a sustainable effort."

A Cluster Can Begin with "Something Successful on the Ground"

She said that an effective cluster "seems to require the preexistence of something successful on the ground that needs to be encouraged." She continued with the gardening metaphor, saying that the green shoots from a great university might need some fertilizing, and perhaps some trellis structure if they are to find productive uses. Like a living process, innovation has significant features that must be supported: it is always

continuous, evolutionary, and inclusive. "It's not just about invention," she said, "but about dispersing those inventions into the world."

While universities can be at the heart of innovation clusters, she said, so too can private firms, which bring the dual approaches of fierce competition and collaboration. "We've seen that the success of Silicon Valley has a lot to do with the easy flow of information and people between and among firms. Cooperative attitudes can allow these informal networks to emerge." The cooperation among firms and universities creates knowledge spillover, which is essential to economic engines. It allows "iterations and repeated modifications so that nothing is stuck. This is again biological, very dynamic, moving constantly."

She said that it is easier to describe successful clusters after they happen than to predict or create them. Silicon Valley, she notes, is exhaustively studied—the quality of its elements and how they work together. But such analyses are of little help in showing the federal government how it can best facilitate the next Silicon Valley.

Coordinating Regional and Federal Initiatives

She then made a suggestion, and asked the participants' help. She said that more than 200 programs across the federal government are involved to varying degrees with local and regional economic development. A challenge, she said, is to make the best use of these scattered programs. She proposed selecting two or three elements of those programs to create a one-stop shop, or "mall of programs," to help clusters move through their life cycle. This was not a suggestion to create another federal agency, but might only require "the work of a few purposeful people with White House assistance in coordination." Such a plan, she said, might make funding strategic, targeted, and effective. Regional programs would know where to direct queries and how to reach out for funding. The question she posed was how to select the most appropriate candidate for a pilot effort. "No one wants to see centralized control of all 200+ programs," she said. "The whole system would come to its knees." She said that a handful of programs "could be drawn into this easy availability for regions that have their act together and are looking for better interaction with government."

She noted that her suggestion reflected the administration's priority to improve the interface between government and its constituents. "The effort is on transparency," she said, "so people see how government works and can gain access to it."

She added that cluster policy should mimic the qualities of clusters themselves—for example, the policy should gain efficiency by targeting efforts, breaking down silos, and combining elements of agencies that overlap. Another crucial element of policy, she said, is to recognize the balance between top-down decree and bottom-up leadership. "It's so

important to find that local leader who makes things go," she said. "The person who is tightly networked and understands how community works."

She closed with an additional question for the symposium: What outcomes can we expect from healthy clusters, and what metrics should be used to evaluate them? "It seems to us," she said, "that outcomes should be tied to national priorities. This will give clusters a greater chance of success." She cited as an example the administration's engagement in clean energy policy and reducing the nation's carbon footprint. Clusters focusing on those areas would be more likely to find support in federal agencies, as would clusters helping to lower the costs of health care and increasing access to improved educational resources for both young people and adults. What outcomes in cluster policy, she asked, should be desirable in helping to achieve these and other objectives?

"That's my introduction," she concluded. "We are all in this together. Our doors are open. I'm very interested in engagement with you and through the Academies to you."

Discussion

Jane Siegel of the International Trade Administration, Department of Commerce, recalled the example of a group in San Antonio, Texas, which had attempted in 2004 to develop an innovation cluster. She said that many people needed language training to participate fully, and asked whether a bottom-up competition with proposals on how to use federal money would be considered. Ms. Crawford replied that the idea of competition was a priority for this administration, but that any cluster proposals should have clear goals and outcomes. "There are risks that you end up dribbling money all around and not understanding what you've gotten out of it," she said. "Be very purposeful. Clusters to what end? Competition might be a great idea, and certainly that notion is in the air."

Scott Sklar of the Stella Group said that he worked with medium-sized and small businesses that were trying to develop clean energy technologies. He said that these firms benefited from the new emphasis of the administration on clean energy and encountered many excellent government federal programs, but that these programs did not cooperate with each other. He asked what might be done to better blend those programs with business and scientific expertise "so they can be more agile and hand off to one another." Ms. Crawford replied that the Small Business Administration was working closely with the National Economic Council and with science and agriculture agencies. "This is exactly the direction we want to take," she said. "We don't want the science ideas over here and business over there. We want to get people to work together."

Ed Penhoet of the Academies STEP Board added that it is "hard to overstate" the importance of a university in a cluster. He noted that much of the nation's biotechnology activity is located in five regions—San Francisco, Boston, San Diego, Research Triangle Park, and Seattle—and that each of them includes one or more major research universities. "One of our challenges," he said, "is to think about the timing of the university's role. NIH funding started in a significant way in 1950, but biotech did not grow significantly until 25 years after that. A challenge is to find ways to stimulate innovation from university research that don't have a 25-year lag."

KEYNOTE ADDRESS

The Role of Research Universities in the Formation of Regional Innovation Clusters: The Impact of Arizona State University on Metropolitan Phoenix

Michael Crow
Arizona State University

In an effort to establish an appropriate context for considering the relationship of university research to the formation of innovation clusters, Dr. Michael Crow began by underscoring the critical significance of institutional structure and academic organization to the network of innovation. As president of Arizona State University, the nation's youngest major research institution, he expressed his intent to consider innovation clusters from the perspective of the research university as the keystone of the knowledge creation network driving discovery and innovation. Within this context, he interspersed summary overviews of selected elements of the reorganization of the institution he leads to be considered as representative of a case study in the facilitation of innovation. He explained that ASU is the sole comprehensive baccalaureate-granting university in one of the most rapidly growing and demographically diversifying metropolitan regions in the nation. The population of metropolitan Phoenix has grown by a factor of 13 over the last 50 years, and with a regional economy excessively dependent on population expansion and housing construction, the impact of the recession there has been particularly severe. Property values in the metropolitan region have declined by 50 percent since their mid-2006 peak while state revenues have declined by nearly 40 percent during the last 18 months, following three years of unprecedented annual increases. "I'm from one of the few large North American cities that's still in its early stages of development," he said. "ASU is the only research university in a metropolitan area of four million people that is growing to eight million, at which point it will become the size of metropolitan Chicago."

He further specified that ASU efforts to facilitate innovation be considered within the context of an ongoing comprehensive

reconceptualization and restructuring of the university initiated in 2002. While the complex redesign is shaped by a host of broad societal concerns, the university has sought to align its public mission with strategies to spur regional economic development, consistent with its role as a center for discovery, knowledge creation, and innovation. The commercialization of academic research is key to such efforts: One of the university's goals, he said, was to become the "central node of an integrative knowledge discovery and commercialization network."

To advance the role of the university in both knowledge creation and the advancement of innovation networks critical to regional economic development, ASU has developed its own approach to innovation and commercialization, rather than following models developed elsewhere. "We found that all the things that were important in California and in other innovation clusters made sense," he said, "but could not be copied in Arizona. If you attempt to replicate what was done in Silicon Valley, it just will not work. You need to learn from them, draw on their lessons, and then work out your own solution."

He considered the role of Arizona State University in the regional approach to innovation from the following perspectives:

- **Reinforcing existing knowledge clusters**. While regional economic development efforts generally focus on the formation of new knowledge clusters, metropolitan Phoenix is reinforcing existing industries—those that have been already successful over three or four decades. Rather than "stepping past them and thinking that somehow we're going to evolve some completely new industrial cluster," stakeholders are asking the question, what can we do to sustain the success of our industries? A dense concentration of aerospace manufacturing companies, for example, has flourished for decades in metropolitan Phoenix. Apart from their reliance on ASU for engineering graduates, however, these companies have interacted to a negligible and insufficient extent with the university or one another. A first step was thus to help them continue to remain competitive by integrating them into a cluster within which each could draw on and build from knowledge created at the university.
- **Group problem-solving (1)**. The second strategy, which Dr. Crow called a "hard-fought lesson," was to implement the practice of group problem-solving. He used the example of a $100 million grant awarded to ASU by the U.S. Army to develop a flexible display technology that could be worn on soldiers' uniforms in combat. The university was not asked to "do research, problem solving, submit scientific assessments about new materials, or publish papers," he explained. He offered the following summary of instructions from the Army: "You cluster yourselves together with whoever you have to and figure out how to manufacture this one thing. If you write academic papers, that's wonderful, put them off to the side. All we want is a flexible display wearable on a soldier's uniform in

combat." The university developed a cluster of 30 companies to work together on the project, and some additional companies were created just for the purposes of the collaboration. "We used a completely differentiated mindset," he said. "Just solve the problem, build the end product."

- **Group problem-solving (2)**. A second problem addressed through group problem-solving techniques is the impact of the built environment on a fragile semi-arid ecosystem in the metropolitan Phoenix region. He characterized sprawling development there as a "huge energy footprint in a very complex natural ecosystem." In metropolitan Phoenix, he observed, the average nighttime temperature has risen more than 10 degrees Fahrenheit over the last 20 years. "It affects the ecosystem, it affects energy consumption rates, and it affects the quality of life." Accordingly, the university, the city, and the private sector have jointly agreed to reduce the carbon footprint of Phoenix to the lowest possible number, by whatever means necessary. "That means innovation and problem solving, and modeling and networking, and materials advancement and working together," he said. "We're finding that group problem-solving is changing the way we're able to move forward." By clearly defining the intended return on investment to stakeholders, the partnership has been able to bring in funding from the university, the EPA, local industries, and private foundations. "We will not know that we are successful," he said, "until we have collectively lowered the trajectory of the nighttime heat index."
- **Innovation laboratories**. Another technique developed by the university to promote innovation in metropolitan Phoenix is the formation of a number of innovation laboratories. The concept of "innovation laboratories" is loosely construed as these can assume various forms and configurations according to their purpose, Dr. Crow explained. A leading example is SkySong, the ASU Scottsdale Innovation Center. Unlike conventional university-affiliated research parks, SkySong is a global business and innovation complex that ASU established in collaboration with the city of Scottsdale to advance education, entrepreneurship, and innovation. A number of ASU innovation laboratories are focused on education in entrepreneurship, including initiatives supported by an endowment designated for the advancement of student ideas for new companies. For life sciences entrepreneurs, ASU has established Technopolis, an innovation laboratory to convert ideas into commercially viable businesses, with guidance available for product development, business infrastructure development, proof-of-concept capital formation, and revenue development. The primary objective of these innovation laboratories is to start new enterprises, Dr. Crow emphasized, and depending on the objective, companies from the United States and around the world are invited to participate. Some

innovation laboratories focus on educational technologies and have been created with the objective of improving education at all levels. Other innovation laboratories may be clustered around issues associated with disadvantaged communities or specific societal challenges. The university welcomes input and support from the public sector, private sector, and philanthropic institutions.

- **Arizona State University Decision Theater**. The "standard model" of innovation, by which ideas are thought to move linearly from the laboratory to the prototype to the marketplace, is in itself insufficient and does not adequately represent the processes associated with the formation of innovation clusters in twenty-first century metropolitan Phoenix, Dr. Crow observed. A chief obstacle to the formation of innovation clusters is lack of understanding and communication between the public sector and the private sector, and between scientists and engineers on the one hand and on the other those responsible for the implementation of new technologies, including decision-makers in business, industry, and government. In an effort to overcome this obstacle and allow stakeholders from diverse fields "who don't speak the same language" to gather together and solve problems, the university raised $6 million to build a facility termed the ASU Decision Theater for the presentation of interactive and immersive, three-dimensional scientific visualizations of complex multivariate relationships based on actual environmental data and modeling results (<*http://dt.asu.edu/page/about_us/facility*>). A unit of the Global Institute of Sustainability (GIOS), the Decision Theater facilitates collaborative decision-making to address issues such as water management, land use, and public health. In order for Arizona to leverage its potential as a leading center for the development, manufacture, use, distribution, and control of solar-based energy systems, for example, ASU is developing robust modeling and simulations tools to advance the hybrid public-private partnership models and policy-driven market approach that will be required for success. ASU researchers from various units are developing an analytical tool known as RenewSim, for example, that will support the development and deployment of a solar energy roadmap through analysis, design, engineering, financing, and deployment. In order for produce 20 gigawatts of electric power derived from solar technologies for Arizona, Nevada, and southern California, innovation challenges include not only the development of engineering models for energy production and the grid infrastructure but also economic models and quantitative analysis for budgeting, efficiency, environment impact, and land use. The construction of knowledge and research infrastructure is an imperative over and above the urgent requirement for the construction of an adequate civic infrastructure, and in this sense, ASU is breaking down barriers to the formation of innovation clusters in the American Southwest.

American innovation policy is limited to the extent that it fails to recognize local expertise and regional innovation capacity, Dr. Crow observed. Potential synergies remain unrealized because of the lack of coordination and collaboration between the public and private sectors, and between the federal government, regional enterprises, and academic institutions. He relayed an example from Karen Mills, administrator of the U.S. Small Business Administration, regarding such lack of regional coordination in her home state of Maine. The University of Maine, he said, was trying to build a materials research center while the nearby University of Massachusetts boasts the world-class Materials Research Science and Engineering Center (MRSEC). "They could be linked to and clustered with this site," he said. He said that a more synergistic strategy for Maine would be to leverage its expertise in boat technology, including the application of new composite materials for boats and the development new engines. "We need to leverage local assets," Dr. Crow reiterated. "We need to build regional innovation clusters around local expertise."

Leveraging the Government's Investment in Regional Growth

What should the administration do to leverage its investment in regional economic growth? He proposed that one approach is to identify regional problems of national importance. For example, the federal government could help solve the ecological problems of the Everglades, which he called "a train wreck happening before our eyes," by assuming leadership for an effort that will require a massive coordination involving the public and private sectors. Solving the problem, he said, would require innovations from mining, agriculture, urban planning, the construction industry, water infrastructure, energy distribution, ecosystem management, and fisheries. With sufficient resolve to solve the impending ecological disaster, a host of innovations in a series of industries could coalesce surrounding the causality of the problem. Such federal leadership, he concluded is nor forthcoming.

Within the context of the global knowledge economy, Dr. Crow argued, the present rate of innovation in the United States is inadequate. He pondered, "Where then is the national innovation cluster working on that problem?" He asked how the country could accelerate the process of innovation, and expressed his agreement with Susan Crawford, professor of law, University of Michigan, and special assistant to the president for science, technology, and innovation policy, that the first priority was to clarify outcomes. Today, he said, an outcome is often equated with how many dollars are spent, with the assumption that investment in science will automatically produce positive outcomes. Such investment frequently does produce remarkable returns, he continued, but because we are not sufficiently focused on outcomes, our success often comes in spite of ourselves. A focus on outcomes would require coordination

between the Department of Energy and Department of Defense and the National Science Foundation, for example, as well as investment in education in the STEM fields—science, technology, engineering, and mathematics. It is common knowledge, he observed, that U.S. students lag behind those of other countries in math and science education in grades K-12. "Where is the national innovation cluster working on that problem? Give me every possible tool imaginable that can drive math learning across every cultural cluster in this country in every family of every income."

He concluded by urging a shift in perspective, particularly at the federal level, from the "project mode of thinking" to the advancement of policy that encourages "innovation clusters that are driven by outcomes" followed by investment to facilitate those outcomes. He lamented the present absence of analytical tools to measure outcomes as well as their economic impact. He framed investment in math and science education, for example, as an economic development opportunity. Speaking from his perspective as the president of a research university guiding the economic diversification of the economy in metropolitan Phoenix, he observed, "What I can say is that standard stuff seldom works. The country is evolving rapidly and the problems are challenging. Any standard approach that's not somewhat regionalized or localized is not likely to succeed. We need customization, and that comes through the establishment of new kinds of innovation clusters guided by new kinds of tools and outcome measures."

Discussion

Adam Rosenberg, of the House Science and Technology Committee, asked whether the large energy institutes recommended recently by the Brookings Institution[1] might too easily become earmarks that are difficult to terminate, and whether they are needed at all, given the current availability of national laboratories and major universities. Dr. Crow acknowledged the concern about earmarking, which he said had been expressed by Chairman Gordon[2] during congressional deliberations on the proposal. However, Dr. Crow, who said that he co-chaired the Brookings study, replied that the danger of earmarking could be addressed by ensuring that the selection of institutes be done on a strictly competitive basis.

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[1]The Brookings Institution's Metropolitan Policy Program—joined by a number of leading universities, regional alliances, and corporate partners—has laid out a detailed plan for launching a network of energy innovation institutes around the country. These institutes would "serve as the hubs of a distributed research network linking the nation's best scientists, engineers, and facilities." <*http://www.brookings.edu/reports/2009/0209_energy_innovation_muro.aspx*>

[2]Bart Gordon chairs the House Committee on Science and Technology.

He noted that the Department of Energy was planning energy hub projects that would likely have many of the features of the energy institutes, but saw two differences between the plans. First, he said, the DoE projects did not focus on solving a regional problem. Second, none of the funding proposed by the Brookings report would go toward infrastructure. The institutes would make use of existing institutions, taking the form of coordinating hubs and distributed networks of participants. He insisted that their efficiency and quality would be ensured by a rule of "strict, rigorous competition, no exceptions."

Dr. Edward Penhoet asked whether a criterion for locating a hub would be local capability. Dr. Crow replied, "Yes, absolutely."

Samuel Leiken, senior director of policy studies for the Council on Competitiveness, commented that in the course of studying universities and regional development, he had visited SkySong,[3] the innovation center Dr. Crow described during his remarks. He praised the usefulness of SkySong in creating a "tool that promotes serendipity for free-enterprise capitalism," allowing entrepreneurs to find a foreign partner, for example, or a university professor interested in collaborating. He said he was troubled by the risk that clusters with strictly defined outcomes might "define out" the essential "serendipity of free-enterprise capitalism." Dr. Crow replied that SkySong was a "transaction time reduction facility." He asked: "How do you take your idea and move as rapidly as possible through whatever transaction you need to move it forward." The development of SkySong was made possible through partnerships with the city of Scottsdale and private developers. More than 50 global and American companies from more than 20 countries are current participants, he explained. He suggested that the way to maintain serendipity is to focus on the problem rather than to establish a rigid regional structure. "You invite everyone to assemble around the problem itself," he said. "Then all the natural juices inside the university, the start-up company, and the established company flow on their own. Stay focused on the idea, not the structure."

[3]SkySong, located in Scottsdale, Arizona, describes itself as "a global portal connecting the world through technology." <*http://www.skysongcenter.com/project_vision.html*>.

PANEL I

WHY CLUSTERS MATTER: INNOVATION CLUSTERS AND ECONOMIC GROWTH

Moderator:
William Kittredge
Economic Development Administration
Department of Commerce

Cluster Development: A Path to Growth

Maryann Feldman
University of North Carolina

Dr. Feldman began by noting the strong interest in cluster development she had found in other countries, and joked lightly about how late this interest had come to her own country. "It's my pleasure to be with you today," she said. "This is very similar to a talk I've been asked to give in India, China, Europe, Japan, and Korea. It's wonderful to now be giving it in the U.S."

She began her discussion by giving "the academic viewpoint on cluster development," and signaled her agreement with previous speakers on the fundamental point that "all growth is local and grounded in place," taking the focus from nations to sub-national units." She attributed this shift to a local focus on understanding innovation as a "cognitive and contextual process," predicated on face-to-face interactions, serendipity and chance encounters and their outcomes.

One kind of outcome, she said, is that people, when dealing with something new, naturally develop a shared common meaning and a language to describe it. And the characteristics of knowledge are such that it grows when it is shared among people. These network effects lead to increasing returns and greater productivity from economic activity. "When we look at firms in that context, we realize why they benefit from strategic location. This doesn't mean firms that are attracted to a jurisdiction for a while and then move out. It means firms that have deep roots and deep social connections. Often these firms are homegrown. One of the great paradoxes of globalization is that even as we are all more interconnected, what really matters is place and location specific context. Clusters form both here and in other nations because humans are

physical and social beings." The best position is to be locally grounded but globally connected.

Clusters Reflect the Qualities of the Place

In this light, it is logical that cluster formation reflects the local qualities of the place where it forms. And it follows that it is seldom possible to imitate a cluster formed elsewhere. In the words of Robert Metcalfe, a pioneer of the Internet: "Silicon Valley is probably the only place on earth not trying to copy Silicon Valley."[1]

How, then, do clusters come into existence? That is, how do regions change from being inert—with little innovation, little entrepreneurship, slow economic growth—to being active places? She said that a central finding of scholars who study clusters is that they are not "economic development sausage machines," where the right ingredients added at one end produce the desired product at the other. This logic leads to a persistent creation myth that calls for lining up a research university, some venture capital, and some entrepreneurs, and then "turn a crank" to produce a cluster with good economic growth.

Studies of famous clusters revealed no evidence of a single creation formula; on the contrary, they suggest the opposite. Hollywood, California, for example, is such a successful cluster of film industry activities that the name refers to both the place and the industry. This success, according to a study by Allen Scott of the University of California, Los Angeles, drew on a unique blend of causes. The movie business, he showed, depends on its own form of clustering and a coincidence of new ways of organizing the film industry.[2] Similarly, Silicon Valley had its own particular characteristics as a cluster region that far transcended the presence of major universities, entrepreneurs, and venture capital firms. The task of creating a cluster by conscious intent is further complicated by the fact that many appear to be the products of historical accidents or serendipity. She concluded that the consensus in the literature is that social processes are the most important determinants of cluster development.

These social processes, more than location or physical attributes, combine with or produce a vision of some new way of doing something.

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[1]Robert Metcalfe, an early pioneer in developing the Internet, has also been an entrepreneur, publisher, and columnist, and is currently a venture capitalist with Polaris Venture Partners in Waltham, Massachusetts.

[2]Allen J. Scott, *On Hollywood: The Place, the Industry,* Princeton, NJ: Princeton University Press, 2004. Scott attributes much of Hollywood's success to its physical density and the proximity of many specialized but complementary skills. This clustering is essential, he writes, because "the relations between firms cannot be planned over extended periods of time so that useful inter-firm contacts need to be constantly programmed and reprogrammed."

For example, Hollywood superseded New York as the nation's movie capital because of their new innovative ways of making a film. The old way was a theatrical model, in which the action, including not only human speaking and actions but also train crashes and other simulations, were filmed on an old-fashioned stage. The resulting film was sold by the foot, like a commodity. The new social consensus about making films was to add value to the product by using a studio and a continuous script. And this was more easily done on the huge outdoor Hollywood lots than on the Broadway stage, quickly attracting the rest of the film business to the West.

Metrics Should Include the Quality of Community Life

In planning how to measure the outcomes of clusters, she suggested we should not limit metrics to innovation or job formation. For example, in a recent report from the Milken Foundation reported an innovation index of 100 for Silicon Valley; the next closest place scored 50[3]. "But we don't all want to live in Silicon Valley," she observed. "When we think about metrics, we need to think about economic outcomes more broadly, about community prosperity. Prosperity is a wonderful word that means sharing in the distribution of the outcomes." This community prosperity includes the broad question of what kind of world we want to live in, including all relevant economic and social objectives. She discouraged planners from thinking of Silicon Valley as the cluster archetype; creating another such cluster, she said, was unrealistic, undesirable, and unsustainable. There is a paradox in such thinking because "the essence of corporate strategy is doing something unique that is not easily replicated." To prove this point, she cited the current example of the biotechnology industry. "When you look around the U.S., everyone is trying to capture a biotech industry, even though a few places have already moved so far ahead."

What, then, is a city or region to do? Feldman returned to her point that designing an economic development strategy "may be the ultimate local innovation." In Asia, the government is able to dictate from the top down that a cluster will be established in a certain location. She put this in contrast with the West. "In a free-market capitalist economy," she said, "that won't work. The clusters we have in the U.S. and Western Europe are complex, self-organizing, and composed of a broad patchwork or ecology of people and institutions." For such clusters, the role of the government is to provide appropriate incentives. Feldman

[3]Ross C. DeVol, Kevin Klowden, Armen Bedroussian, and Benjamin Yeo, *North America's High-Tech Economy: The Geography of Knowledge-Based Industries*, June 2, 2009.

cited Nassim Nicholas Taylor's 2007 book *The Black Swan*[4] and its premise that people tend to be limited by their own experiences in thinking about what outcomes might be possible or feasible. "What Black Swan teaches us," she said, "is that it's difficult to anticipate new technology or future economic change." The role of the government in promoting innovation is therefore more challenging than that of a private company. While a private company seeks primarily to grow and to earn a profit, a government must consider many outcomes of cluster activity, including the quality of life in the community. "An economic development strategy that will work," she said, "has to be predicated on a deep understanding of the location."

Ideas Do Not Stop at Borders

Feldman then referred to the concept of "coherent geographical systems" as a framework for organizing economic activity. The defining feature of a coherent system is one that catalyzes the flow of ideas. Political boundaries are not useful frameworks for clusters, because ideas do not stop at borders. Instead, it is more helpful to think of political units as divisions of the same economic entity. These units can collaborate in economic activities for the greater good, rather then competing for the benefit of one fraction of the population. She urged planners to consider each place's position in an urban hierarchy, for example, in deciding what kinds of collaboration are feasible.

Another topic she discussed under the concept of coherent systems was the danger of concentrating resources. "Do we want to live in a world where everyone is in a city?" she asked. "We need to consider synergies between urban and rural areas. We have wonderful lessons from 30 years of state and local technological development initiatives. We need to learn from these laboratories."

She addressed Susan Crawford's question about the role of Government, responding that "private activity is just the tip of the iceberg." Capacities, incentives, and institutions drive innovation. These are traditionally the responsibility of government. "We have seen the growth of new quasi-governmental entities, such as public-private partnerships and nonprofit organizations, to become catalysts in this process. And it is important to remember that economic development policy is increasingly about social policy and enabling development potential."

A New Language for Clusters: Resiliency and Diversity

She urged that the debate be recast to replace competitiveness and a "winner-take-all, casino economy" with a new language of biology. By

[4]Nassim Nicholas Taleb, *The Black Swan: The Impact of the Highly Improbable,* New York: Random House, 2007.

this, she did not mean "survival of the fittest," but other lessons of evolutionary biology such as resiliency and diversity. "You would never tell an investor to put all his money in one stock or one sector. You would advise diversification. The same lesson needs to be applied to the economy." Resiliency is needed to survive external shocks; diversity is needed to ensure that enough members survive changing conditions.

She also suggested several revisions to our understanding of how academia, industry, and government contribute to economic development. With respect to the academic contribution, "A dirty little secret of universities is that very few university offices of technology transfer make money. But universities still provide fundamental resources that are critical in establishing clusters." Similarly, she said, many people disdain the lifestyle of entrepreneurship as mundane. But the day-to-day "hunting and gathering" activities of small firms can be essential to the success of clusters. Finally, government is often characterized as an agency of collective action, she said, but government does not function remotely or unresponsively. "Government action is and should be subject to citizen preferences."

Focusing on Local Capacities

To be viable in the global economy, clusters must act locally and practically. The literature suggests that clusters do best when they focus on local capacity, expertise, and problems that are well understood. When a product or idea is developed and found to be viable locally, it can often be readily scaled for global markets.

A cluster should also focus on education. Its most valuable programs may be strong partnerships between universities, community colleges, and high schools. She offered a reminder that what the United States does best is to support broad-based, universal education and produce well-educated university graduates.

Dr. Feldman concluded by suggesting that knowledge and economic development, as reinforced by clusters, will be essential to the United States as other nations increase their own standards of living. She reminded her audience that innovation must be regarded not only for its economic power, but also in light of its highest purposes, such as providing the means to reduce the causes of disease and human suffering. Too often, she suggested, innovation can become an end in itself, unless we think about the ultimate purposes of new knowledge. "It is time for a new golden age," she said. "Instead of treating knowledge as a commodity, we must value it as something that enhances human potential. Rather than regarding people as skilled inputs to production, we must think about them more broadly for their human potential. These are the outcomes we want from all of our clusters, and from social and economic development."

Stimulating Regional Economies

Andrew Reamer
The Brookings Institution

Mr. Reamer noted that a year previously he, Karen Mills, and Elizabeth Reynolds had collaborated and coauthored a paper on clusters and competitiveness as part of a "Blueprint for American Prosperity" series that Brookings was assembling in anticipation of a new administration.[5] He said that he would report on the major ideas of that piece and offer some updating.

Clusters, he said, have a number of policy-relevant characteristics. All clusters are unique, differing in purpose, scope, composition, trajectories of development, and adjustment to external circumstances. Experience suggests, he said, that three factors are critical to cluster success:

1. collaboration, which he defined as relationships;
2. the skills and abilities of people in the workforce and the people at the head of the organizations in the cluster; and
3. the cluster's organizational capacities for innovation—traditionally thought of as products and processes, but including how to do business and how to relate to one another.

An Industry Can Have Only a Handful of Clusters

Despite long-time experience with clusters, he said, economic development is accompanied by "a lot of magical thinking." He concurred with earlier speakers who said that "every place wants to be Silicon Valley." Despite the fallacy of this wish, economic development agencies continue their efforts to do so, using any number of "magic bullets." In the 1980s, they trusted that a business incubator was the key to success. "Today clusters have that danger," he said. "They're the next magic bullet." The reality, he said, is that any industry can have only a handful of clusters. For biotech, San Francisco, San Diego, and Boston host more than half of the entrepreneurial activity, and it is very difficult for smaller areas to follow. "The more successful a cluster," he said, "the more likely it will pull in firms from small places, because the best thinkers want to be where the action is."

As an example, he mentioned a biotech initiative created by the University of Pittsburgh; the initiative had "some moderate success in building new firms," but when firms reached a certain size, they left.

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[5]Karen G. Mills, Elisabeth B. Reynolds, and Andrew Reamer, "Clusters and Competitiveness: A New Federal Role for Stimulating Regional Economies," op. cit.

Similarly, even the primary clusters fluctuate in relative strength. He said that a venture capital firm that had been in Boston for three decades had chosen the week before to move to San Francisco—one sign, he advised, that Boston is challenged in sustaining its prominence as a center of technology and venture capital. "The economy is in a perpetual state of transition," he said, "so cluster dominance cannot be taken for granted."

Facilitating Natural Collaborations

In a sense, he said, "we all grew up with clusters" of particular industrial activity: a cluster of tire companies in Akron, insurance in Hartford, cars in Detroit, glass in Toledo. Today, with improved information technology and transportations, new kinds of clusters are emerging based on functions, such as transportation in Memphis and Louisville. Part of the key to cluster success, he said, is a paradox: they develop competitiveness through a variety of collaborative activities. The objective of cluster initiatives is to facilitate those natural collaborative tendencies through joint efforts in market development, education and training, R&D, incorporation of new techniques, networking within the cluster and region, new business development, and marketing that attract firms and workers.

In the universe of cluster initiatives, he said, there are both wide differences and some common features. Among the differences are size: Some are tiny, some have hundreds of participants. Some follow economic boundaries, others political boundaries. They may be initiated by a city or a state. They may be a subsidiary of another organization, like a chamber of commerce, or a standalone effort that resembles a trade association. Among their common features: successful cluster initiatives tend to be ad hoc enterprises, formed from the bottom up. Most are led by industry, with government and nonprofit involvement. They occur across the full array of industry sectors, occurring in mature as well as new industries. A typical cluster initiative is supported by a dedicated organization that works hard to promote it and sustain collaboration.

The factors guiding successful cluster initiatives are reasonably well understood. Successful cluster initiatives are almost always industry-led and inclusive. Despite the natural tension between competing and collaborating at the same time, dynamic cluster initiatives manage to bring everybody to the discussion, including supply chain firms, educational institutions, and intellectual property experts. Successful cluster initiatives develop roadmaps to help understand where they are, where they want to be, and how they plan to get there. Successful initiatives have found a way to be financially self-sustaining.

Cluster initiative success, however, can be blocked by a number of barriers. Among these are:

- **Market failures**.
- **The "public good and free rider problem**." Clusters initiatives require a lot of effort, and there is a tendency to hold back and "let someone else do it."
- **Lack of trust** among competitors or across different cultures.
- **Lack of knowledge**. How to start, who should be involved, how to make it successful.
- **Weak financial resources**.
- **Competition from other priorities**.

State and local public-purpose organizations, he said, take active roles in starting cluster initiatives. Sometimes these are governments, sometimes ad hoc organizations (e.g., the Massachusetts Medical Device Council). Other places, such as Oregon and South Carolina, have set out to stimulate economic development across a number of clusters, which requires a broader program.

Such state-wide experiences, he said, suggests a role for the U.S. federal government as well. Around the world, he said, national governments have played a central role in cluster formation, which is not the case in the United States. Of 31 European Union nations, 26 have a cluster development program at the national level, as do Japan and Korea. Further, the EU even operates a European Cluster Observatory, which maps clusters across the continent.

National and sub-national programs, he said, play different and complementary roles. Sub-national programs are "on site" and can easily promote site synergies. A national program can provide regional groups with information, such as knowledge about best practices and financial resources. Knowledge is a public good that needs to be created only once and can then be shared. A federal program can also transcend political boundaries and stimulate nationwide coverage.

The U.S. Government's Absence from Cluster Formation

He said that the federal government's absence from processes of cluster formation is partly a function of historical trends. Since the 1940s, national economic policy has focused on managing the economic cycle—issues of growth, recession, and inflation. Economic policy has not focused on the institutional foundations of the economy, which seemed to be stable. The economy was largely manufacturing based and dominated by a relative handful of major corporations. They were based in well-established regional clusters where they were thought to be immune from foreign competition. In the 1950s and 1960s, the federal government took several steps to enhance economic activity by creating new structures, such as the National Science Foundation, Federal

Highway Administration, and Small Business Administration. In the 1960s, the government focused on equity, trying to lift certain groups of workers (e.g., the Employment and Training Administration) and regions (e.g., the Economic Development Administration). Both approaches used structural, prescriptive, top-down policies.

In the 1980s, the economy was shaken when it lost 12 percent of its manufacturing jobs. National economic policy, he said, attempted to respond with steps that were ad hoc, siloed, and uncoordinated, such as creation of the Technology Administration, Manufacturing Extension Program, and the Workforce Investment Act. He said that the jointly authored paper mentioned at the beginning of his talk had tallied some 250 programs, budgeted at $77 billion that had been created to "try to staunch the bleeding, to move forward with some effectiveness in regional economy policy."

Time for the Government to "Enter This Space"

However, he said, the national economy continues to be "macro-focused" and to lack a competitiveness strategy. It has failed to recognize that "national competitiveness is a function of regional competitiveness," and that "regional competitiveness in turn is largely a function of cluster competitiveness." Hence, he concluded, we have had no federal policy on clusters. He recommended that it is time for the federal government "to enter this space for purpose of a stronger national economy," and that government participation would require an approach to managing the economic cycle and economic structure in more integrated ways. He suggested several principles for this approach:

- First, federal programs should be flexible, bottom-up, and collaboration-oriented, rather than top-down, prescriptive, and input-focused. In an analogy from physics, he said that federal policy should shift away from "Newtonian physics—the world as a machine" toward quantum physics, "a function of millions of independent decision makers and much uncertainty." An effective role for government is to catalyze the decision makers and to increase the probability of effective action at the "bottom."
- Second, the government should use a kit of diverse tools, including information, knowledge, and grants to promote effective clusters. Information, which is inexpensive, should be the first tool used, grants the last.
- Third, a federal effort should be funded at a level appropriate to need. Strategically, he said, this should include a way to bring some of the energy of "those other 250 programs," which are already funded, into the process.

He concluded by saying that the federal effort should build and rely on the capacity of state and regional organizations so they themselves catalyze competitiveness locally. Federal policy should also link,

leverage, and align existing federal programs that support regional economic development. "This," he said, "creates synergies among what is. This it not a small challenge. It is going to take nothing less than a new federal culture."

PANEL II

REGIONAL INNOVATION CLUSTERS: THE OBAMA ADMINISTRATION'S INNOVATION INITIATIVE

Moderator:
Jean Toal Eisen
Department of Commerce

The Geography of Innovation: The Federal Government and the Growth of Regional Innovation Clusters

Jonathan Sallet
The Glover Park Group

Mr. Sallet said he would summarize a paper for the Center for American Progress that he was writing jointly with Ed Paisley and Justin Masterman.[1] The basic thesis, he said, was that clusters are part of national competitiveness strategies in most countries except for the United States. In the FY 2010 budget, President Obama, he said, sought for the first time to provide explicit funding for the support of regional clusters and associated business incubators.

He noted that it is a difficult time to develop new funding for regional competitiveness, with 47 of the 50 states facing budget shortfalls. He cited the example of California, which projected the nation's largest state deficit of $33 billion and faced large cuts in education and R&D spending. The total proposed federal funding for clusters was only $100 million. How can this help? he asked. Why is it a good idea to involve the federal agencies?

Opportunities for the Federal Government

He said that the answer to these questions was that the federal government already worked at the regional level in many ways, and that if programs make use strengths already available locally, there is no need

[1]See By Jonathan Sallet, Ed Paisley and Justin R. Masterman, "The Geography of Innovation: The Federal Government and the Growth of Regional Innovation Clusters," *Science Progress*, September 1, 2009.

to invent new approaches. These strengths can be used to stimulate positive external benefits, he said, which is how some people define a cluster. Federal agencies can act as effective conveners, form networks, and provide experienced leadership for certain functions.

As a first step, he suggested that the Economic Development Administration (EDA) be more explicitly involved with cluster development. "To me," he said, "it's an opportunity to focus EDA and the Department of Commerce on renewal in comprehensive fashion. There's a fair amount of skepticism in the way EDA has operated. No doubt, it has spent money in ways that members of Congress see as beneficial to local economies. But other people have characterized it as *ad hoc*, unconnected sometimes to what is happening on the ground, not fully integrated into any strategy, state or federal." He said that putting cluster initiatives at the heart of EDA could be an advantage both to the initiative and to the EDA.

EDA involvement with regional clusters, he said, would not require any new institutions. Because the EDA is in the Department of Commerce, it is already well positioned to connect to programs of overlapping expertise, including the Technology Innovation Program, Manufacturing Extension Partnership, export assistance from the International Trade Administration, and infrastructure funding from National Telecommunications and Information Administration and NOAA.

He suggested that the program should have three key features: competitive grants, a program of information exchange, and coordinated delivery of expert assistance.

The Value of a Small Grants Program

The grants program would have a relatively small amount of money, so it is important that it be competition-based and flexible for two reasons: (1) to maximize efficiency, and (2) because of the fundamental premise that federal officials do not have all the answers. A competitive approach calls on the regions themselves to take the first step, which is to define the structure and objective of the initiative. Also, a flexible grants program can respond to the reality that economic and political boundaries are not always coterminous. The grants should be matched by industry contributions, he said—perhaps one to one from the beginning or increased gradually to that level as the economy recovers. Grants could be used for business incubators, training programs at universities, and technology transfer for small and medium-sized firms. States have little or no money available for such programs now.

Among the criteria for grant applicants is that proposers have a proven track record, strategies created with the private sector, and that efforts can move fast with impact. An important requirement, he said, is that the programs show how they will integrate smaller areas into larger

regional economies, combating the assumption that distressed areas are a "separate" part of the economy that cannot contribute. "We want to foster integration that brings strengths together," he said. Among the criteria for selection is that the cluster consider goals in sectors of national priority, such as energy, health care, manufacturing, and life sciences. This would make clear not only the regional but also the national advantage of the activity. Not every place in the country has a cluster, he pointed out, so some grants should be smaller planning awards—for universities, regional governments, planning agencies—to help move such a region toward clustering. "That's useful," he said, "because it would help regional authorities make the right decisions about their comparative strengths."

Data Exchange and Flow

The second key feature, data exchange and flow, is described expressly in the Obama Administration's FY2010 budget submission. "It is an obvious point," he said. "If we can all be on our PDAs during a conference, surely we can find ways to exchange information easily and efficiently between the federal government and regional clusters." The federal government can provide data on cluster formation, performance, and composition from a national information center. Participants within the cluster can benefit by knowing what businesses are located there, or have filed patent applications, which helps understand the level of expertise in an area. Also, clusters have much to teach other clusters, which "is a fundamental aspect of what we ought to be trying to achieve here." That could be done efficiently—not just through data exchange, but through the next point, which is learning. In short, policy should not only focus on knowledge as an output of a cluster, but on steps need to facilitate the sharing of knowledge within clusters. At the federal level and among regions, websites, wikis, and social networking help people exchange knowledge and understanding.

Forms of Assistance for Clusters

The third feature was "one-stop shops," in acknowledgement of the need for people in clusters for some forms of assistance that require in-person consultation. The intended audience would be not only businesses, but also those who contribute to business success. The one-stop shop would not have all 250 federal programs related to regional economic development, but perhaps a selected few: e.g., existing Department of Commerce programs related to infrastructure, trade, and technology; programs of the Small Business Administration; the WIRED[2] program of the Department of Labor; and other business-

[2]The Department of Labor's Workforce Innovation in Regional Economic Development (WIRED), was initiated in 2005. According to its website, it "goes

generating efforts with a regional focus. "The point is not to try everything at once," he said, "but to align federal efforts with the expertise of the regions, to make sure the way the federal government acts in a region is suited to the region. The one-stop shop is not just a delivery mechanism; it's a dialogue mechanism."

TABLE 1 Potential Criteria for One-stop Shops

One-Stop Shops for Cluster Assistance
1. Initial inventory of need: bottom up
2. Importance of in-person expertise
3. A cluster plan to share "shared advantages"
4. Tight coherence between distinct federal programs
5. Integrate distressed areas into larger regions
6. Convenient location to existing regional offices

SOURCE: Jonathan Sallet, Presentation at June 3, 2009, National Academies Symposium on "Growing Innovation Clusters for American Prosperity."

He suggested a pilot program that begins in two kinds of areas: those with many resources, and those with few resources. "We already know that some forms of federal assistance bring gains where there are resources on the ground. But other regions have few resources—just an SBA office and nothing else. We want to know whether long-distance professional assistance can add to those locations in useful ways."

Locating the One-stop Shop

To win a one-stop shop, a region would be expected to complete a bottom-up inventory of need and demonstrate the value of in-person expertise. "It's location, location, location," he said. "We need to think about where they are. For example, they should be near existing regional offices." In addition, a cluster plan should demonstrate how it would benefit from shared advantages, how it would enhance and make use of tight coherence between the distinct federal programs, and integrate distressed areas into larger regions. "We ought to be talking not only about why this is smart economics, but why it is smart public policy."

He concluded by saying that the notion of clusters is based on a long history of academic scholarship that is rigorous and strong. He said that clusters have been implemented at the state level by Democratic and

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beyond traditional strategies for worker preparation by bringing together state, local and federal entities; academic institutions (including K-12, community colleges and universities); investment groups; foundations; and business and industry to address the challenges associated with building a globally competitive and prepared workforce." <*http://www.doleta.gov/wired/*>.

Republican governors alike. The current proposal in the FY2010 budget has funding requirements that "are very modest by federal standards, and provides "a basis to think about federalism for the 21st century."

"This is not just a question of top-down or bottom-up," he summarized. "It's the federal government having a defined role that is complementary to regional efforts. The federal government can frame national challenges, facilitate information exchange and learning, and fund the cluster efforts in helpful but not exclusive fashion."

New York State's NANO Initiative

Pradeep Haldar
Energy and Environmental Technology Applications Center (E2TAC)
Albany, New York

Dr. Haldar told a story of rapid technological evolution near Albany, New York, that in just a few years has produced a high-tech cluster so vibrant as to reverse the declining image and reality of the region. The story began in the 1990s, when much of upstate New York was in an "economic shambles," he said. Manufacturing jobs were disappearing from every region: steel mills from Buffalo, high-tech Xerox and Kodak jobs from Rochester, the gas turbine division of General Electric from the capital. Traditional industries, such as textiles, shoes, and typewriters had long since conceded to foreign leadership. Albany itself was "a sleepy government town" of 800,000, including the surrounding area.

In the 1990s, then-Governor George Pataki gathered a diverse group of stakeholders to develop a strategy to revive the economic fortunes of the Upstate. They decided they needed an integrated R&D, education, and business strategy, built around a Governor's Center of Excellence that was anchored by a university. They chose nanotechnology as the focus, and in 1993 launched a Center for Advanced Technology. This was joined in 1997 by a NanoFab 200 Building, and the following year the Semiconductor Industry Association (SIA) chose the site for a National Focus Center Consortium.

"When I arrived in 2001, it was mostly still a dream," said Dr. Haldar. "We had about 40 people at the site, hoping we would create a great nanotech center. What we really needed was an 'anchor tenant' for our high-tech mall."

Just such a tenant arrived, in the form of IBM, whose corporate headquarters were in suburban Armonk, New York. IBM decided in 2001 to build its new Nanoelectronics Center of Excellence in Albany, along with a consortium of partners. The following year, this news was followed by the announcement that SEMATECH would establish a new research center there, called International SEMATECH North. In 2002 a

TEL R&D Center was added, and in 2003 a NanoFab 300S, and in 2005 an ASML R&D Center.

A Nanotechnology College from Scratch

Still, these new enterprises all needed a highly trained work force, and university strength in engineering that was not locally available. The Albany campus of the State University of New York, built in 1999, had only one building, a great deal of green space, and no engineering department. The planners decided to build what they needed from scratch and, in 2004, a College for Nanoscale Science and Engineering (CNSE) was established. By 2007, it was ranked the number one college in the world for nanotechnology by Small Times Magazines, and today it has 48 faculty members and 150 graduate students. An undergraduate program is scheduled to begin in 2010.

TABLE 2 Infrastructure: Shared-use, Co-location Model

Key Features of the Albany NanoFabs
800,000 square feet in facilities, including 80,000 square feet of 300 mm wafer clean rooms
Partners include SEMATECH, IBM, AMD, Micron, Infineon, Tokyo Electron, and ASML among others
Over $4.5 billion in assets, in addition to the buildings themselves
Over 2,200 employees within the complex

SOURCE: Pradeep Haldar, Presentation at June 3, 2009, National Academies Symposium on "Growing Innovation Clusters for American Prosperity."

Once the CNSE was established, IBM's consortium partners and other firms came to Albany as well, including Applied Materials, Micron, AMD, Infineon, and a NIST/Army partnership. Vistec closed its facility in Cambridge and moved it to Albany. In 2008, IBM announced a new $1.5 billion packaging R&D center. Today the "green space" holds a cluster of half a dozen major buildings, totaling about a million square feet.

Bringing in the Entire Value Chain

The "main mantra," said Dr. Haldar, was industry-government partnership. In the last six years, about $4.5 billion have been invested by industry, seeded by less than $800 million in state investment, a leverage effect of six. Today the campus has more than 2,500 employees, which will grow to 2,900 by the end of 2009 when SEMATECH is scheduled to complete its move north from Texas. One objective, he said, is to bring together in a single cluster the entire value chain of the nanotechnology

industry. This includes not only manufacturers and end users, but also suppliers and construction firms.

Knowing What Industry Needs and How It Works

At the nanotechnology college, he said, one of the main strategies was to "break silos" and bypass ordinary departmental categories in favor of constellations of engineering and business people who could communicate easily. "Our model differs from traditional university setting," he said. "Since we built from ground up, 70 percent to 80 percent of the people we hired came from industry, so they know what industry needs. Academics do good basic research, but in the future, universities are being forced to deliver for companies in exchange for support. The traditional model—do the research, throw it over the fence, try to license it—will not work." CNSE does not rely on a tech transfer office, he said, which seldom produce income. "That's a barrier we've broken down," he said. "Instead, we partner with our industry and figure out ways to break down IP barriers. We're not trying to make money at the college—the companies give us money in return for the research we do."

The consortium now extends all the way from Buffalo to Long Island and includes more than 800 companies spread throughout the supply chain. These companies support more than 364,000 high-tech jobs paying average wages of more than $75,000. The cluster had become a one-stop shop for not only technology, but also for business, financing, IP, and eventually manufacturing.

The largest success story was the announcement by AMD that a fab, built in 2006 in Saratoga, would be expanded. "This will be the first green field manufacturing site built in the U.S. in 20 years," he said. "It will need up to 6,000 highly skilled workers. They look at us to provide the technology, a lot of the work force, and the business connections they'll need going forward."

He said that the key drivers of the cluster have been the center of excellence model and creation of the college. "We created a lot from scratch. It looked crazy when we started 10 years ago. But looking back, we changed the paradigm."

Bridging the Gap between Knowledge and Making Money

In summary, he said, the cluster is bridging the gap between the knowledge creation of the universities and the stage where companies begin to make money. The activities in this gap include business incubation, pilot prototyping, and test bed integration. "We do the entire gamut of what's of interest to these companies." Workforce development is a key component, including partnerships with community colleges, with K-12 schools, construction trades training, high school and

undergraduate internships, equipment supplier training, and institutes to develop the semiconductor workforce.

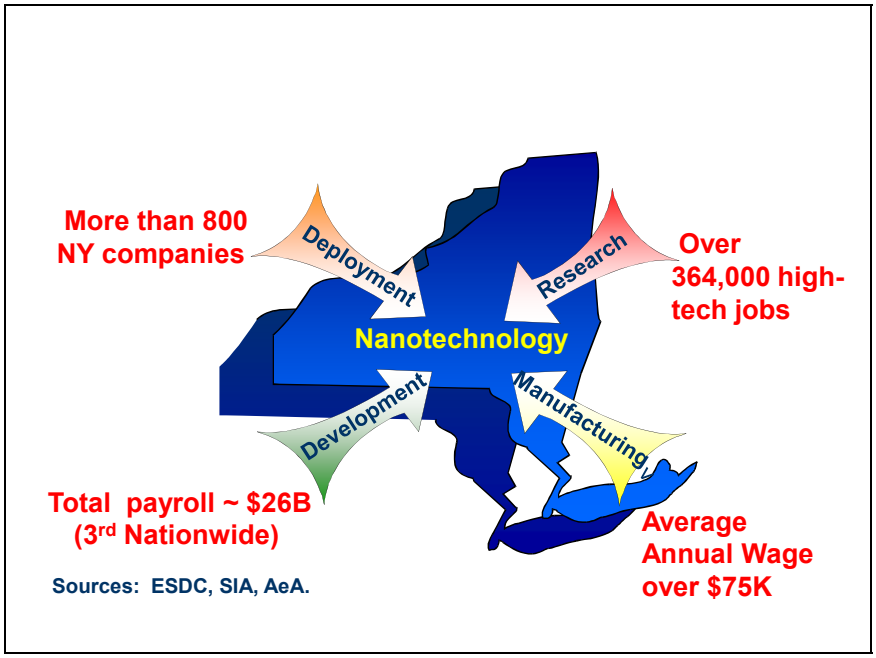


FIGURE 1 A statewide industry, extending from Albany to Buffalo and NYC to North Country and Long Island.

SOURCE: Pradeep Haldar, Presentation at June 3, 2009, National Academies Symposium on "Growing Innovation Clusters for American Prosperity."

He concluded by recalling that planners of the regional cluster wanted it to be a global force from the outset. "Our governor and industry leaders saw the vision of creating a real key gateway for industry clustering," he said. "We had companies from all over, including Asia, come to work here. We have huge investments in a range of semiconductor technologies and we are looking at deploying them into every sector, including energy, wireless communications, automotives, aerospace, sensors, bio-health, and defense. Right now, we're again in partnership with New York State to create clusters for green technology jobs. The applications of nanotechnology are just huge."

The Technology Innovation Program: Connecting the Dots

Marc G. Stanley
Technology Innovation Program
National Institute of Standards and Technology (NIST)

Mr. Stanley began by noting the Obama administration's strong interest in innovation. "I have never seen such enthusiasm," he said, "which began with transition people coming to see us at NIST, trying to find ways we can be engaged." Given that interest, he said, the challenge is to "find ways to remanufacture what we're doing at the federal level so it gets to the states and is useful."

Saying that the states can be considered "laboratories of democracy," he offered a quote from former Justice Louis Brandeis: "There must be power in the states and the nation to remold, through experimentation, our economic practices and institutions to meet changing social and economic needs…It is one of the happy incidents of the federal system that a single courageous state may, if its citizens choose, serve as a laboratory; and try novel social and economic experiments...."

Looking for Ways to Support Clusters

He said that the TIP would look for ways to support clusters and other state programs that share this spirit of adventure. TIP could do so, he said, by bringing federal R&D dollars and helping retain or develop high-tech industries. Indirectly, this would bring or maintain high-tech jobs and increase local revenues. It would also be consistent with national imperatives, he said, and administration priorities:

- To use science, technology, and innovation to solve the nation's most pressing problems, including affordable health care, climate-friendly energy, modern public safety networks, and advanced biomedical and stem cell research.
- Promote a "transparent and connected democracy."
- Improve America's competitiveness.

"I think this approach is essential," he said," and I think it will work. We all have a responsibility to help it work."

Rejuvenating American Innovation

At the heart of the effort is the challenge to rejuvenate American innovation. He outlined several aspects of this challenge.

The first is to invest resources that are commensurate with the challenge. These resources include talent, in the form of an educated and motivated workforce; investments that provide resources for invention and innovation; infrastructure, including physical environments to

support innovation and business conditions that encourage risk-taking and collaborative endeavors. He noted that investments are a particular problem during the recession, when the venture capital community has reduced its investments in early-stage projects.

A second key to rejuvenating innovation is encouraging public-private partnerships at local, state, and federal levels. Useful partnerships may involve foundations, consortia of firms, philanthropists, corporations, venture capitalists, angels, and investors. Because each of these sectors has its own ideas and perspective, partnerships can develop and use more knowledge than individual actors can.

Rejuvenating innovation also needs policies that consistently reward invention, innovation, and competitiveness. He said that he had worked toward these goals for many years, and was familiar with how difficult it is to propel exciting discussions into actual implementation. "We all talk about it—and then it stops. Innovation is a change agent, and it takes a lot of hard work. Every other country is trying to do this." He said that he had just talked to a group representing 40 companies based in France, and all of them wanted more information about the TIP program.

Joint Ventures Led by Universities

The TIP program itself, he asserted, had "changed the paradigm." It is different from its predecessor as TIP focuses on early-stage basic research and investment in areas of critical national needs. Only small and medium-size companies were eligible to participate, and the majority of joint ventures were being led by universities.[3] This, he said, represented a "huge shift." TIP would still be involved in high-risk, high-reward research, but it would be targeted at critical national needs rather than open to all ideas.

The identity of TIP was shaped by its relationship to NIST, he said, which provided $65 million in funding for FY2009, including management of ongoing TIP and ATP awards. Because TIP is able to draw upon NIST's scientific and technical expertise, it can more credibly and easily identify and select areas of critical national need for TIP funding and evaluate proposals. Among these national needs, he said, are building the smart grid electrical system, enhancing cyber security, and strengthening technologies, including those developed under ongoing ATP programs.

TIP uses a filter of critical national needs to shape its competitions and collaborative programs. Such a need is defined as "An area that justifies government attention because the magnitude of the problem is large and the societal challenges that need to be overcome are not being

[3]Large companies may participate as joint venture members that fully fund their participation, as contractors, or as informal collaborators.

addressed, but could be addressed through high-risk, high-reward research."

Key Features of TIP

He said that TIP has three key features. First, it emphasizes societal challenges that are not being addressed and that have potential benefits that extend significantly beyond the proposed project. Second, the program has exceptional scientific and technical ability to pursue high-risk, high-reward research. Third, the program has exceptionally strong potential to advance research, contribute to the U.S. science and technology base, and help the nation deal with major societal challenges. "What I'm interested in," he said, "is investing in disruptive technologies."

For eligibility in the TIP program, applicants can have one of several structures:

- Single-company projects proposed by a small or medium-sized U.S. company (SME).
- A joint venture of at least two for-profit U.S. companies with an SME as lead project.
- At least one SME and one institute of higher education or other eligible organization, with the lead being either the SME or the institute of higher education.

Single-company projects may receive up to $3 million over a maximum of three years. Joint venture projects may be funded up to $9 million over a maximum of five years (these include direct project costs only). Cost sharing is required on a 50-50 basis, with matching funds including yearly total project costs (direct plus indirect). These may be a combination of cash and in-kind contributions.

He ended by asking for input from a host of external stakeholders and organizations to uncover needs not yet being addressed. For example, at the end of 2008, TIP issued a call for white papers on critical national needs. TIP has so far identified civil infrastructure and manufacturing as areas of critical national needs.[4] It has also highlighted five "interest areas": energy, green technologies, health care, networks, and water. "What I need from you," he told the participants, "are your views about what we should be focusing on. Most of all, we need innovators who will strengthen U.S. global competitiveness."

[4]The 2009 TIP competition for civil infrastructure projects emphasized two elements: (1) inspection and/or monitoring technologies; and (2) repair/retrofit materials and application technologies. The competition for manufacturing also emphasized two elements: (1) process scale-up, integration, and design of advanced materials; and (2) predictive modeling for advanced materials and materials processing.

Discussion

Sam Morris of the Association of Public and Land Grant Universities asked for additional comment on the role of university leadership in the Albany initiative. Dr. Haldar said that the university played the central role in bringing together both public and private partners. "If we had not played that intermediary role," he said, "competing companies wouldn't have wanted be part of the process. Being neutral let us get people together, and to convince government to make the substantial investment in infrastructure to make it happen."

Dr. Eisen asked about how best to build support for regional programs. She said that the Department of Commerce had been criticized for trying to impose industrial policy from the top down. "While we appreciate the advantage of federalism and regional approaches," she said, "how do we talk to people outside this room?" Mr. Sallet suggested that she "try a little tenderness." He noted that the Congress was debating funding for this area, and that they must hear about advantages of policies at state and regional levels. He said that committee members need to hear from governors and other local leaders. "Maybe the 21st century paradigm," he said, "is that states lead, and the federal government facilitates."

The Issue of Picking Winners

Dr. Wessner raised the issue of winners and losers, which he said is usually applied in a misleading fashion during debates about federal support for innovation. He noted that the U.S. and state governments—like industry—had always picked and favored "winners," as have other governments around the world. For example, choices have to be made in defense procurement and those choices are often decisive. More broadly, it is easy to forget that government policy and support played key roles in industries as diverse as radio, aircraft engines, radar, computers, semiconductors, nuclear power and, more recently, GPS and the Internet. Some distinguished economists, such as Vernon Ruttan have argued that most major industries, agricultural sectors, and other exporters owe at least some of their success to some form of public subsidy.[5] A key point to keep in mind is that the rest of the world is not worried about whether they should support local "winners"; their only concern is how.

Dr. Haldar said that the Albany project was not built with federal money because New York State was then "flush with cash," but that more recently they have received more federal grants. In terms of choosing winners, however, he said that the decision to give SUNY/Albany, a liberal arts school, $100 million for nanotechnology

[5]Vernon Ruttan, Technology, Growth, and Development: An Induced Innovation Perspective, Oxford: Oxford University Press, 2001.

was certainly a case of choosing a winner, and one that had paid off many times over.

Mr. Sallet said that while he did not predict that the government would ever select which firms would succeed, he did see it creating more institutions that would be "public goods that create shared advantages to the benefit of communities that assist universities and businesses alike," he said. "They do not look like anybody's depiction of industrial policy, but this will be a formulation that is important for us to use."

Steve Crawford of the Brookings Institution followed up with a question about the Sallet report. He said that while economies and innovation are regional, it is difficult to match them with programs because of "dozens of competing townships, cities, and other entities." He suggested that EDA reorganize itself around the concept of regions, and help them coordinate infrastructure and workforce investments. He proposed "extra points" for an economic region that is coterminous with a political region, such as a city, to better align these efforts. "Otherwise," he said, "there is a real tension." Mr. Sallet said his proposal intended to use grants as incentives to promote clusters and regional cooperation. Having grants go to an economic rather than political unit, he said, would be an incentive for regional cooperation. But, he added, small planning grants could be used by those with a regional understanding of networking. He concluded that "your point is important."

PANEL III

STATE AND REGIONAL INITIATIVES

Moderator:
Ed Paisley
Center for American Progress

Clusters Growing in Pennsylvania

Rebecca Bagley
Pennsylvania Department of Community and Economic Development

The mission statement for the Technology Investment Office (TIO) in Pennsylvania, she said, did not use "innovation" in its title. Instead, its objective is "to serve as a catalyst for growth and competitiveness for Pennsylvania companies and universities through technology-based economic development initiatives, including funding, partnerships, and support services." Its customers include pre-revenue, emerging, and mature companies, as well as universities, community organizations, and investment partners. "We collaborate with everyone," she said. The TIO, she said, does not just manage grants, but takes "an extremely active role. Really, the goal is collaboration, and clusters are just what we fund, supporting companies at every stage."

She said there were four pillars of technology-based economic development: innovation, capital, workforce, and support services. But the ideas that fuel innovation, she said, can come from the private sector, state government, or the federal government.

Primary Industry Clusters

The primary industry clusters supported by the TIO are biosciences, nanotechnology, manufacturing (including seven centers of the Manufacturing Extension Program), alternative energy, and telecom/information technology. "I sort of joke that this is everything we can find," she said. "Collaboration and those four pillars bring these clusters together." Alternative energy was especially strong, she said, since the state had recently set aside $650 million, which could now be used to match stimulus money. In the biosciences, the state had strength in large pharmaceutical companies (including two of the top 10 NIH grant recipients). But it did not have venture capital or seed-stage

activity, so the TIO used tobacco settlement money to create three life sciences "greenhouses" across the state. These are designed to find and develop technologies from universities and to invest in VC funds, of which there are now 32 in their portfolio. This allows the state government to brand the region, she said, and address the biotech sector with one cohesive voice. It also allowed the TIO to see what resources the region had, where the gaps were, and how they could be filled.

She described technology investment as a process with five stages:

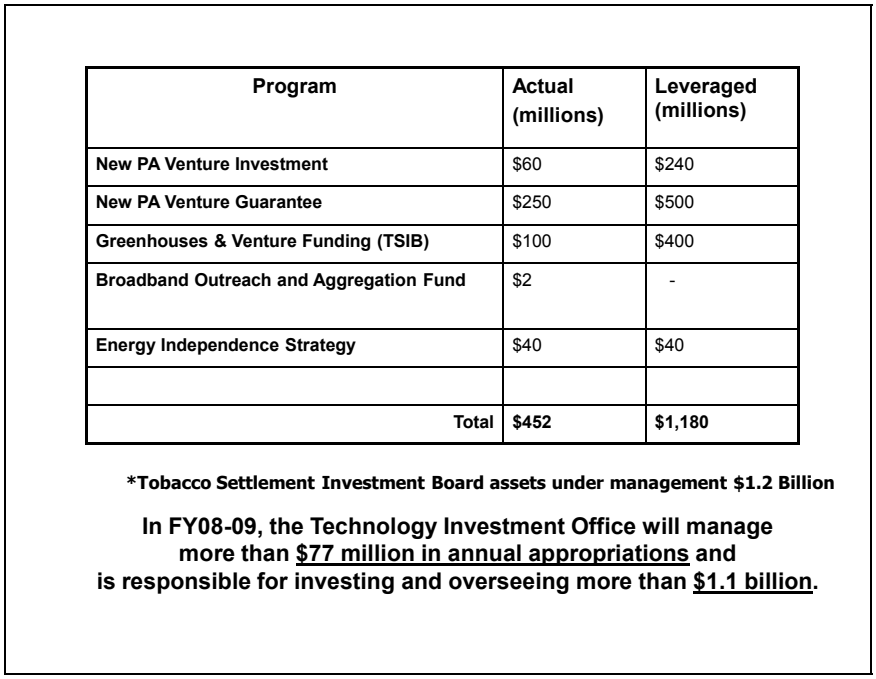
- **Concept**: The idea for the company is hatched.
- **Formation**: The company begins to establish itself and its product, hiring employees and winning customers.
- **Growth**: the company grows with increased pace.
- **Maturity**: The company has an established customer base and flattening growth.
- **Reinvention**: The company takes action to seek new market opportunities.

She summarized the many programs supported by the state, saying that the objective common to all of them was "articulating to people what we do." Returning to the biosciences, she noted that the federal role could be especially important, since six of the largest pharmaceutical companies in world are located within 50 miles of Philadelphia. "But some are in New Jersey and Delaware," she said. "So if federal programs can fund innovation by region, we can have a really robust cluster." The same would be true for the area between Pittsburgh and Cleveland. "But this is tough for states to do," she said, "because we can't spend taxpayer money outside our borders."

Gaining and Losing Momentum

She said that the TIO had raised a total of $452 million in actual funding, which had been leveraged to a total of $1.18 billion. The TIO in FY2008-2009 had managed more than $77 million in annual appropriations and was responsible for investing and overseeing more than $1.1 billion. Now, she said, that process was losing momentum in the recession, with the Senate contemplating a budget cut of 60 percent. "We had gained a lot of momentum over last eight to 10 years," she said "but now we may lose a lot from lack of funding."

Another successful cluster, she said was the Pennsylvania energy cluster. Governor Rendell and the legislature had taken steps before the recession to invest nearly $915 million to spur the alternative energy economy. Funds distributed since 2003 and new legislation, such as the Alternative Energy Investment Fund, she said, would ensure that the commonwealth would be a national leader in this emerging sector for years to come. Since 2003, state investments in this sector had funded 564 projects that had created and retained more than 8,300 jobs.



Program	Actual (millions)	Leveraged (millions)
New PA Venture Investment	$60	$240
New PA Venture Guarantee	$250	$500
Greenhouses & Venture Funding (TSIB)	$100	$400
Broadband Outreach and Aggregation Fund	$2	-
Energy Independence Strategy	$40	$40
Total	$452	$1,180

*Tobacco Settlement Investment Board assets under management $1.2 Billion

In FY08-09, the Technology Investment Office will manage more than $77 million in annual appropriations and is responsible for investing and overseeing more than $1.1 billion.

FIGURE 2 Technology investment: Funds under management.
SOURCE: Rebecca Bagley, Presentation at June 3, 2009, National Academies Symposium on "Growing Innovation Clusters for American Prosperity."

Fortunate Timing for Job Creation

The state had also created an Alternative Energy Investment Fund, enacted in July 2008 for infrastructure that was needed to support the energy cluster. The act provided $650 million in funding and tax credits for alternative energy and conservation. The strategy was to tie together the expertise of existing industries with research being done in universities and support it through infrastructure development. "The timing was lucky," she said. "This will also create many jobs." The fund was divided into two streams: $500 million in bond funding, $20 million in annual funding and tax credits over seven years, and $10 million in the eighth year.

The state had also funded an alternative development investment program to be managed by Ben Franklin Technology Partners, the state's TBED organization. This fund received $40 million in assistance for energy-related investments to support early-stage activities. "This fund," she said, "is near and dear to my heart. It lets us do management support, translational support, incubator support services, and company investment—to make sure we're developing new companies."

She closed on the topic of metrics, which had been discussed by several participants, some of whom suggested that no useful metrics had yet been developed for early-stage firms. "I don't agree," she said. "We have a methodology, and we survey all of our companies. Nor everyone likes it, but the questions are consistent. We went through a year-long process. A lot of that came out of my feeling that there had to be a way to measure these collaborations and all of these soft things that happen in technology-based development. We brought together 100 people we'd funded, hired an economist, broke up into groups, talked about what to measure and how. The Penn State survey center helped us. We ended up with 10 metrics, including jobs created and jobs retained, which most people ask. The one question they weren't asking was how many new companies were formed. There are problems with data that we can debate, but I think new company formation is something we that can hang our hats on and is something unique to us. Jobs come from that, and that connection has held up pretty well with other people's numbers. If you talk about those new companies in relation to jobs and salaries, we think you have something meaningful."

Building and Branding Clusters: Lessons from Kansas and Philadelphia

Richard Bendis
Innovation America

Mr. Bendis said that he was first involved in designing cluster formation in Kansas in 1999-2000, "before cluster strategies became the vogue. So we can look back and see which Kansas clusters have worked and which have not."

He noted that in discussing the public sector's role and where it should it intervene, one change since 2000 had been a migration away from the concept of "technology-based economic development" (TBED) toward one of "innovation-based economic development" (IBED). While the goals of TBED tended to focus on natural resources, brick-and-mortar projects, and business parks, the goals of IBED were clusters, networks, innovation and technology products "intervening at the margins of the private sector."

The flows of financial and intellectual capital, he said, now have the following objectives:

- Address the current economic transition.
- Capture more benefits of investments in research, development, and higher education.
- Build a stronger entrepreneurial culture.
- Help existing industries modernize.

- Diversify the economy.
- Create jobs.
- Innovate.

Despite the fundamental differences between the structures of the private and public sector, he continued, government does have an essential role in moving society closer to the objectives of IBED. Specifically, it is government's role to sustain the following:

- A healthy, educated public.
- Structures for job creation, economic health, knowledge worker development.
- World leadership in science, technology, engineering, and mathematics (STEM).
- Improved environmental quality and sustainable development.
- National infrastructure for information technology.
- Enhanced national security.

Government's Responsibility to Involve Itself Deeply

To support these objectives, he said, the federal government has a particular responsibility to involve itself deeply in science and technology. The government is uniquely positioned to maintain a long-term vision and provide the support to sustain it. Government can also identify gaps and trends, and catalyze activities through strategic investments and partnering. With its breadth of agency expertise, it can sustain a balanced and flexible R&D investment portfolio and encourage private sector innovation through agency partnerships and incentive programs.

He offered more detail on the evolution of economic development. Traditional economic development, he said, sought advantage in such areas as natural resources, highways or rail systems, proximity of manufacturing and markets, and low production costs. They sought to develop value by investing in such structures as business parks and manufacturing facilities attracted by tax, land, and other incentives. They were led by long-standing organizations such as chambers of commerce and economic development commissions.

New Features of Modern Economic Development

IBED, by contrast, looks very different. Companies now compete through collaborative membership in clusters. They develop specialized talent through networking, liaisons with academic partners, and quick adaptation to market conditions. The key value offered by an IBED company is knowledge, which is gained through access to research and workforce competencies. The lead organizations tend to be innovation intermediaries, innovation based economic developers, or other entities

that may evolve rapidly or assemble on an ad hoc basis for new projects or programs.

Several additional features serve to more fully define IBED, he said. First is human connectivity, which emphasizes new forms of cooperation. Another feature is the public-private partnership, in which the missions of education, industry, and government are seen as inseparable. Finally, a cluster of more specific features emerges from an analysis of IBED best practices, including longevity, bipartisan support, continuous reinvention, private-sector involvement, accountability, and effective leadership. The clusters themselves, which might be considered the essential structure of IBED, embody all of these features and can uniquely concentrate knowledge assets, host globally competitive firms, create high-wage jobs, and attract scarce global talent and investment.

The Kansas Experience

He turned to his experience with the Kansas Technology Enterprise Corporation, or KTEC, which is a quasi-public body, funded through the state lottery, with the following mission: "To create, grow, and expand Kansas enterprises through technological innovation." It was founded in 1986 as a holding company that managed a portfolio of programs, investments, subsidiaries, and affiliates operating as for-profit and not-for-profit entities. It is directed by a 20-member, industry-led board representing the legislature, government, universities, and the private sector.

In 2000, Mr. Bendis helped lead an assessment of the program to gauge its accomplishments after 12 years of operation. A standardized rating system was developed to determine the level of "capacity and opportunity" for critical technologies. The plan recognized "that Kansas is a flyover state," he said, which meant that the study should not expect "class I research institutions or the presence of a large venture capital community. We had to link our strategic plan to local and national opportunities that matched the capacities in the region. We developed a Strategic Assessment Framework to see how Kansas ranked against national and global opportunities, based on the capacities it had at the local level."

The assessment found that the state had high capacity ratings in four areas: human biosciences, agriculture and agricultural biotechnology, information and communications technology, and aviation. The researchers decided, in consultation with four universities, that biotech and biosciences were the strongest clusters, followed by information and communications technology. Agriculture was judged to have high capacity but not large opportunity. Aviation was judged to be an important cluster, but one whose growth prospects were seen to be

limited.[1] The study also identified three "enabling clusters" that could support some or all of the primary clusters: nanotechnology, manufacturing technology, and polymers.

The next step was to make policy recommendations based on the study's framework and assumptions. The concluding recommendation, which constituted a "broad guideline," was that "each state, country, or region must adjust and prioritize policies according to its individual context." The study also recommended several objectives, especially the improvement of competitiveness of key industrial sectors—those identified as having high capacity. It was decided not to compete with emerging nanotechnology clusters, or with SEMATECH, because the state did not have sufficient infrastructure. "We chose to build on existing capacity and strengths," he said.

In terms of structure, the Kansas Technology Enterprise Corporation had a portfolio of research and investment programs that it leveraged heavily with SBIR and business assistance programs. Instead of creating business incubators, it created innovation and commercialization corporations, linked them together, and recruited managers with national experience in venture capital to create regional early-stage investment funds.

Lessons and Results from Kansas

Mr. Bendis said that the study of the Kansas experience produced several organizational lessons that others might find useful:

- Begin with a clear articulation of the problem.
- Recruit or identify a respected, experienced, and patient "champion" to see the program through to completion.
- Develop a public-private partnership as a priority from the outset.
- Focus on tasks with a good chance of success; don't waste resources where success is unlikely.

Ten years after the study, in 2009, the KTEC had produced the following organizational results:

- The Kansas BioScience Authority was created, without federal help, and funded at the level of $581 million to support innovative life science startups and research in Kansas.
- The National Agricultural Biosecurity Center was created in 2008, funded on a competitive basis with $500 million.

[1]Wichita, often called the "Aircraft Capital of the World," is the manufacturing base of Cessna, Hawker Beechcraft, Bombardier Learjet, Spirit AeroSystems, and Boeing Integrated Defense Systems. <*http://www.wingsoverkansas.com/about/*>.

- A new National Institute for Aviation Research was created to focus on creation new composites.
- A Software and Technology Association of Kansas was established to advocate for Kansas' software and IT sector. A problem here, he said, was that IT companies did not feel a strong need to collaborate. His advice was "not to waste your limited resources on an industry cluster that thinks it can support itself."

He then turned to Innovation Philadelphia (IP), a public-private partnership that differed from KTEC in spanning 3 states and 11 counties. Greater Philadelphia was judged to be at an economic crossroads, he said, and at risk of losing its status as a top-tier economic center. Innovation Philadelphia had goals similar to those of KTEC, beginning in 2002 with a cluster analysis for both the region and the city. An Innovation and Entrepreneurial Index indicated "more resources than most people thought we had," and our glass, rather than being empty, was truly more than half-full.

In Philadelphia, A Need for a Roadmap

One challenge, he said, was the need for all participants to identify who their natural partners were in order to generate both an urban and regional perspective. Hence, a primary need was greater coordination and collaboration among all parties. This required not another economic development plan, but an umbrella roadmap to coordinate disparate and often competing activities. IP launched a research program with both qualitative approaches (one-on-one interviews) and quantitative tools (prior studies, federal funding data, private-sector R&D spending). This was done in partnership with the greater Philadelphia Chamber of Commerce and the city. A plan was produced in 90 days after the primary research and regional market analysis had been completed. This plan indicated that the primary strength in the city were financial services firms, while in the counties the strength was distributed among chemicals, pharmaceuticals, education, and biotechnology.

Critical ingredients of success included the willingness of civic, business, and political leaders to work on Hot Teams, each one consisting of members from academia, government, small and large innovative businesses, venture capital, as well as each geographical region represented. These leaders were willing to hold "feet to the fire" when necessary to catalyze collaboration. "We had respected leaders that served as a high-level oversight committee in the process," he said, "so this was not just an exercise. Each one agreed to put vital resources and time into it."

The group began with seven "prime targets of opportunity," which it reduced to five based on concentration of assets and leadership. Today, "through a process of self-elimination," there are three active clusters: Biomedicine (pharma is greater Philadelphia's number one industry),

nanotechnology (including the Ben Franklin Technology Partners and Mid-Atlantic Nanotechnology Alliance), and "The Creative Economy," which is the primary cluster that Innovation Philadelphia supports today and is a major employment cluster in the Philadelphia region.

Regional Branding and Marketing

The core actions of IP, he said, began with regional branding and marketing.

"You need to market your strengths," he said, "so people know what you're strengths are doing. The organizations also shared a common investment review process and shared due diligence procedures. Qualities that worked for both KTEC and IP included a focused and integrated approach, private sector leadership, operation of the efforts as a business, managing investments for ROI, flexibility, and with accountability.

He concluded by reviewing the need for such cluster activity. Paramount was the early-stage funding crisis in America, in which the "valley of death is wider and deeper than it's ever been," he said. "Just to have proof of concept isn't enough these days. Now you need proof of relevance and a product that's market-ready before you can get the attention of funders."

He closed by recommending a new National Innovation Framework for the United States, an idea he had presented in December to the presidential transition team. The centerpiece was a $2 billion National Innovation Seed Fund that consisted of a Fund of Funds and a technical assistance grant fund; the latter provided entrepreneurial support and services to portfolio companies and fund managers. It also called for a new public-private innovation intermediary to accelerate the growth of the innovation economy and oversee the National Innovation Seed Fund. He said he had just met the day before with a working group for an innovation coalition seeking to raise innovation to a higher priority level within the Obama administration.

Innovation and entrepreneurship will be critical to accelerate America's recovery from this economic recession. Innovative small entrepreneurial businesses that are supported by state and regional IBED programs and organizations will create the new knowledge-based jobs of the future.

Virginia Industry Cluster Analysis

John Mathieson
SRI International

Mr. Mathiesson observed at the outset that "economic development people and S&T people don't really speak the same language. One group speaks in terms of jobs and investments, the other in terms of funding for research and publications and maybe patents. From our perspective," he said, "you have to look at one through the eyes of the other, back and forth."

Virginia, he said has suffered from what had been called the "Dutch disease." For the Netherlands, resources of offshore gas long provided sufficient wealth that the country did little to develop other industries. "In Virginia, we suffer from easy access to Washington, D.C., which drives the entire economy."

An Overdependence on the Federal Market

To address this "disease," Mr. Mathieson's group did a state-wide examination of clusters. It found that like most states, Virginia's economy was dominated by service industries. "Roughly two-thirds of the economy is there only to serve the local population," he said. "You really have to focus on export-type industries." Several technology and knowledge-based sectors stood out for their high levels of employment: life sciences and medicine (337,000 workers), research and engineering services (162,000 workers), and IT services (140,000 workers). Analysis of employment concentration ratio by cluster again revealed that key employers are IT, research and engineering, aerospace, defense, national security, and telecommunications. But all of these sectors owed their large numbers to easy access to the federal market.

Weak Innovation Resources

They also benchmarked Virginia's innovation foundations, which revealed that "the commonwealth has a lot more going for it than it's getting a bang out of," he said. In financial resources, the state was doing well in STTR and SBIR awards, but small business loans and venture capital investment were weak compared to nine other benchmark states. Human resources were very strong as measured by educational level, but almost all qualified graduates work for the federal government or federal contractors rather than owning their own businesses. Innovation resources, he said, were "pretty weak," other than those associated with federal R&D. The state was at the bottom of its comparison group for patents issued per 100,000 residents, and close to the bottom for entrepreneurs per 100,000 residents. Total R&D as a share of gross state

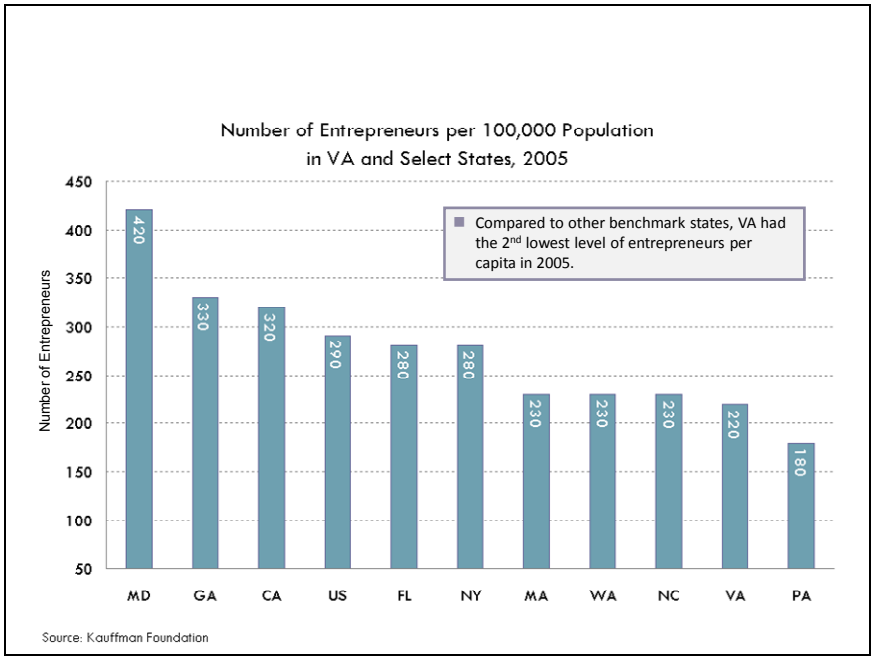


FIGURE 3 Innovation economy outcomes: Entrepreneurs per capita.
SOURCE: John Mathieson, Presentation at June 3, 2009, National Academies Symposium on "Growing Innovation Clusters for American Prosperity."

product was about average. "So Virginia isn't getting much for the incredible assets it has."

Mr. Mathieson reviewed what the state could do to support high-potential technologies through various targeted interventions. It had become clear during the study that resources for R&D and technology were limited, "so you really do have to pick winners." He agreed with the earlier comment that everyone, from the National Science Foundation to corporations, picks winners, and that a state is no different.

The study put the high-potential technologies through a "winnowing process" of five screening criteria. It identified several clusters in biomedical sciences and health care, including point-of-care diagnostics and computational technologies. The state was very strong in IT, and investments in IT would have benefits for health care, cyber security, and many other kinds of technology. Other technology-based industry clusters included chemicals and materials, clean energy and environment, and transportation and logistics, each with its own set of high-potential technologies.

Little Entrepreneurial Activity

Mr. Mathieson also examined the major cluster of biomedical sciences and health care by mapping economic growth against R&D locations, using publications, patents, and major research facilities by sector and by region. This review revealed considerable assets in terms of innovation and research facilities, but—again—little entrepreneurial activity. Another map showed the state's IT assets. This revealed a "huge concentration," he said, "higher than any other state." Most of this concentration was in northern Virginia, because of both the huge federal market and the large number of internet-based companies that have grown or moved there. A similar exercise was performed for energy and environment, including research centers and concentrations of employment.

One conclusion was that "stove piping" was a major impediment to innovation in the state. "Everyone wants to do their own thing: national labs, large companies, etc. We identified gaps and then did case studies of other state programs that might help us enhance research excellence at universities and increase our bang for the buck. Promoting innovation is not just a matter of spending research dollars."

A second conclusion was that the state had very little public-private collaboration. "You need to use experts as key players," he said. And finally, Virginia needed to enhance entrepreneurship and access to capital. "As I mentioned," he said, "the universities are really not hotbeds of entrepreneurial activity. They're feeder systems to the big contractors and the federal government."

After looking at the case studies, Mr. Mathiesson came up with a series of lessons learned:

- Highlight collaboration as a central component of all programs.
- Use industry and technology experts as key players in decision-making.
- Seek to leverage multiple sources of funding.
- Clarify key economic development objectives and milestones.
- Maintain strong systems of accountability.
- Use flexible tactics that allow for long-term adaptivity.
- Measure innovation progress.

In closing, he offered an overview of the need for innovation strategies. First, states must expand knowledge-based industries to compete nationally and globally. In OECD countries, knowledge-based industries are growing 20 percent faster than all industries, and salaries in those industries are 20 percent higher than in all industries. At the same time, manufacturing is following agriculture in its dwindling employment base, and some large service sectors, such as housing and

retail, are poised to repeat this pattern. "You have to look at innovation as your sweet spot," he said.

An Innovation Initiative to 'Transform the State'

In the case of Virginia, many industries depend on the federal market. While this is important and will not go away, he said, it does not reflect innovation in the true sense. The commonwealth has enormous assets but has not achieved its potential. "An initiative to stimulate innovation and catalyze collaboration among the groups," he said, "can transform the state. This initiative must enhance research excellence, engage the private sector, nurture entrepreneurship and access to capital, and support technologies with the greatest economic potential.

To take on this task, Mr. Mathieson concluded, the state had created the Virginia Innovation Alliance (VIA), a public-private partnership endorsed by the governor and cabinet but placed on hold during the recession. The VIA was specifically designed to catalyze technology, generate desired outcomes, and evaluate those outcomes. "You can map out metrics at different points along the value chain," he said, "both in terms of innovation and its outcomes. The outcomes you want are well known: cluster health and growth, jobs, investments. We want to gain political support that transcends administrations, which is why it would be led by the private sector. We want to increase collaboration among stakeholders, and sustain centers of excellence in technology. If we do all these things and do them right, Virginia will become a model innovation economy."

The Washington State Innovation Economy

Egils Milbergs
Washington Economic Development Commission

Mr. Milbergs began optimistically with the thought that "a crisis is a wonderful time to rethink and reinvent. In Washington State, we don't like the term 'economic recovery,' because it implies going back to the same old ways. We don't want a recovery, we want something new. This recession will be the mother of the innovation economy of the 21st century."

He followed this thought with three caveats:

- "The federal government can get things wrong. We are wary of too-rapid spending, because it has the potential to distort local and regional economies. We want to take advantage of resources, but have to be thoughtful how we use them."

- "Cluster analysis can get things wrong. It gives you backward-looking data about where you have been. It doesn't tell you where you're going."
- "The most important process in building an innovation economy is not the money; it's the relationships and the time to build those relationships. We need leaders to sit around the table and think things through and actually implement some of the strategies we've heard about."

He said that the state, which spends about $3 billion a year on economic development, stands to receive $7 to $8 billion from the stimulus package. "We have to think about how to spend those monies," he said, "because we don't want to produce our own bubble."

He said that in his opinion, the most important metric for innovation success is the experience of the consumer. "The most important way to create jobs is by creating customer satisfaction." Washington State depends on consumers, he said, and on innovation. The state does not have much government involvement, and the private sector has adopted the goal of making Washington "the most attractive environment in the world for private industry."

To do so, he said, the state is planning a new model for economic development.

Toward a New Model of Economic Development

This model will make substantial changes from traditional economic development. He said that the major features of the traditional model have been the following:

- Investment in attracting and retaining companies.
- Creating jobs.
- Emphasizing low-cost inputs, especially labor.
- Developing the economy from the top down.
- Regarding different regions as competitive, and economic development as a zero-sum game.
- Supporting a closed and linear innovation system.
- Supporting local clusters.

An innovation-driven model, by contrast, would have the following features:

- Investment in talent, ideas, and infrastructure.
- Creating high quality, high-income jobs.
- Using high-value inputs that increase productivity and outcomes.
- Developing the economy from the bottom up, building on ideas and knowledge.

Traditional Model	Innovation Driven Model
Attracting and retaining companies	Investing in talent, ideas and infrastructure
Jobs	Quality of jobs, per capita incomes
Lowest cost of business inputs	Higher value inputs, increasing productivity and outcomes
Top-down economic development	Bottom-up and organic growth
Competing regions: zero sum game	Collaborating regions: value creation
Closed linear innovation system	Open innovation ecosystem
Locally focused clusters	Globally focused clusters

FIGURE 4 New model for economic development.
SOURCE: Egils Milbergs, Presentation at June 3, 2009, National Academies Symposium on "Growing Innovation Clusters for American Prosperity."

- Regarding the regions as partners and the entire state as a toolbox for growth.
- Supporting an open and networked innovation ecosystem.
- Supporting global clusters.

He stressed a key feature of the innovation-driven model—the exchange of cheap inputs for high-value inputs. Traditional planning, he said, would opt for cheap labor based on cost alone. An innovation-based approach, by contrast, would see the advantages of well-trained employees who are qualified to contribute not just labor but also ideas and leadership, which are the basis for bottom-up productivity in the knowledge-based economy.

Key Drivers of Innovation: Talent, Investment, Infrastructure

The key drivers of innovation and growth, he continued, are talent, investment, and infrastructure. Educating and training young talent is an increased challenge during today's financial crisis, he said, but necessary

to sustain innovation. Investment is needed to diversify the R&D base and to ignite local innovation and entrepreneurship. Investments in infrastructure are needed to create a "smart, clean, and green" economy, which eventually functions without oil. He noted that 70 percent of his state's electricity is produced by hydroelectric plants at low rates, a valuable economic advantage.

Mr. Milbergs said that the state's key industry clusters were diverse and strong, including agriculture (the wine industry had grown from a handful of vineyards 20 years ago to more than 600 today); health services, centered in Spokane; the beginnings of a smart grid; information technology; aerospace; alternative energy, "Silicon Forest"[2]; defense; and film production. In 2007, the Innovation Partnership Zones (IPZ) program was created by Gov. Gregoire and the state legislature as part of the state's efforts to stimulate industry clusters within specific geographic areas. He said that the Puget Sound "tech universe," one of the strongest zones, had already spawned 719 companies.

Philanthropy as a Wealth Creator

A new wealth-creating sector in Washington, he said, had been catalyzed by the Bill and Melinda Gates Foundation, whose endowment exceeds the size of the combined venture capital firms of the United States. This Global Health Ecosystem partners with some 160 organizations, mostly nonprofits, that operate in nearly 100 countries. "As they are trying to solve about 20 major disease problems," he said, "they are also creating a health ecosystem that's going to be sustainable. This is a recent example of philanthropy as a wealth creator.

One of the objectives of the Washington Economic Development Commission, he said, was to connect the regions of the Washington innovation ecosystem. He described a "Glimmers of Hope" virtual tour of Washington's innovation clusters whose purpose was to learn about the visions of each cluster, as well as their financial plans. Anyone, he said, could "follow the 'tour' via the Internet, communicate with it, invest in it, comment, collaborate, and even use the output." Eventually, he said, this process will connect the regions, so that the entire state can function as a "toolbox" or a "social and economic laboratory of democracy." By building such a system, he said, the state would have an economic model of how inputs drive the business environment and how the business environment creates wealth, jobs, and ultimately state revenues.

[2]A cluster of high-technology firms exist in the area of Portland, Oregon, and southwest Washington.

He closed with a time-honored quotation about innovation: "The best way to predict the future is to invent it."[3]

[3]This quote is attributed to Alan Kay, a developer of the object-oriented programming language Smalltalk invented at Xerox PARC in the early 1970s. Smalltalk was the inspiration for the graphical user interface pioneered by Apple Computer. A more extensive version of the quote is: "Don't worry about what anybody else is going to do…. The best way to predict the future is to invent it. Really smart people with reasonable funding can do just about anything that doesn't violate too many of Newton's laws!" <*http://www.smalltalk.org/alankay.html*>.

LUNCHEON ADDRESS

Karen Mills
Small Business Administration

Karen Mills, who has been an active hands-on investor in and successful manager of small businesses since 1983, began by recalling several experiences in Maine, where she was appointed to chair the state's Council on Competitiveness and the Economy in 2007. There she focused on attracting investment to rural and regional development initiatives. She was able to help Maine boat builders win a WIRED grant to apply new composite technology to boat building, a traditional industry. She also developed support for local and regional producers of many products, from disability insurance (in Portland) to blueberries and lobsters.[1] "This work gave me a passion for what you all know so well," she said. "I understood that if you are going to create jobs, you do it from the ground up in these clusters."

Scope of the SBA

In 2009, she was appointed administrator of the Small Business Administration, where her opportunities are far wider. The SBA has an extensive nationwide reach, with $90 billion of loan guarantees in direct loans, scores of chapters, and many small-business development centers that provide advice and service. The Administration now employs some 2,000 people, 1,000 of them outside the Beltway.

The ideas being discussed at the symposium, she said, were finally moving to forefront of policy making in the federal government. "These ideas have been bubbling up for years," she said, "but the federal government has been absent. The agencies have been living in silos, and with an attitude that the government doesn't have a role in regional economic development."

Referring to the paper that she, Andrew Reamer, and Elizabeth Reynolds had written for the Brookings Institution,[2] she recalled the 250

[1]The Maine Technology Institute administers the state-funded cluster grant program with initiatives in boatbuilding, composite technology, food, forest products, and sustainable energy.
[2]Karen G. Mills, Elisabeth B. Reynolds, and Andrew Reamer, "Clusters and Competitiveness: A New Federal Role for Stimulating Regional Economies," op. cit.

federal programs that had responsibilities in regional innovation. Most of these programs, she said, were in the Departments of Labor, Commerce, Energy, and the SBA, with additional elements being added by the Recovery Act. "You see how all these endeavors are designed to do the same broad thing," she said: "Drive innovation and create jobs. We know that 70 percent of new jobs are created by small businesses. About 50 percent of the population either owns a small business or is employed by one."

An Umbrella Structure in the Federal Government

She said that large companies have already found the necessity to compete globally, and to locate their assets around the world. "Who's going to create the good-paying jobs here in America?" she asked. "They're going to be innovation-driven companies that grow to be our new foundation for competitiveness. We have to think, "Where in the federal government is that initiative going to live?" The answer is that it is going to live in multiple places, so we need to create an umbrella structure that will make that a priority. That initiative is now in formation. This is the moment. The piece that's missing is not the understanding that this will be the underpinning, but the structure that puts it there."

She concluded her brief talk by asking the participants for their input on designing a "structure that will let us turn innovation into jobs." This is especially urgent in towns and regions hard-hit by the recession, she said. "It is not going to be a perfect structure," she said, "nor necessarily elegant, but we have the opportunity to do a number of things that are going to bring together all of these programs in a powerful way."

Discussion

Christina Gabriel of the Heinz Endowments asked about working with the SBA. She noted that the programs supported by the SBA did not always fit the small high-tech companies that were trying to grow out of universities or other companies. In particular, she said, banks and other lenders tended to label technology companies as high-risk, greatly reducing their chances of funding when compared with companies that do not have this label, such as a food franchise. Ms. Mills tried to clarify the situation by describing two kinds of small business. "There are Main Street small business, and a high-growth, high-impact small business," she said. "They have different needs." She said that the SBA has always had many programs that deal with "the restaurant on Main Street. It's gonna close, it's gonna open, and when it opens it needs an SBA loan to do the new fixtures. All of that churn we support and if we don't, we won't have those jobs."

The high-growth firms rely on other programs, especially SBIR. She urged participants to write letters of support for this program, which was then up for reauthorization. She said it would probably need additional equity capital programs—" the next-generation SBICs."[3] The SBIC was a relatively early design initiated "when you didn't have a lot of the other tools." She noted that the distinction between "Main Street" and high-growth companies did not mean old vs. new. Many firms of both kinds had been functioning for decades, she said; the average firm receiving SBA assistance was 24 years old. "Some technology companies have been there for generations," she said. "They're in every sector, and we need to be there for them as well as for Main Street."

Jane Muir of the University of Florida said that the technology licensing office had helped start about 10 companies a year based on university technology. She asked whether the SBA might create additional programs to help new firms survive the rigors of pre-commercialization development. Ms. Mills said that her agency had "a placeholder pilot in the budget," but that the effort was "very much in the initial stages."

Reauthorizing the SBIR Program

Dr. Wessner referred to earlier comments about the importance of using existing programs to aid the economic recovery, rather than starting new ones. He asked whether Ms. Mills favored an expanded Phase III (the commercialization phase) for the SBIR program. She responded by first thanking the National Research Council for its recent analysis of the SBIR program. This analysis, she said, allows the SBA for the first time to go into the reauthorization process with a "fact-based analysis. This is very powerful and positive for us." She said that SBA's present priority was reauthorization, using a lot of the NRC recommendations, and in using the current program to its full potential before thinking about expansion.

Mr. Milbergs, referring to the regional economic development plans of the state of Washington, asked advice on how to integrate the components of the state innovation economy across multiple agencies. Ms. Mills said there was no single model, but that the President placed high priority on integration among agencies—on using taxpayers' money efficiently. Her agency worked closely with the Department of Commerce and the U.S. Trade Representative, she said, to integrate export activities. "There's no point in having five different voices," she

[3]Small Business Investment Companies (SBICs), with their own capital and with funds borrowed at favorable rates through the Federal Government, provide venture capital to small independent businesses, both new and already established. <*http://www.sba.gov/aboutsba/sbaprograms/inv/index.html*>.

said. The administration was also working to coordinate health care across agencies and with OSTP.

"Entrepreneurs in Residence"

Gregory Horowitt of the University of California and T2 Venture Capital said he wanted to create a national "entrepreneurs in residence program," partnering with the Kauffman Fellows Program, "somewhat of a Peace Corps for the venture industry." This would deploy underutilized people from Silicon Valley, Boston, and other places and redeploy them to work with research institutes. The program would combine the activities of a venture fund, an educational institution, and the translation of science from research institutions. He asked whether U.S. agencies would be interested in collaborating. Ms. Mills answered that certainly the Department of Energy would be interested, along with the White House institute being developed. "We are very much interested in partnering," she said, "and have begun to do that with a lot of you."

She concluded on a note of optimism. "If you look at the initiatives out there," she said, "you get the feeling we are going to be successful. We are not Amsterdam; this is not the end of a golden era. We are going to reinvent ourselves as a new golden era because we have this spirit of entrepreneurship, the entrepreneurial know-how, the capital, the rule of law—and now we have the federal government interested in partnering with state and private institutions, focused on this issue of turning innovation into jobs. This crisis has helped us remake our foundations in favor of competitiveness.

"The past is not coming back," she predicted. "I believe that small business is going to be a core underpinning in the future. We have to find a way to take all this innovation, create clusters of small companies, and turn them into the foundation stones of America's competitiveness."

PANEL IV

THE UNIVERSITY CONNECTION

Moderator:
Robert Samors
Association of Public and Land-Grant Universities

Mr. Samors reminded the participants that the National Association of State Universities and Land-Grant Colleges—well known as NASULGC—had just changed its name about a month previously to the Association of Public and Land-Grant Universities (APLU). The APLU's members included 215 public research universities, 76 land-grant colleges, and 24 institutions. "Our goal," he said, "is to help them become the best possible partners in regional economic growth and development."

The APLU has three primary areas of activity:

1. to design better metrics for evaluating how institutions contribute to "innovation ecologies";
2. to develop tools institutions can use to assess and improve participation in regional economic development; and
3. to make available the capabilities of major research universities in distressed areas, rural or urban, to help maximize their potential, in partnership with government and industry.

The Akron Model

Luis M. Proenza
University of Akron

Dr. Proenza opened with a summation of the effort to optimize innovation in Akron, Ohio: "It's really about relevance, connectivity, and productivity—making do with relatively little to come to significant outcomes."

He began with a nighttime satellite photograph showing clusters of light around metropolitan areas that he said represented 87 percent of the nation's economic activity. These cluster also held 80 percent of the colleges and universities, he said, and illustrated an important feature of clustering: there were no visible boundaries between populated regions. "Often the sub-elements of clusters extend through these regions across political boundaries and into other states." He said that greater Akron

held four million people, and that northeast Ohio, counting Cleveland, represented the fifth largest market in the United States. He listed 11 industrial clusters in the region, including polymers and advanced materials, a particular local strength.

Dr. Proenza began working to strengthen the Akron economic and educational cluster around the year 2000, soon after assuming the presidency. The region faced significant challenges. First was its image as part of the Rust Belt. Then there were a local aversion to risk and a lack of investment capital. The university itself was losing enrollment and overshadowed by the state's two dominant institutions, Ohio State University and Case Western University.

Beginning with the Underutilized Assets

The university focused on what it saw as opportunities, beginning with underutilized assets and the greater flexibility of the new economic environment. Akron, like cities anywhere, could take advantage of globalization and its message that any region could compete with any other—given sufficient innovation resources.

"We began," said Dr. Proenza, "with the realization that the university was nearing its 130th birthday. It was founded as Buchtel College in 1870, in the same decade and city as four major tire companies." The college opened the first rubber chemistry program in 1909, and, along with the tire companies, developed what is today the "largest polymer program in the world."

Akron also formed its own research foundation in 2001 to build on its historical record of research. "This record is very complex and comprehensive," he said. "A university's impact on its region through its own technology and outreach is far broader than we'd recognized." The university began by looking at local knowledge assets. Many companies were downsizing and could no longer manage their technical libraries. Some of them donated their libraries to the university, which would manage them at much lower cost. They took advantage of available space to work more actively on industry research projects. The Ohio Research Foundation was developed expressly to offer university services to other institutions.

Transforming the University and the Region

More broadly, the university began to transform itself and the region in fundamental ways. It found that 7,000 of its 23,000 students were not living on campus because housing had been neglected for so long. The neighborhood around the campus had little vitality. In response, the university launched an initiative that resulted in a virtual rebuilding of the campus and improvements to a 40-block area around it. Results included 15 new buildings, 17 major additions, 36 acres of new space, 30,000 new trees and bushes, new walkways, plazas, terraces, and

gardens. It built new residence halls and broadened its efforts into a University Park Alliance that reached beyond campus into the city itself. "The goal is to make the whole area a nice place to live, learn, work, shop, and play," said Dr. Proenza. Summa Health System joined the university as a development partner, and the Knight Foundation provided critical seed money. To date, the effort has mobilized some $500 million, and confirmed results include 920 new jobs, 80 new housing units, $52 million in civic investments, and $300+ million in private investments. The University Park now includes more than 1,000 acres, and a new 30,000-seat football stadium is scheduled to be ready for the 2009-2010 season.

National Recognition

As the decade progressed, the University of Akron began receiving national recognition. In 2007, it was ranked seventh in the nation in licensing revenue among universities that do not have a medical school—and first in the nation when results were normalized to total research expenditures.[1] By the end of 2008, the university's technology and invention portfolio included more than 450 active and pending patents. The university had generated nearly 30 start-up companies and hosted 115 active industry-sponsored research projects.

In 2007, the university bought two buildings adjacent to the campus to create the Akron Innovation Campus, which now houses 17 tenants. One organizational innovation is the creation of University of Akron Research Fellows, retired or active entrepreneurs and student interns who volunteer their time helping various small firms and individuals around the university. They may participate in small-firm formation and development, advice on technologies, and facilitate networking. "This saves the community about $4 million-$5 million a year," said Dr. Proenza. "Anything they do adds value to the community."

The ARCHAngels were formed, a regional network of investors that hosts financing events and supplements other more established intermediaries. The group has presented 45 companies to investors at quarterly events since November 2005, and 22 of them have reported total follow-on funding of $36 million.

At the request of Proctor & Gamble, headquartered in Cincinnati, the university also started a series of Open Innovation Seminars. Their purpose was to promote outreach and networking among companies—to transform corporate culture from an inward-looking, isolated model to one of open innovation in which firms are receptive to the ideas of partners. Its motto is "proudly invented elsewhere."

[1]Association of University Technology Managers (AUTM), February 2009.

A Bioinnovation Institute

Another initiative, he said, is an example of "the thing that doesn't occur to you until it's obvious." That thing was named the Bioinnovation Institute, and grew out of existing local strength in polymers. "The human body," he said, "when you take away the water and the calcium, is basically polymeric stuff. So the concept of biomaterials becomes an exceptional opportunity to deepen the relationship between materials science and biomedicine. We asked the three major hospitals in Akron, as well as a regional public medical school, to join in forming this new entity. They agreed, and it was catalyzed by another grant from the Knight Foundation. This initiative is dedicated to making Akron the #1 biomaterials and orthopedic research program in the world."

Among the lessons learned during this experience, he emphasized the following:

- Assemble weak assets to create new strengths.
- Assemble "guerrilla" (volunteer) entrepreneurial talent at no cost.
- Be open to unusual partnerships (such as a university without a medical school teaming with three hospitals).
- Recognize that the university and the city must be close partners.

A Role That Is Still Evolving

He noted that the role of the university in economy development had been evolving since 1862, when the Morrill Land Grant Act specified a role for universities that taught applied agriculture and the mechanical arts. "This role is still evolving," he said, "toward a much expanded sense of relevance and connectivity for every university discipline." In the 21st century, he said, the university had become central to the knowledge-conceptual economy. It had also become a convener, developer of applications, and anchor for clusters of innovation.

He closed by endorsing five elements of a new university strategy, which he said were adapted from the Department of Commerce's report on Strengthening America's Communities:

- **Public purpose**, tied to enhancing the health of regional economies.
- **Workforce development**, fully integrated into parallel strategies at the national, state, and regional levels.
- **Interconnected communities**, with critical economic mass.
- **A competitive strategy for all regions**, and the collaborations to act on it.
- **Public-private-university partnerships**, with a system of compacts or incentives to remove barriers and promote cooperation.

The South Carolina Innovation Ecosystem

David McNamara
South Carolina Research Authority

Mr. McNamara said that South Carolina, a small and traditionally rural state, had come only recently to emphasize the importance of economic development based on innovation clusters. A beginning step was taken by the state legislature in 2002 when it funded the Endowed Chairs Act to attract high-quality academic researchers. The legislature followed this in 2003 with the Research Infrastructure Act to provide the facilities and equipment for academic research. In 2005, Mr. McNamara was hired, with a straightforward mandate: focus on the knowledge being produced by the three research universities—the University of South Carolina, the Medical University of South Carolina, and Clemson University—and build an innovation system to commercialize that knowledge.

For this purpose, the 2005 Innovation Centers Act was passed and created SC Launch,[2] under the umbrella of the South Carolina Research Authority (SCRA). SC Launch is funded not by the state but out of competitive federal contracts with mission agencies. He began to rally support for innovation clusters around each of the research universities, and to flesh out the details of his mission:

- Help create startups.
- Provide support for applied research and commercialization.
- Promote knowledge-based industries and research facilities.
- Focus SC Launch client efforts on new scientific and technological advances.
- Foster dialogue between university and industry.
- Assist the universities to increase research capabilities.

The SCRA hired Michael Porter to help produce a five-year plan for the clusters, and created another entity, the New Carolina Council on Competitiveness to focus specifically on those clusters. SC Launch focused on technology sectors that had good commercialization potential and some strength in the state—primarily advanced materials and fibers, alternative energy, automotive technology, energy and chemicals, life sciences/ biotechnology, and related information technology and software.

[2]The website is <*http://SC Launch.org*>.

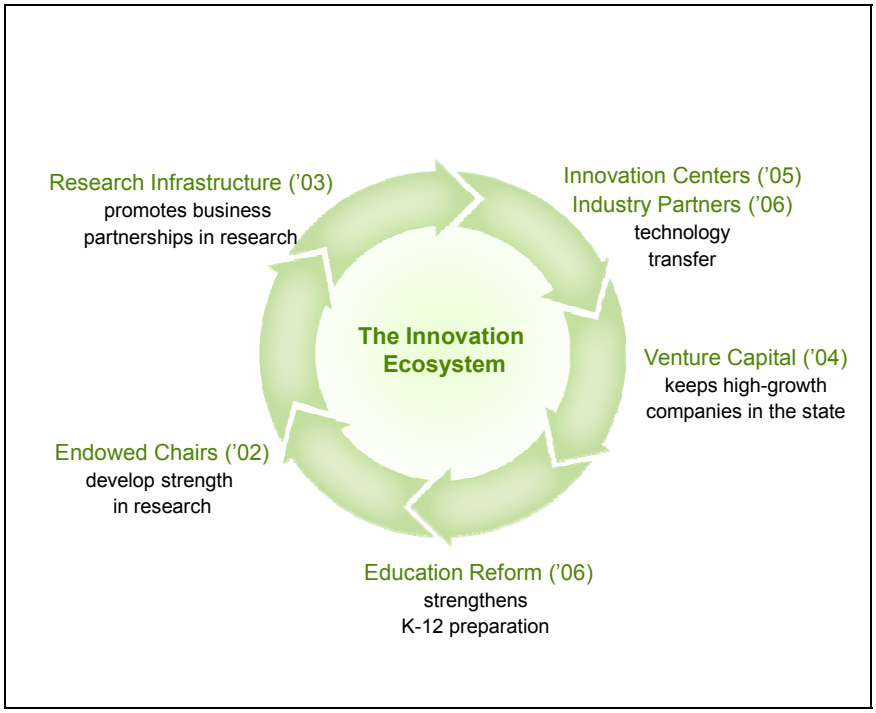


FIGURE 5 The innovation ecosystem.

SOURCE: David McNamara, Presentation at June 3, 2009, National Academies Symposium on "Growing Innovation Clusters for American Prosperity."

The group received some seed funding and began to develop criteria for firms desiring to join the program. These firms had to have:

- Their base in South Carolina, or a commitment to moving there.
- High potential to create jobs and pay attractive wages.
- Intellectual property that was protected or capable of being protected.
- Linkage to SC research universities (preferred).

Using Leverage to Start Companies

SC Launch, with a budget of only about $6 million, had helped start about 130 companies start in the last three years, he said. "We have to use a lot of leverage. We raise money donated by taxpayers, and give them a tax credit. We have to work with every other entity in the state. The good news about being small is that we can get all the legislators and economic development people we need in one room when a company wants to come to town." SC Launch offers not only seed funding, but

also up-front counseling and access to resources, including training, seminars, networking, access to investors, and coaching.

Despite the organization's youth, said Mr. McNamara, it had brought to the state about $65 million in follow-on funding secured by launch companies. "The average salary in our companies is $77,000," he said, "in a state where per capita income is between $38,000 and $50,000, depending on region." It has attracted 130 members to its Circle of Innovation, which provides resource partners who want to participate and people who can contribute. In 2008, SC Launch received a national award for "Achievement in Building Knowledge-Based Economies" from the State Science & Technology Institute (SSTI).

Of the companies helped by SC Launch, several sectors dominated. Of the 130 companies, 26 were in the engineering and chemicals sector, 27 in information technology, and 44 in life sciences, biotechnology, and biomedicine. The automotive cluster, he said, was small but successful and growing rapidly, with research facilities supported by BMW, Toyota, Timken, a motor sport center at Clemson, and a hydrogen fuel cell program. He concluded that while SC Launch was not charged explicitly with the mission of forming clusters, "they seem to be forming on their own."

California Initiatives

Ed Penhoet
Alta Partners

Dr. Penhoet noted at the outset that California, home of Silicon Valley, had had no state program to form or support innovation clusters. "They're all home grown," he said, "most of them derived from the very powerful universities."

Instead, he said, the state has inherited natural assets that originally drew people to the region, including:

- Geography.
- Climate.
- Natural resources.
- Large population (about 10 percent of the country).

These assets had been used and transformed over the years into created assets, including:

- Top universities, which had themselves been a major driver of innovation, especially in biotechnology and information technology.
- Research centers, including leading national laboratories.
- Talented people.
- An entrepreneurial culture.

- Networks of people in different sectors.
- Vibrant downtowns.

He emphasized the entrepreneurial culture of California. "Talented people live everywhere," he said, "but for innovation, you need people with the courage to start a new business, and an environment that supports this. The attitude is important. You might say that entrepreneurial people are cocky, confident that they can do it."

The Role of State Government

At the same time, he said, entrepreneurial people depend on many features and actions of state government. The state government is a partner in this process in several ways:

- Government is a major investor in human capital, from elementary to doctoral levels.
- It is the major provider of physical infrastructure, including roads, bridges, highways, ports, and local transit.
- Government often has jurisdiction or regulatory control over business activities. This control can either hamper or expedite business choices. "People worry a lot about macro issues," he said, "but often your success comes down to whether you can get a permit from the local sewage agency."
- Increasingly, government directly funds research and development.

The state government can play a central role in creating a climate for entrepreneurial activity, he said, by following some common-sense guidelines. These may include:

- **Put all the pieces together**. Make R&D investments part of a coordinated innovation strategy.
- **Make the right bets**. Each region has its own strengths, and a regional strategy should build on them. "You do have to choose winners," he affirmed. "But this is not the same as creating them. People often ask how to build a biotech industry, as though there is a secret formula. They fail to understand that what is required is the fertile ground to plant the seed." He said that Germany had tried to build a biotech industry in the former East Germany by placing a center in a region that needs economic help. "That simply doesn't work," he said. "You can't just build some facilities and bring in some people because you think an area needs economic development. There has to be a reason to think the business will thrive where you put it."
- **Innovate for the real world—globally and locally**. Research must be relevant to industry and the community. "We've witnessed a disconnect between ownership and economy activities," he said. "We talk about GM and Chrysler being American companies, but

many countries own those companies. The New York Stock Exchange is 25 percent owned by foreign entities. The issue is not so much ownership as where you actually locate economic activity."

- **Invest in collaboration**. Innovation needs partners from universities, industry, and government.
- **Listen to the smart people**. "There are hard decisions in this process, and you will need the best advice. Too many groups have tried to act in isolation."
- **Be consistent while embracing change**. Innovation needs both flexibility and sustained effort.
- **Make sure you get what you want, but be patient**. It will take time to accomplish long-term goals, but measuring short-term gains is critical to getting there.[3]

California, he noted, is by no means absent from efforts to transform knowledge into commercial products and firms. It has created a number of large innovation funds that support both partnerships and focused research. These include:

- **University of California Discovery Grants (1996)**. The state invested money in UC to be spent only on projects with private partners that have an outcome associated with that funding. The objective of the program is to support activities that are relevant to society and have a chance of creating a new business. It resembles the SBIR program in offering seed grants to move projects out of the laboratory into early-stage development. The University of California budgets about $15 million for the program, while industry has contributed about $20 million in a variety of areas, including electronics manufacturing ($13 million), digital media ($7 million), and multidisciplinary research in the three categories of energy and environment, health and wellness, and nanotechnologies ($2M).
- C**alifornia Institutes for Science and Innovation (2000)**. These four institutes were launched by Gov. Gray Davis within the UC system. The institutes, in information technology, nanotechnology and biomedicine, were distributed throughout state and have received a total state investment of $400 million, equally distributed among the four centers.[4] These have generated an additional $800 million in funds from the federal government and private sector, bringing the

[3]Adapted from the National Governors' Association, *Innovation America,* Washington, DC: National Governors' Association, 2007.

[4]These centers are (1) The California Institute for Quantitative Biosciences at UCSF, UCB and UCSC, The California Institute for Telecommunications and Information Technology, at UCSD and UCI, The California Nanosystems Institute at UCLA and UCSB, and the Center for Information Technology Research in the Interest of Society at UCB, UCD, UCM, and UCSC.

total investment to about $1.2 billion. The program has been a major driver of growth.

- **Proposition 71 (2004)**. Voters approved Prop 71 to establish the California Institute of Regenerative Medicine, which regulates and funds stem cell research. The measure was paid for by issuing $3 billion in state general obligation bonds, the first time a state has raised that much money for a specific kind of research. This was passed at a time when the federal government did not support stem cell research.
- **Climate Change Institute (Proposed, 2009)**. Funding in excess of $300 million has been proposed to initiate an R&D program.

Some Features of Propositions

Dr. Penhoet added several comments on Proposition 71. It actually had two explicit goals. One was to find cures for disease using stem cells as a therapy or tool. The second was to enhance California's competitive position as the world's leading biotech region. The funding had indeed built up the most robust stem cell program in the world, he said, attracting numerous scientists from within and outside the United States. "So it has had a positive effect."

At the same time, he noted that Proposition 71 had raised a knotty political issue. "The Proposition was good for us [in biotechnology], but bad for the state." The Proposition specified funding by general obligation bonds, effectively embedding the obligation in the state constitution. "This means that the legislature can't cut the budget," he said. "This is one of California's problems as it tries to deal with the current financial crisis. Many such things are not under the control of the legislature, so in difficult times it has limited ability to adjust the budget."

Clusters Have Few Rules

Dr. Penhoet offered a comment on cluster formation, illustrating that there are few firm rules about participation. While first-rank universities are almost always associated with successful innovation activity, he said, this is not always true; nor is it true that leading technology companies depend on cluster membership. In California, for example, the biotech industry is concentrated largely in two places, San Francisco and San Diego. Yet the largest independent biotech company, AMGEN, is located in Thousand Oaks, outside Los Angeles. This company is isolated geographically, is not associated with any university, and has not spawned a cluster of smaller startups, as Genentech and other leading firms have done. He drew no conclusion from this anomaly, other than to reiterate the lack of any formula for successful innovation.

Discussion

Mr. Samors asked the panelists to summarize the key elements needed to create productive partnerships. Dr. Proenza placed proper incentives at the top of his list. Mr. McNamara commented that different technology firms regard the language and opportunities of commercialization in different ways. For example, he said that many firms considered licensing and commercialization to be synonymous. Also, he noted that many investigators are reluctant to file their discoveries because of the time this takes away from their research. Finally, he said, some researchers had no interest in commercializing under any circumstances. "We have to win their trust and walk the floor and encourage them to file that discovery."

Dr. Muir of the University of Florida noted that many of the disclosures received by her Technology Licensing Office cross disciplines. "The collaborations are occurring," she said, "but they are occurring because they happen around a particular goal or problem to be solved."

Mr. Milbergs asked a question "about headhunting." Washington State had hired two global research leaders, in biofuels and nanophotonics, in hopes that they would attract federal funds, build partnerships, and help create emerging new industry clusters. He asked whether such recruitments have this potential. Dr. Proenza affirmed that many states had a similar "eminent scholars programs," and that most are successful. "If the person has stamina, interest, and perhaps an emerging entrepreneurial track record, the prospects for generating funding are there." Dr. Penhoet said such people are difficult to find—especially those with "good science and reasonable business skills. My own experience is that it is a recipe for disaster to hire scientists who don't understand business, or business people who don't appreciate science. You'll ride off a cliff together unless the communication skills are very good." Mr. McNamara said that he had difficulty enticing good entrepreneurs to a new program, and he was studying the use of an incentive plan offering several years of salary or income.

PANEL V

FILLING THE GAPS: THE ROLE OF FOUNDATIONS

Moderator:
Jim Turner
Association of Public and Land-Grant Universities

Mr. Turner said that the United States is unusual in the role played by foundations in economic development. "In the Rust Belt, where I come from," he said, "industrialists and even their companies may die, but they tend to leave foundations behind that support their communities. This is a powerful tradition because it's creative and it can be done through a grant process that looks at many good ideas. He praised in particular the Heinz Endowments of Pittsburgh, where he grew up. "The foundation has been a godsend," he said. "It and several other family foundations are focused on Western Pennsylvania and how to make it better. It's hard to think of Pittsburgh without them."

How Innovation Clusters Are Reviving the Economies that "Urban Renewal" Destroyed

Christina Gabriel
Bomani Howze
The Heinz Endowments

Dr. Gabriel agreed with Mr. Turner that Pittsburgh is the fortunate beneficiary of entrepreneurs who were active a century ago, and that the Heinz Endowment indeed focuses its efforts on the local region. "But the idea," she added, "is to treat the region as a living laboratory for problems that are national in scope."

She began by referring to her title, which began: "2532 Neighborhoods, 992 Cities, 1 Million People." These figures represent those who were involved in federally subsidized urban renewal projects between 1949 and 1973. "This matters to every one of us," she said, "because the legacy of those urban renewal years exists in so many of our cities. Many of these projects are now considered failures, and these failures may be located very close to our universities and other

communities where economic activity is beginning to aggregate in innovation clusters."

This symposium is considering how we can create successful innovation clusters in more places, she said. "You cannot tell the story of the nation's strongest innovation clusters without recognizing the role that federal policy and federal funding played in making these clusters possible. You have to remember that every year since World War II, Boston and Silicon Valley have had hundreds of millions of current-year dollars poured into their research universities. After 65 years, it would be shocking if those places were not centers of innovation. All the other regions trying to innovate are trying to accelerate the process so it doesn't take them all 65 years."

In the same way, she said, "you cannot tell the story of the nation's economically distressed communities without recognizing the role that federal policy and federal funding played in making this economic distress inevitable." She said that it was important to talk about these two issues "in the same breath." An innovation cluster cannot be considered apart from where it is situated in its community. A cluster can indeed lift all boats, she said, but they cannot be successful if they are isolated.

The Urban Renewal Movement

She said that the urban renewal movement, which began just after World War II, was partly responsible for the shape of many urban communities today.[1] A popular idea was that cities were declining because buildings were aging and street grid patterns were out of date. One solution proposed was to make the cities more attractive by removing aging housing stock and replacing it with malls, parking lots, and other modern structures. At that time, she said, the well-meaning foundations in Pittsburgh were "doing what you would hope foundations would do—taking the lead." Richard King Mellon, head of the largest foundation in Pittsburgh, was involved, as was Mayor David Lawrence and the Allegheny Conference on Community Development.

"The foundations started very proudly," she said, "grabbing this issue of urban renewal before anyone else in the country. We took our smoky city and turned the area where the Allegheny and Monongahela Rivers come together into the Golden Triangle, a major success story. Because of this success, we felt we could do other things. So across the river, in Allegheny City, which is now called the North Side of Pittsburgh, hundreds of city blocks were bulldozed, including what were a beautiful park and vibrant weekend market. In their place is an empty

[1]For an examination of urban renewal, see: Mindy Thompson Fullilove, *Root Shock: How Tearing Up City Neighborhoods Hurts America, and What We Can Do About It,* New York: Ballantine Books, 2005.

neighborhood. The street grid was cut off by a huge suburban-style Allegheny Center Mall, which we all now recognize was a mistake."

She referred also to a section of the city called East Liberty, which in 1928 was a vibrant economic zone. By 1970 it, too, was reshaped to resemble a shopping mall. Now the foundations have joined to remove some of the replacement structures and fund a community plan to resuscitate the neighborhood.

Reaching out to the Hill District

The third of the failed Pittsburgh projects she mentioned was the Hill District, playwright August Wilson's neighborhood, between downtown and the University of Pittsburgh. The old street grid was severed, cutting it off from the downtown business district, and some 100 city blocks were removed to make room for what is now a large parking lot and a domed arena. It has virtually none of the amenities one expects in a vibrant neighborhood, such as bars and clubs, coffee shops, restaurants, lodging, banks and ATMs, gas stations, grocery stores pharmacies, and hospitals. These amenities are found instead in the areas surrounding the Hill District, such as the Strip District along the river below the hill and the South Side on the far bank of the river. Indeed, it is in these areas where new innovation clusters are springing up: robotics companies in the Strip District, software companies on the South Side, gaming companies just to the east of the software firms, arts companies in Lawrenceville just north of the Hill, and biotech and InfoTech firms just southeast of the hill and next to the universities.

Connecting the Hill to High-tech Clusters

Accordingly, The Heinz Endowments and other foundations have joined with community organizations to integrate the Hill District with these adjacent zones within the state-funded Pittsburgh Central Keystone Innovation Zone. This "PC-KIZ" features "direct and deliberate bridges" to connect the Hill to the surrounding high-tech clusters. One pilot project under development focuses on a 1929 building originally designed as a trade school for the Pittsburgh Public Schools. Its classrooms, high-bay shops and labs are being converted to support a holistic program for education and training along the entire K-12 and adult workforce pipeline with a focus on green jobs at all levels. The collaboration intends to connect the community to a new magnet high school, a university biofuels research and testing lab, a green building operating engineers training program, and a greentech-focused business incubator. In short, these neighborhoods can now become centers of true urban renewal if grassroots community participation is integral to the design.

The Improvisational Quality of Clusters

Bomani Howze, also with the Heinz Endowments, noted that promoting a Hill District connection to the innovation economy could only begin by understanding the neighborhoods and learning how to optimize the impact of funding on neighborhoods. Likening the process of innovation to jazz, he suggested that renewing neighborhoods, too, can have a "free-flowing improvisational quality." There can also be, he said, "organic freedom in the culture of a neighborhood that would lend itself to the innovation processes seen in technology centers—which in many cases are just down the road."

He said that today there are many development projects moving into the open spaces created by bulldozers decades earlier. "The real issue is how this can connect to community small-business development initiatives," he said. The PC-KIZ, a state program, is an example of how philanthropic dollars can be complemented by other monies to attract private interest. "We hope that it will be industry-led," he said, "so people will be trained for jobs that will come."

The objective is to attract small businesses of all kinds to the area. One hurdle is that shops and restaurants are absent, so the PC-KIZ is trying to encourage those amenities to move in, bringing the technology clusters closer together and helping revive the neighborhoods.

Dr. Gabriel concluded with a recommendation for the federal government. She recalled working in the Technology Reinvestment Project during Clinton Administration, and said that six agencies were able to work together out of the same general fund and still be effective and quick at making joint funding decisions. In that case, the objective was to find ways to support dual-use technologies. She said the lessons learned in that exercise could directly assist the multiple federal agencies that want to integrate cluster formation with community issues, such as those being addressed in Pittsburgh.

Building the Workforce and the Universities

George W. Bo-Linn
Gordon and Betty Moore Foundation

Dr. Bo-Linn began by describing some unique roles played by foundations. First, they can identify "possible pockets of innovation and inflection points. We are not encumbered by an existing bureaucracy. In many cases the founders are businessmen and entrepreneurs who have long personal experience in finding and supporting those pockets of innovation and inflection points."

Second, he said, foundations are able to provide seed money outside the traditional funding process. This differs from the venture capital

approach in that foundations can take longer to examine a project, pursue a deeper due diligence examination, and support more capacity building. With its flexibility and stature, a foundation can take risks, act quickly, and catalyze consensus. He noted that the tradition of philanthropy was being enriched by "a whole array of Silicon Valley entrepreneurs who have been enormously successful, and who are putting their money into foundations. The difference is that the living founders play a key role in their foundations. They want to know that something's happening, that innovation is occurring."

Third, the stability, resources, and freedom from political pressures allow a foundation to stay with a project for the long run. Gordon Moore, he said, believes that for large, important problems, it may take a decade to have measurable success. Hence the Moore Foundation takes deep due diligence in assessing opportunities and will commit resources for multiple years. "He feels that if you want to see change, then you have to commit to it."

A Profile of the Foundation

The founding agenda of the foundation was to "make a positive impact on the world for generations to come." The Gordon and Betty Moore Foundation, founded in 2000, is already the 10th largest foundation in the United States and has provided grants of almost $2 billion. Its primary program areas are environmental conservation, science (mostly U.S. science, especially at California Institute of Technology), and the San Francisco Bay Area program. A notable ongoing commitment is the foundation's role in funding the new Thirty-Meter Telescope on Hawaii's Mauna Kea which, when completed, will be the world's largest optical telescope.

Program areas, he said, are organized around large-scale initiatives with high potential for success. He likened these initiatives to business decisions. "We need to have a strong case," he said. "Tell us why it's going to work, how much it's going to cost, what the measurable outcomes are." He said that measurable outcomes are a "defining quality" of the Moore Foundation, because of its objective to have "enduring impact. We try to leverage each program as much as we can—ideally, we try to contribute about 25 percent to 35 percent. If we can't find collaborators to come in with us, we tend to think it isn't time for that project to more forward."

A Focus on California

From 2000 to 2009, 58 percent of the foundation's awards went to recipients in California ($810 million, in 938 grants) and 42 percent outside California ($981 million, in 677 grants). Among grants to California, organizations were $291 million to the "San Francisco Bay Area," which for the Moore Foundation extends from Santa Cruz to

Sacramento. The majority of the California money—57 percent—was spent on science. Grants in California went mostly to the UC system, with 56 percent going to Caltech and 39 percent to the UC state system.

A special focus on science spending is the Marine Microbiology Initiative, which is helping a young field to grow. Gordon Moore believes that science should be able to move as quickly as possible from basic research into application, where application is appropriate."

The foundation also funds new ways to publish scientific knowledge quickly, as shown by PLOS, the Public Library of Science. "We believe that dissemination is key," he said, "so PLOS was in large part catalyzed by Moore. We also work with Google Earth to document what forests are being preserved, what ice caps are melting, what are the effects of drought and other climate change. We can't know that without instrumentation, and Moore has a particular interest in that."

Another theme of the foundation is to support scientific discovery before its application. "We seek the best scientists to do the best type of science," he said. "We don't know what is going to have applications in advance, but the best science inevitably has application."

A Commitment to Nursing

Another major commitment of the foundation, the San Francisco Bay Area Program, contains several activities, two of which support nursing: the Betty Irene Moore Nursing Initiative and the Betty Irene Moore School of Nursing. The primary theme is workforce development, which is shaped by the foundation's conviction that more and better nursing education and training are essential to keeping the quality of health care high and the costs low. U.S. health care accounts for about 16 percent of GDP, said Dr. Bo-Linn, and 45 percent of all private-sector jobs added in 2007. "It's the economic engine right now. Hospitals support 1 of 10 U.S. jobs. In 2006, with "ripple effects" included, hospitals supported almost 14 million jobs and almost $2 trillion in economic activity. Hospitals are the largest employers in most communities."

"What's the driver of health care?" he asked. "Hospitals," he answered. "What's the driver of hospitals? Nurses. And here we face a problem." He said that the shortage of well-trained nurses is "enormous," and consequently the foundation has developed partnerships with over 71 institutions, investing in universities and directly supporting the development of nurses and nurse educators. When the foundation concluded that there were not enough nursing faculty in California and nationally, it allocated $100 million to create a new nursing school at UC Davis. To date, he said, the foundation had directly supported more than 1,100 individuals to become frontline RNs and nursing educators.

He said that high-quality health care saves money and lowers health-care costs, offering several examples. One was that some 80 percent of

the Moore Foundation grantee hospitals had reduced hospital-acquired complications, he said, including

- 66 percent fewer central-line bloodstream infections, saving $25,000 per avoided case.
- 60 percent fewer ventilator-acquired pneumonias, saving $12,000 per avoided case.

He also said that grantee hospitals were working to reduce hospital readmission rates.

Another program area of the San Francisco Bay Area focus is science education, which is "investing in the future," he said. The foundation sustains ongoing support for informal science education, increased professional development for teachers, enhanced classroom teaching of students, and development of more competent teachers. The Foundation also supports the science and technology museums of the San Francisco Bay Area and other science rich educational institutions.

In closing, he noted with satisfaction that the Moore foundation was created in perpetuity. "So we'll be around to see fruits of our labor."

Discussion

Dan Berglund of the State Science and Technology Institute (SSTI) asked two questions: whether the locally oriented foundations, such as Heinz in Pittsburgh and Danforth in St. Louis, had a mechanism for collaboration with one another, and whether the large national foundations had begun to support entrepreneurship. Dr. Gabriel, speaking for Heinz, said that the foundations did talk to each other, for example through the Council on Foundations and various affinity groups that meet regularly. She said that Heinz also worked as closely as possible with the state, and is studying how to make a bigger difference nationally. "We'll never have as much money as the federal government," she said, "but we can be more flexible, and a little flexible money can often make a big system work better." On the second question, she said that the world of foundations was undergoing a "sea change" as the newly rich become philanthropists. "There is a lot of social entrepreneurship," she said. "There's a huge backlog in 501(c)3 applications.[2] Everyone wants to start a new social enterprise, and there's so much foundation money out there. Innovators in the field of philanthropy are asking how we can push the envelope in order to do the things that are most needed to address problems that have been intractable for a long time."

[2]501(c) is a provision of the United States Internal Revenue Code that lists non-profit organizations exempt from some federal income taxes.

"Giving While Living"

Dr. Bo-Linn agreed with Dr. Gabriel about the "huge amount of money made recently by entrepreneurs," many of whom are "giving while living." The Gates foundation, he said, will self-terminate 50 years after the death of the founders. He saw a move to areas of social responsibility, measurability, and transparency. "These problems are so huge," he said, "that it requires working with private industry and government to affect policy. Foundations cannot influence either pending or actual legislation, but we can educate, convene consensus, and catalyze movement."

Dr. Wessner asked whether the Moore Foundation had tried to broaden its commitment to hospitals by attracting more matching grants from state or federal governments. Dr. Bo-Linn said they have not gone to the governments for such in-kind matches, for various reasons, but that they do collaborate with other foundations, private industry, and the grantee itself. "There is a consortium of grant-making bodies," he said, "who work often with each other."

Helping Spend Recovery Money Well

Dr. Wessner asked what other needs were most pressing to the foundation representatives. Dr. Gabriel said that with the sudden spending triggered by the Recovery Act, many recipients needed help to determine the best way to spend new money. For example, she said the Pennsylvania Workforce Investment Board had asked Heinz for assistance. "They told us they were graded on how fast they spent the funds, but they couldn't spend it on staff and they didn't want to just shovel it out the door to the usual suspects. People who are not already in the system and don't already know how to navigate it are going to lose." Heinz was able to fund a person who was well acquainted with the right community organizations and had experience with workforce investment who was able to help the board seek out and secure a more diverse pool of providers. "This is a once-in-a-lifetime opportunity," she said. "We have to make sure it lifts all boats and doesn't further polarize us."

Mr. Turner asked how organizations like the Moore Foundation, which often reflect the efficiency and leanness of the high-quality organizations that generated their endowment, were able to choose grantees that were equally efficient. Dr. Bo-Linn said that a large part of capacity building is finding the right people. The Moore Foundation had discovered that the people who work in NGOs do so by choice and bring to their mission real passion. At the same time, he said, it was not always possible to measure all the activities of grantees by Six Sigma standards.[3] "The engagement in broad social enterprise, distressingly, may be more

[3]Six Sigma is a certification program improving measurable results in organizations. <*http://www.6sigma.us/*>.

like jazz," he said. "We often innovate as we go, trying to stay engaged, to stay together, rather than get that melody out as efficiently as possible and demanding that you do it in half the time you did in the first cycle."

ROUNDTABLE: KEY ISSUES AND NEXT STEPS FORWARD

Moderator:
Charles Wessner
The National Academies

Luis M. Proenza, University of Akron
William P. Kittredge, Economic Development Administration, Department of Commerce
Jim Turner, Association of Public and Land-Grant Universities
R. Lee Cheatham, Washington Technology Center

Dr. Wessner said he would like to encourage an open dialogue to close the symposium. He asked Dr. Proenza to begin by describing some overarching themes on the topic of innovation clusters. Dr. Proenza said that even though it is not possible to duplicate Silicon Valley, some clusters shared common elements that could provide helpful models for others. He said that his discussion of Akron had focused largely on "connectivity and relevance," and on building on particular strengths of the region. He suggested that "when you have a $50 billion industry in your state and you add five percent to its value, that's a much larger incremental benefit than you're likely to get by creating a new industry that you hope will some day do something magical." This did not mean that regions should neglect new firm formation, he said, but that existing strengths of industry and the community were the places to begin.

He also added a point to the earlier discussion about collaboration among foundations. He had seen foundations in many regions join together to form a "fund of funds." In northeast Ohio, he said, some major foundations had joined with about 60 smaller foundations to generate an annual asset of about $30 million to enhance the vitality of a region and ensure that key segments of the community are not left behind. He encouraged more foundations to examine similar opportunities for partnership.

Ideas for the Developing World

Joshua Mandel of the World Bank said he had attended the symposium to listen for innovation ideas that could be relevant for the developing world. He asked the panelists whether they would suggest any strategies for sub-Saharan Africa, Asia, or Latin America, all of which have little human resource capacity but a yearning for innovation and R&D as drivers of economic growth. Dr. Kittredge replied that "innovation is one of those slippery terms." He said that Americans tend to measure it in terms of patents and other advanced markers. "But Fed Ex doesn't have any patents," he said. "I think that for developing countries, you want to be looking at the local competitive advantage. What does a region have intrinsically that can be developed, and how can it be extrapolated to create wealth? We have found a broad range of techniques that don't require fancy stuff to drive this forward." Dr. Proenza agreed that there are "a lot of things happening in developing countries that are better integrated at the national, state, and local levels into comprehensive strategies. We have done very poor job in this country at integrating federal and state agendas."

Dr. Gabriel of the Heinz Endowments followed up on the World Bank question. She noted that the strategy in Pittsburgh was to "create deliberate bridges between the communities and the innovation centers. It's the same for the World Bank: If you have the right people on the ground who are trusted by the community, programs can work."

The World Bank Development Model

Dr. Wessner commented that the basic World Bank development model had not been as successful as anticipated in some countries, notably in Asia, where some countries had ignored most Bank advice while achieving rapid economic success. He said that in some countries of Eastern Europe, the Bank is playing a more catalytic role, bringing best practices to bear, as the Inter-American Development Bank is doing in Latin America. He suggested that the Bank might profitably follow the innovation concept used in the SBIR and TIP approaches, where the innovation comes bottom-up from small companies rather than specified through programs organized in Washington. He added that bottom-up partnership policies had had a direct impact on Finland, Sweden, the Netherlands, Taiwan, Korea, and India.

Mr. McNamara agreed, but suggested another angle. "The question is how third-world countries can benefit from the knowledge economy sector. I suggest that the entrepreneurs there could take advantage of the entrepreneurs there, and vice-versa, whether they are working in alternative energy, biofuels, or pharmaceuticals," he said. "Bring them along with us. I would say that connecting entrepreneurs can do more good than any policy."

"Throwing Money at Planning Grants Doesn't Work"

A participant asked another question of Mr. Mandel of the World Bank. He said he had worked with the United Nations in Ghana and Senegal for the past five years, trying to evaluate the potential benefits of science parks in Accra and Dakar. A small amount of money was available for planning, but when the funds were exhausted, there was no local matching money or commitment to sustain the project. "When you fly in experts, hit the ground, and then leave, you need to turn it over to people living there and working on a full-time basis. Throwing money at planning grants does not work."

Lee Cheatham of the Washington Technology Center followed up on Mr. McNamara's comment about inviting more people to the conversation. He said that Washington State holds an Innovation Summit each year, which in 2008 included a group from central Africa. While the group at first seemed to want only to visit, their interest had grown so rapidly that at this year's Summit a whole day will be set aside for conversation with them. "We should not underestimate," he said, "how little things like that might get things started and lead to initiatives we've been describing."

Dan Berglund of SSTI asked how the $50 million planned for a national network of incubators would be spent. He said that he had heard from many people who thought that money should go not to physical infrastructure but to operating capital. He also asked whether the $100 million for the EDA budget could get through Congress, given that the amount would be coming out of an existing pool of money for which there was already a built-in constituency.

Small Amounts for a Large Impact

Dr. Kittredge of EDA said that the questions had not been resolved, although he said he saw the two programs as conceptually integrated. The fate of the $50 million program, he said, would depend heavily on which EDA program it is appropriated to. If it was appropriated to the public works program, it would be limited to infrastructure projects. If it was appropriated to the economic adjustment assistance program, it could be used for infrastructure, planning, feasibility studies, or revolving loan funds. With respect to the $100 million program, he said, his office regarded it as part of the overall EDA program. Dr. Wessner added that the country does need spending for infrastructure. "And our work," he said, "suggests that relatively small amounts of federal funding have a very large catalytic impact."

Dr. Kittredge continued that the major theme he had heard during the symposium was "government, innovate thyself." Opportunities for innovation, he said, included coordinating among government programs, implementing collaborations with local innovators, and learning how to

sustain those collaborations beyond changes of political administrations. More broadly, he said, economic development measures have to go beyond dollars spent or jobs created. They need to consider whether the measures are producing "places we want to live and the quality of life we expect."

Mr. Turner said his lesson for the day was that "all money is not created equal." Traditionally, he said, in federal research grants, the bias against picking winners and losers has been so strong that securing matching funds has been viewed as stretching federal funds and regarded as a success regardless of where the money came from or how it is spent. When a local program receives money from the state, by contrast, the purpose is local economic development and it needs to "pick a winner with that money" if it expects additional support and needs to solicit and invest matching funds accordingly. Measures of success should include not just total dollars gained for a project, but should also include metrics on how those dollars are matched and spent to achieve actual community goals.

Leadership from the Local Community

Dr. Cheatham said that Washington State was still working on the best strategy to shape federal-state partnerships, but that experience had shown the value of a local lead partner. "If we liken federal programs to the anchor tenants, we might say that SBIR and TIP are the Nordstrom and Macy's of our mall. But we don't ask Nordstrom or Macy's to run the mall. We put in people from the local communities to do that. The innovation-based economic organizations and local organizations are the places where that coordination can happen. This helps federal programs remain true and accurate to what they need to provide, and allows local color to work its way in for just a small investment. What we'll see is something like a one-stop shop, but different depending on where you stop, and it must be different."

He also said that in Washington and the Pacific Northwest generally, innovation does come from large national labs and universities, but it also comes from groups that had not been adequately discussed at the symposium—nonprofit research institutes. In the state of Washington, he said, only two of the largest five or six research institutions are universities; one is a national lab, and the rest are nonprofits. "We heard this morning that clusters require three things: collaboration, workforce, and innovation. Let's take the first one, collaboration, to heart, and design mechanisms to include everybody in this."

Dr. Proenza recalled the statement that some 250 federal programs dealt with the broad arena of cluster development. He urged the Small Business Administration to help advance a framework that allowed all those programs to collaborate and leverage each other's resources for both better deployment and better decision making. He offered the

second point that in some parts of the country, programs were "not really focusing on productivity." Instead, he said, they were creating ever-more facilitating agencies. "Often we have more of these agencies than we have things that need to be facilitated. This is a real danger. We can do most of what we've been doing with literally one funded position."

Changing the Federal Culture?

Dr. Wessner said that he had been troubled by the unstated assumption that "we're going to rationalize the federal government, or somehow change its culture. For those who hope to do this," he said, "I wish them well and I hope they're very young. There might be more success in efforts to coordinate programs with influential folks in the White House, which might lead to those synergies and economies we've discussed. Another path that could prove productive is to follow the private sector's example in rewarding excellence, which the federal and state governments are reluctant to do."

A questioner asked how closely correlated was the locations of federal facilities or long-established universities with clusters of innovation. Dr. Kittredge said that the presence of an established facility could often be key. He cited one recent example from Fargo, North Dakota, where North Dakota State University had recognized its competitive advantage in the high number of students graduating from the engineering school. It called together the other major university in the state, the University of North Dakota, along with the EDA, state and county governments, entrepreneurs, and people from the community. Together they formed a technology park adjacent to the campus. This was termed an "overnight miracle," which five years later is indeed producing innovation clusters. "This is not a traditional place, or a Silicon Valley," he said. "It started with existing assets, brought everyone together, and came out of ideas on how a local competitive advantage might be exploited."

Importance of Rewarding Behavior

Dr. Cheatham followed up with the example of Warsaw, Indiana, a town where some 2,000 small companies produce about 80 percent of the nation's orthopedic hip and joint parts. He added to the point made by Dr. Wessner about rewarding excellence. The cluster analysis done by his organization, he said, had shown that it was indeed important to reward behavior. "This is so much of what drives outcomes," he said. "The reason Silicon Valley, Boston, and San Diego have excelled is that organizational and cultural changes have emerged within their communities. Without change, collaboration is just a word. You have to align and incentivize the motivations of various groups. They come to

the table for many different reasons, and you have to reward the desired behavior appropriately. When you do that you can build a critical mass."

Mr. Turner returned to the debate about whether the behavior of the federal government could be changed. He said that those who worked for the Obama campaign and transition teams were optimistic that it could, and recommended that STEP revisit the issue of innovation clusters after the leadership appointments process had been completed and new officials had had time to implement new policies.

Some Common Themes

Dr. Wessner closed with several remarks. He began by thanking the group for bringing out common themes, "especially President Proenza's notes on continuity, relevance, and finding strength in local communities. One thing I like about this country," he affirmed, "is that we tend to think a problem is our problem and we have to do something about it. In some other countries, there is a habit of calling a problem the central government's problem and expecting it to be fixed immediately." That said, he added, the U.S. government sometimes "abandons communities to their own fate." In this regard, he suggested several ideas. First, states can be regarded as "laboratories," which is "something we at the Academies want to understand so we can learn from each of them." He also said it was important to learn from abroad, where there are some very good innovation models. "Other countries are helping to shape the world we're living in," he said. "Too often we hear economists discussing what you *should* do in the world, rather than what the world is actually doing."

One lesson that had emerged from the symposium, he said, was the value of closer connections with local organizations. "By looking at what local organizations are doing," he said, "we can find out how to help them. Small amounts of federal aid can have a disproportionate impact on state and local ecosystems." He said the same was true for the impact of foundations, which "need to think hard at this time about where they can put even more significant funds."

He reviewed comments about the federal government's primary mechanism to promote innovation and commercialization, the SBIR and TIP awards. "Our empirical analysis shows that these awards act as glue grants," he said. "And to a greater extent than we knew, the companies are working with universities as they evolve. We learned this through evaluation, which does help. It's been a recurring theme here today, and it's very encouraging to hear such a positive discussion about the importance of metrics. It's like taking pictures of your children as they grow. We tend to forget what they looked like unless we take snapshots."

He concluded by reminding the audience how much material on innovation clusters is still to be discussed, and promised an effort to

revisit the issue. Already planned for the near future were meetings on early-stage finance, renewable energy, and international programs. “We have much to learn from others,” he said, “and major opportunities to cooperate on how to capitalize on science and technology.”

III
APPENDIXES

A

AGENDA

GROWING INNOVATION CLUSTERS FOR AMERICAN PROSPERITY

Organized in Cooperation with the Center for American Progress

3 June 2009
Lecture Room
National Academy of Science
2100 C Street, NW, Washington, DC

8:45 AM	**Welcome** *Charles Wessner, The National Academies*
8:50 AM	**Opening Remarks** *Susan Crawford, National Economic Council, The White House*
9:00 AM	**Keynote Address: The Role of Research Universities in the Formation of Regional Innovation Clusters: The Impact of Arizona State Universityon Metropolitan Phoenix** *Michael Crow, Arizona State University*
9:20 AM	**Panel I: Why Clusters Matter: Innovation Clusters and Economic Growth** *Moderator: William P. Kittredge, Economic Development Administration, Department of Commerce*

Cluster Development: A Path to Growth
Maryann Feldman, University of North Carolina

Stimulating Regional Economies
Andrew Reamer, The Brookings Institution

10:00 AM **Coffee Break**

10:15 AM **Panel II: Regional Innovation Clusters: The Obama Administration's Innovation Initiative**
Moderator: Jean Toal Eisen, Department of Commerce

The Geography of Innovation: The Federal Government and the Growth of Regional Innovation Clusters
Jonathan Sallet, Glover Park Group

New York's Nano Initiative
Pradeep Haldar, Energy and Environmental Technology Applications Center (E2TAC), Albany, New York

The Technology Innovation Program: Connecting the Dots
Marc G. Stanley, National Institute of Standards and Technology

11:15 AM **Coffee Break**

11:30 AM **Panel III: State and Regional Initiatives**
Moderator: Ed Paisley, Center for American Progress

Clusters Growing in Pennsylvania
Rebecca Bagley, Pennsylvania Department of Community and Economic Development

Building and Branding Clusters: Lessons from Kansas and Philadelphia
Richard Bendis, Innovation America

Virginia Industry Cluster Analysis
John Mathieson, SRI International

The Washington State Innovation Economy
Egils Milbergs, Washington Economic Development Commission

12:45 PM **Lunch**

1:45 PM **Luncheon Address**
Karen Mills, Small Business Administration

2:00 PM **Panel IV: The University Connection**
Moderator: Robert Samors, Association of Public and Land-Grant Universities

The Akron Model
Luis M. Proenza, The University of Akron

The South Carolina Innovation Ecosystem
David McNamara, South Carolina Research Authority

California Initiatives
Ed Penhoet, Alta Partners

3:00 PM **Coffee Break**

3:15 PM **Panel V: Filling the Gaps: The Role of Foundations**

Moderator: Jim Turner, Association of Public and Land-Grant Universities

How Innovation Clusters Are Reviving the Economies that "Urban Renewal" Destroyed

Christina Gabriel and Bomani Howze, The Heinz Endowments

Building the Workforce and the Universities

George W. Bo-Linn, Gordon and Betty Moore Foundation

4:00 PM **Roundtable: Key Issues and Next Steps Forward**

Moderator: Charles Wessner, The National Academies

Luis M. Proenza, The University of Akron

William P. Kittredge, Economic Development Administration, Department of Commerce

Jim Turner, Association of Public and Land-Grant Universities

R. Lee Cheatham, Washington Technology Center

5:00 PM **Adjourn**

B

BIOGRAPHIES OF SPEAKERS*

REBECCA BAGLEY

Rebecca Bagley is deputy secretary for the Technology Investment Office of the Pennsylvania Department of Community and Economic Development (DCED). Rebecca oversees operations of the Technology Investment Office which serves as a catalyst for growth and competitiveness for Pennsylvania companies and universities through technology-based economic development (TBED) initiatives including funding, partnerships, and support services. Major programs administered by the office include: Keystone Innovation Zones; the Ben Franklin Technology Development Authority (BFTDA) including the Ben Franklin Technology Partners; the Tobacco Settlement Investment Board; Life Science Greenhouses; Venture Capital Investment Program; Industrial Resource Centers; and additional targeted technology investments. Rebecca managed for DCED, the $650 million Energy Independence Strategy that was signed into law in July 2008. As deputy secretary, Rebecca manages approximately $79 million in appropriations and more than $1.7 billion in investments.

RICHARD BENDIS

Mr. Bendis has distinguished himself as a successful entrepreneur, corporate executive, venture capitalist, investment banker, innovation and technology-based economic development leader, international speaker and consultant in the technology and healthcare industries.

He currently serves as the founding president and CEO of Innovation America (IA), a national 501(c)3 not for profit, private/public partnership focused on accelerating the growth of the entrepreneurial innovation economy in America.

Mr. Bendis has been engaged and appointed to selected national innovation related organizations and committees that include the White House U.S. Innovation Partnership (USIP) Advisory Task Force and Co-Chair of the Small Business Innovation Research Committee), the National Governor's Association (NGA) Science and Technology Council of the State's Executive Committee, the State Federal Technology Task Force, the National Academies (NAS) committee on

*As of June 2009. Appendix includes bios distributed at the symposium.

"Competing in the 21st Century: Best Practices in State and Regional Innovation Initiatives"; National Academies National Research Council Review of "an Assessment of the SBIR Program; National Institute of Standards and Technology Manufacturing Extension Partnership (MEP) National Advisory Board; U.S. Small Business Administration's Angel Capital Electronic Network (ACENET) Board of Directors; American Academy for the Advancement of Science (AAAS) Nominating Committee and the American Association Research Competitiveness Program Advisory Committee; Council on Competitiveness—Clusters of Innovation Committee.

Mr. Bendis has also served as a board member and representative to the following organizations: National Association of State Venture Funds (NASVF) Founding Board member and Executive Committee member; American Society of Mechanical Engineers (ASME) Strategic Innovations and Initiatives Committee; State Science and Technology Institute (SSTI) Founding Board member and Executive Committee member; Eisenhower Fellowships Nominating Committee and the Ernst and Young Entrepreneurial Institute as national/regional Judge.

Mr. Bendis has or continues to provide global consulting services to several international organizations including the International Science Parks and Innovation Expert Group, the United Nations, NATO, UK Trade and Industry, European Commission, French Embassy, the German Marshall Fund, and others global ventures.

Mr. Bendis founded the Bendis Investment Group LLC, (BIG), a financial intermediary and consulting firm which has a joint venture with the Fortress Investment Group (NYSE, FIG) and is responsible for the origination of debt and equity investments located in BIG's Network. Mr. Bendis, also recently provided interim CEO consulting services to the National Association of Seed and Venture Funds (NASVF) and strategic growth and repositioning services to the Pennsylvania Biotechnology Center.

Previously, Mr. Bendis served as president, and CEO of True Product ID, Inc.; a global publicly traded anti-counterfeiting technology company (NASDAQ, TPID), which he relocated to Beijing, China. Mr. Bendis also founded and served as the founding president and CEO of Innovation Philadelphia (IP), a three-state regional public/private partnership dedicated to growing the wealth and workforce of the Greater Philadelphia Region. IP managed a portfolio of programs in four distinct areas: Direct Equity Investment/Financing Assistance; Technology Commercialization; Global/Regional Economic and Workforce Development; and Market Research and Branding. Mr. Bendis is on the IP Board of Directors.

Previously, Mr. Bendis successfully leveraged a career in the private sector (with Quaker Oats, Polaroid, Texas Instruments, Marion Laboratories, and Kimberly Services) and the venture capital industry (RAB Ventures) to lead the Kansas Technology Enterprise Corporation

(KTEC). As its president and CEO, he developed KTEC into a globally recognized model for technology-based economic development. Mr. Bendis also successfully built an Inc. 500 healthcare software company, Continental Healthcare Systems, Inc., which he took public on NASDAQ and later sold to an international conglomerate. In addition, Mr. Bendis manages his own angel investment fund.

Mr. Bendis is a frequent consultant and speaker to the United Nations, NATO, the European Commission, METI, AKEA, National and International technology-based economic development organizations, as well as over 20 states, several U.S. cities and regions and 16 countries. Mr. Bendis serves on several regional and national not-for-profit boards and committees including the National Association of Seed and Venture Funds (NASVF) and the State Science and Technology Institute (SSTI), both of which he was a founding Board member. He was a nominee for the 2005 Ernst and Young National Entrepreneur Supporter of the Year Award (EOY) and was the 1996 recipient of the Regional Ernst and Young Entrepreneur of the Year Award; he currently serves as an EOY Judge. He also serves on the board of FlagshipPDG (NASDAQ, PDGE).

GEORGE BO-LINN

George W. Bo-Linn, MD, is the chief program officer for the Foundation's San Francisco Bay Area Program, which includes the Betty Irene Moore Nursing Initiative, the Betty Irene Moore School of Nursing at UC Davis Commitment, and areas of focus including Science and Technology Museums and Land Protection.

George comes to the Foundation with over 25 years of extensive executive leadership and expertise in the field of healthcare including medical research, private practice, health insurance plans, nursing and physician organizations, and health/hospital systems. Most recently George was the senior vice president and chief medical officer at Catholic Healthcare West, the largest non-profit hospital system in the western United States. His responsibilities included all aspects of clinical quality, patient safety and satisfaction, risk management, resource utilization management, clinical information systems (including privacy and security), and healthcare professionals (physicians, nurses, pharmacists, and others). He is the author of numerous scientific publications, lectures extensively nationally and internationally and serves on several boards of national healthcare organizations.

George holds a B.A. from Rice University, and an M.D. from Baylor College of Medicine. His residency in internal medicine was at the Johns Hopkins Hospital, gastroenterology, and he had a subspecialty fellowship at the University of Texas, post-fellowship training at the Johann-Wolfgang-Goethe University in Germany, and received his Masters of Healthcare Administration at the Carlson School of Business, University of Minnesota.

SUSAN CRAWFORD

Susan Crawford is a special assistant to the president for Science, Technology, and Innovation Policy and a member of the National Economic Council. She is on leave from the University of Michigan Law School where she teaches cyberlaw and telecommunications law. Ms. Crawford was a member of the ICANN Board from 2005-2008, and is the founder of OneWebDay. She was formerly a partner at Wilmer, Cutler & Pickering (now WilmerHale).

MICHAEL CROW

Michael Crow became the sixteenth president of Arizona State University in 2002. He is guiding the transformation of ASU into one of the nation's leading public metropolitan research universities, an institution combining academic excellence, inclusiveness to a broad demographic, and maximum societal impact. During his tenure ASU has established major interdisciplinary research initiatives such as the Biodesign Institute, the Global Institute of Sustainability (GIOS), and more than a dozen new interdisciplinary schools, and witnessed an unprecedented research infrastructure expansion and doubling of research expenditures.

He was previously executive vice provost of Columbia University, where he oversaw Columbia's research enterprise and technology transfer operations. A fellow of the National Academy of Public Administration and member of the Council on Foreign Relations, he is the author of books and articles analyzing research organizations and science and technology policy. Crow received his Ph.D. in Public Administration (Science and Technology Policy) from the Maxwell School of Citizenship and Public Affairs, Syracuse University, in 1985.

MARYANN FELDMAN

Maryann Feldman is the S.K. Heninger Distinguished Chair in Public Policy at the University of North Carolina, Chapel Hill.

Her research and teaching interests focus on the areas of innovation, the commercialization of academic research, and the factors that promote technological change and economic growth. A large part of Dr. Feldman's work concerns the geography of innovation—investigating the reasons why innovation clusters spatially and the mechanisms that support and sustain industrial clusters.

Previously, Dr. Feldman held the Miller Distinguished Chair in Higher Education at the University of Georgia (2006-2008) and the Jeffery S. Skoll Chair in Technical Innovation and Entrepreneurship and Professor of Business Economics at the Rotman School of Management, University of Toronto (2002-2006). She started her career at Johns Hopkins University.

Dr. Feldman has served on the Advisory Panel for the U.S. National Science Foundation's Program on Societal Dimensions of Engineering, Science, and Technology.

CHRISTINA GABRIEL

Dr. Christina Gabriel joined The Heinz Endowments in 2006 with extensive experience in research, research management, university-industry collaboration, and technology transfer. She is responsible for the foundation's efforts to capitalize on the research strengths of the region's universities, medical centers, corporate and government laboratories to promote economic growth and opportunity in southwestern Pennsylvania.

After receiving her doctorate in electrical engineering and computer science from the Massachusetts Institute of Technology, Dr. Gabriel began her professional career in 1985 as principal investigator conducting experimental research at AT&T Bell Laboratories in New Jersey. Her work focused on lasers, optical fibers and thin-film waveguide devices for telecommunications, switching and computing applications. She holds three patents.

Dr. Gabriel joined the National Science Foundation in 1991 to direct industry-university collaborative centers programs and by 1997 was deputy head of the $350 million engineering directorate. During the 1994 legislative cycle she served a detail on Capitol Hill as one of three majority professional staff members for the $90 billion VA, HUD and Independent Agencies Subcommittee of the U.S. Senate Committee on Appropriations. From 1998 to 2006, she worked at Carnegie Mellon University in Pittsburgh, eventually becoming vice provost and chief technology officer. While in that position she also represented the region's three major research universities on the leadership team of the corporate consortium that competed successfully in 2004 to manage the five-year R&D Services Support Contract for the U.S. Department of Energy's National Energy Technology Laboratory.

Dr. Gabriel received both her master's and doctoral degrees from MIT and her undergraduate degree in electrical engineering from the University of Pittsburgh. In 1990 she was a visiting professor at the University of Tokyo in Japan. She has served as a reviewer and steering committee member for the National Science Foundation and the National Academies, and is a member of the MIT Corporation Visiting Committee on Sponsored Research and the Penn State Research Foundation Board. Dr. Gabriel has served on several nonprofit boards in Pittsburgh and as an external technology adviser for the Pittsburgh Public Schools' strategic planning process. She was a National Merit Scholar and an AT&T Bell Laboratories GRPW Fellow. Dr. Gabriel is married and has three children.

PRADEEP HALDAR

Dr. Pradeep Haldar serves as Founding Professor and Head of the NanoEngineering Constellation at the College of Nanoscale Science & Engineering (CNSE) at the University at Albany, (SUNY). He is also Director of the Energy and Environmental Technology Applications Center at the College. At CNSE he has been actively involved in applying and integrating nanotechnology related innovations to solve engineering challenges related to energy efficiency, photovoltaic devices, and ultracapacitors. He has partnered with several universities, start-ups, and large companies in interdisciplinary technology research, development, and outreach initiatives. He serves as founder, Board Member, and Executive Director of New Energy New York Consortium and Chair, DoE NREL's Clean Energy Alliance. He has led and organized several initiatives including Tech Valley Energy Forum, NY Loves Energy, and the Solar Initiative of New York.

Prior to joining the University at Albany, Dr. Haldar founded and served as director of technology and general manager of rapidly growing SuperPower, a new subsidiary of Intermagnetics (now Philips). Prior to leading SuperPower, Dr. Haldar was manager of the Technology Development Organization at Intermagnetics in charge of the company's efforts to pursue new opportunities and technology strategies in electric power, medical, and electronic industries. He has over 20 years of diverse technical, research, development, and management experience. He is senior member of IEEE and other professional organizations including NYAS, MRS, TMS, and AIP. Dr. Haldar is the author or co-author of over 250 reviewed technical papers, conference proceedings, and has three patents issued and four pending. Dr. Haldar is a fellow of the Institute of Physics and recipient of the President's Excellence in Research award and the Business Review's 40 under forty upcoming individuals in New York's Capital Region. He has played a key role in developing New York State's Hydrogen Roadmap, Superconductivity outreach programs, and the New York State Solar Roadmap. Dr. Haldar has his Ph.D. from Northeastern University and an MBA from Rensselaer Polytechnic Institute.

BOMANI HOWZE

Bomani Howze joined the Heinz Endowments in 2007 as the program officer for the Innovation Economy Program. He is responsible for a grant-making portfolio that promotes entrepreneurship and economic opportunity within innovation clusters deriving from the region's academic and industrial research asset base. A particular focus for this work is on collaborative and industry-led efforts to create green jobs that can offer family-sustaining career paths. Grant-making also includes micro-financing and social entrepreneurship, balanced and restorative justice, access to employment for ex-offenders, and targeting of federal

and state programs, including Recovery Act funds, in collaboration with grassroots community organizing initiatives. In earlier positions Mr. Howze has served as a nonprofit executive, a small business entrepreneur, and an elected community leader. He began his professional career as a public school teacher selected to help implement an innovative, year-round curriculum in an economically depressed neighborhood in Norfolk, VA. During his tenure the school realized dramatic improvements in student achievement, and Mr. Howze later introduced some of the same reforms within an African-centered public school curriculum in Pittsburgh. Mr. Howze earned his bachelors degree at Norfolk State University in Virginia and his MBA at Point Park University in Pittsburgh. He has served as vice president of the Pittsburgh chapter of the National Black MBA Association, president of the Three Rivers Investment Club, and elected keynote speaker for Leadership Pittsburgh XXV. As an interdisciplinary international studies fellow he worked with education programs in Venezuela, Brazil, South Africa, Kenya, India, Vietnam, Taiwan, Hong Kong, and Japan. He is married and has two children. Mr. Howze was recently appointed by Governor Rendell to serve on the Pennsylvania Minority Business Development Authority.

WILLIAM P. KITTREDGE

William P. Kittredge is the Director of National Programs and Performance Evaluation at the U.S. Department of Commerce. He has served in this position since its creation in 2006. Dr. Kittredge's responsibilities include administration of the Trade Adjustment Assistance for Firms program, the Research program, and National Technical Assistance program. He is responsible for the development and implementation of performance measures and metrics for all EDA programs. The office also provides quantitative and qualitative analytical services, and GIS (Geographic Information Systems) support for EDA.

Dr. Kittredge is an internationally recognized program evaluation and performance measurement authority. Dr. Kittredge has been engaged in strategic planning, program evaluation, and performance management since the inception of the Oregon Benchmarks and has served as project director during the 1996 update. He served as the senior analyst and project manager for the Pew Trust-funded Government Performance Project from 1997-2000. His former students and interns mentored in his office now occupy senior positions at OMB, GAO, World Bank, USTR, Grant Thornton, CitiFinancial, and many local governments.

Dr. Kittredge's research has been published in academic journals, including *Public Administration Review* and *Municipal Finance Journal*, and in the popular press, including *USA Today*. He is the author of two books addressing local government budgeting and financial condition analysis. His commentary has been broadcast by National Public Radio and Bloomberg News. He receives frequent invitations to lecture and to

speak at conferences, and participates as a peer reviewer in his areas of expertise.

Prior to seeking an advanced degree, he served in local elected office. His decade long local and regional government service included an appointment to the Washington Public Power Supply System Participants' Review Board and a tour as Special Regional Resource to the House Bonneville Power Administration Task Force.

Dr. Kittredge began his public service career following a successful 15-year private-sector career that included the founding and subsequent sale of two small businesses.

Dr. Kittredge received his Ph.D. in 2002 from the Maxwell School of Citizenship and Public Affairs at Syracuse University. He received his M.S. (public policy) from the University of Oregon, where he was admitted by exception without an undergraduate degree.

His voluntary public service includes teaching Practical Economics at the high school level through Junior Achievement. The Veterans Administration awarded certificates recognizing his over 600 volunteer hours counseling Vietnam-era veterans.

A native of Cape Cod, he enjoys white water rafting, scuba diving, and sea kayaking.

JOHN MATHIESON

John (Matty) Mathieson directs the Center for Science, Technology, and Economic Development at SRI International, formerly known as Stanford Research Institute. Mr. Mathieson has over 26 years of project leadership and management at SRI. He has led teams on projects in over 120 countries and 60 states and regions in North America. Mr. Mathieson has expertise in industry development and cluster strategy; technology and regional economic development; corporate and industry growth strategy; economic and commercial policy analysis and reform; trade and investment planning; and financial sector development. Prior to joining SRI, he served as a senior fellow at the Overseas Development Council. He held previous positions in the Treasurers Department of Exxon Corporation, the Economic Planning Council of Taiwan, and The Brookings Institution. Mr. Mathieson received his B.A. in political economics from Williams College, and his M.P.A. in economic policy from Princeton University. He has published and spoken on a wide variety of economic, technology and financial issues.

DAVID MCNAMARA

Dave McNamara, an experienced Fortune 500 and start-up executive, is senior vice president of SCRA and director of SC Launch! SCRA is a leader in establishing the Knowledge Economy in South Carolina and the

nation by successfully advancing applied research and technology through collaboration.

McNamara provides leadership at SC Launch! by directing all aspects of operations, research, communications, and recommendations of the new SCRA program. SC Launch! supports technology ventures in South Carolina with seed money, counsel, and facilities in an effort to grow high-paying technology jobs in the state.

McNamara, who is an adjunct professor at the University of South Carolina and Midlands Technical College, comes to SCRA from two start-ups. At Excelergy, a Lexington, MA, energy software company, McNamara was vice president of North American Market Operations. He managed sales, architecture and customer relationships and was instrumental in the Company's turn-around. At Conita Technologies, a provider of speech-enabled personal virtual assistants in Columbia, SC, McNamara was vice president of Global Sales. He built sales and reseller channels, established partnerships with companies such as Avaya and Fujitsu, and helped obtain venture funding for the Company.

McNamara was vice president, sales, of the Energy, Utility, and Communications Market Unit for Systems & Computer Technology Corp., Columbia, SC, from 1996 to 1999. Under his direction, sales increased 15-fold to $90 million, and a 40-person sales staff was built. During the prior 5 years, he was vice president of sales and marketing at Anchor Continental, a pressure-sensitive tape manufacturer in Columbia, SC. McNamara built sales to $120 million and created an industry-leading customer service function.

At South Carolina Electric and Gas, Columbia, SC, McNamara held a variety of top-level executive posts between 1977 and 1991, including vice president of electric marketing and sales. He implemented innovative marketing programs that resulted in dramatic increases in sales and return on investment. He also held vice presidential posts in public affairs, operations, and finance at various subsidiaries. Previously, he was a senior auditor/CPA for Arthur Andersen Co. in Atlanta, GA.

McNamara was first in his M.B.A. class at Rutgers University, Newark, NJ, and received a graduate degree in professional accounting. He earned a B.S. in marketing at Virginia Polytechnic Institute (VPI), Blacksburg, VA. McNamara is a Columbia, SC, resident.

KAREN MILLS

Karen G. Mills was sworn in April 6, 2009, as the 23rd Administrator of the U.S. Small Business Administration. Appointed by President Barack Obama and confirmed unanimously by the Senate, Ms. Mills directs a federal agency with more than 2,000 full-time employees, and a leading role helping small business owners and entrepreneurs secure financing, technical assistance, training, and federal contracts. SBA also plays a leading role in disaster recovery by making low interest loans for

businesses and residents. With a portfolio of direct and guaranteed business loans and disaster loans worth more than $90 billion, SBA is the nation's largest single financial backer of small business.

Since 1983, Ms. Mills has been an active hands-on investor in and successful manager of small businesses. Ms. Mills also has distinguished herself as a passionate advocate for small business policy that encourages innovation, economic development, and job creation.

Most recently, as the president of MMP Group, Ms. Mills invested in and took a leading role in companies involved in the consumer products, food, distribution, textile and industrial components sectors. Prior to that, in the late 1990s, she was a co-founder and a managing director of Solera Capital.

Ms. Mills has spent much of her career working with small manufacturing firms, including producers of hardwood flooring, refrigerator motors and plastic injection molding. During the recession of the early 1990s, her hands-on management and commitment to innovation is credited with helping several small manufacturers increase efficiency and competitiveness, and ultimately survive in a tough economy.

Her background also includes consulting in the U.S. and Europe for the management consulting firm McKinsey and Co. and product management for General Foods. In 2007, she was appointed by Maine Gov. John Baldacci as chair of the state's Council on Competitiveness and the Economy, where she focused on attracting investment in rural and regional development initiatives. She also served on the Governor's Council for the Redevelopment of the Brunswick Naval Air Station.

For several years Ms. Mills has been a leading voice in the U.S. competitiveness discussion and is author of an influential Brookings Institution paper on the federal role in regional economic development clusters, geographic concentrations of interconnected businesses that share knowledge and resources to spur innovation, economic growth and higher wage employment. Ms. Mills' work with boat builders in Maine in using composite materials to increase global competitiveness is one of the leading examples of the success of economic development clusters.

She is a member of the Council on Foreign Relations and has been vice chairman of the Harvard Overseers. Ms. Mills has an A.B. in economics from Harvard University, and an M.B.A. from Harvard Business School where she was a Baker Scholar. Mills and her husband Barry Mills, president of Bowdoin College in Brunswick, Maine, have three sons.

ED PAISLEY

Ed Paisley is vice president for editorial at American Progress. He is a twenty-year veteran of business and finance journalism who joined

American Progress after successfully launching the specialist Wall Street print and web publication *The Deal* as its managing editor. At *The Deal*, he was also responsible for the publication's award-winning coverage of technology finance and international finance.

Before moving to New York to launch *The Deal* in 1999, Paisley spent a decade in East Asia as an editor and journalist covering business, finance, and politics for the *Far Eastern Economic Review*, a Dow Jones & Company publication, and *Institutional Investor* magazine.

Paisley served as the editor of *Institutional Investor*'s Asia edition for five years, winning an Overseas Press Club award for his coverage of the handover of Hong Kong from Britain to China in 1997. From 1989 to 1994, he worked as a print and broadcast journalist for the *Far Eastern Economic Review* based in Hong Kong and Seoul and traveling throughout East Asia and Southeast Asia. Prior to that, he worked as a correspondent for *American Banker* newspaper in Washington, D.C., covering domestic and international financial regulation.

Paisley earned a master's degree in East Asian history from Georgetown University in 1984 and a bachelor's degree in american studies from George Mason University in 1982. He also spent a year as a resident docent at the National Palace Museum in Taipei, Taiwan, where he studied Chinese art history.

EDWARD PENHOET

Edward Penhoet joined Alta Partners in 2000 as a director. He is a member of the boards of directors of ChemoCentryx, Chimerix, Immune Design, Scynexis, and ZymoGenetics, and serves as the chairman of the board for Metabolex.

A co-founder of Chiron, Ed served as the company's president and chief executive officer from its formation in 1981 until April 1998. He is the vice chair of the Independent Citizens Oversight Committee for the California Institute of Regenerative Medicine (CIRM), and recently served as the president of the Gordon and Betty Moore Foundation.

For 10 years prior to founding Chiron, Ed was a faculty member of the Biochemistry Department of the University of California, Berkeley.

Ed is the immediate past dean of the School of Public Health at the University of California, Berkeley. He is a member of the Institute of Medicine of the National Academy of Sciences and has co-authored more than 50 scientific articles and papers.

LUIS PROENZA

Dr. Luis M. Proenza is chief executive officer of The University of Akron. In his first 10 years at UA, he has led its transformation into the public research university for northern Ohio and one of the most attractive metropolitan campuses in the nation. Under Dr. Proenza's

leadership, UA has undertaken a $500-million campus enhancement program, a university-community alliance to revitalize a 50-block area surrounding its campus, a BioInnovation Institute in partnership with three area hospitals and a medical school, and academic program enhancements that have made the university one of only 12 Carnegie Cluster Leaders nationally.

Dr. Proenza has been involved in national science and technology policy matters since the 1970s when he was study director of the National Research Council-National Academy of Sciences' Committee on Vision, then The University of Georgia's Liaison for Science and Technology Policy, a member of the National Biotechnology Policy Board-National Institutes of Health, and Advisor for Science and Technology Policy to the Governor of Alaska. In 1992, U.S. President George H. W. Bush appointed Dr. Proenza to the U.S. Arctic Research Commission. Dr. Proenza became its vice chairman. He later was chair of the Science and Mathematics Education Task Force for the Secretary of Energy Advisory Board.

In 2001, President George W. Bush named Dr. Proenza to the President's Council of Advisors on Science and Technology, the nation's highest-level policy-advisory group for science and technology. Dr. Proenza co-chaired PCAST's committee on Public-Private Partnerships and worked on panels on U.S. Research and Development Investments, Technology Transfer, Alternative Energy, Energy Efficiency and Advanced Manufacturing, Personalized Medicine, Information Technology, and Nanotechnology. He now serves on the Council on Competitiveness' executive committee and its National Innovation Initiative Leadership Council, and co-chairs its Regional Leadership Institute Steering Committee. He is a member of the Council on Foreign Relations, a board member of the National Association of State Universities and Land-Grant Colleges (NASULGC) and the States Science and Technology Institute, and chair of NASULGC's Commission on the Urban Agenda.

Dr. Proenza is a member of many professional, scholarly and honorary organizations; is the recipient of several awards and honors; has written numerous publications in nationally and internationally recognized journals; and edited and co-edited two books. He is invited frequently to speak worldwide, with presentations appearing in *Vital Speeches of the Day* and *The Executive Speaker*. He often is quoted on issues in education, research, economic development, and science and technology policy.

As president of The University of Akron, Dr. Proenza has grown it from a $270-million operation to an enterprise with over $435 million in annual revenues. Under his direction, the institution has financed $500 million in construction to completely transform its metropolitan campus, adding 15 new facilities and doing major renovations and additions to 17 others. Dr. Proenza also increased private donations and research funding

to all-time records and, in 2007, initiated a $500-million comprehensive campaign that already has gained $365 million in gifts and pledges.

Recognized as one of the most influential leaders in the region, Dr. Proenza's acknowledgements include the 2008 Visionary Award, the 2006 Northeast Ohio Regional Vision Award, the 2005 CASE V Chief Executive Leadership Award, and the 2001 SME Executive of the Year Award.

After earning a B.A. from Emory University (1965), M.A. from The Ohio State University (1966), and Ph.D. from the University of Minnesota (1971), Dr. Proenza joined the faculty of the University of Georgia in 1971. There, his research in psychology and neurobiology was continuously supported by grants from the National Eye Institute, including a Research Career Development Award.

Prior to his appointment at Akron, Dr. Proenza was vice president for research and dean of the Graduate School at Purdue University. He also served the University of Alaska first as vice president for academic affairs and research, then as vice chancellor for research and dean of the Graduate School.

Dr. Proenza and his wife, Theresa Butler Proenza, enjoy their careers, friends and numerous community activities. Together, they built the 44-foot sailing vessel, *Apogee*, which they sail on Lake Erie.

ANDREW REAMER

Andrew Reamer is a fellow in the Brookings Institution's Metropolitan Policy Program. At Brookings, Dr. Reamer focuses on federal statistical policy and the federal role in regional economic development. He manages the Federal Data Project, which promotes improved availability and accessibility of detailed, accurate, up-to-date federal socioeconomic data on metro areas, cities, and neighborhoods. With Karen Mills and Elisabeth Reynolds, he co-authored "Clusters and Competitiveness: A New Federal Role for Stimulating Regional Economies" in 2008.

Between 1984 and 2004, Dr. Reamer founded and managed two economic development and public policy consulting firms that aided U.S. cities and states in understanding how their economies work and how they could work better. In this role, he oversaw the preparation of economic analyses, strategic plans, program evaluations, and resource materials. Efforts for the U.S. Commerce Department included "Technology Transfer and Commercialization: Their Role in Economic Development" and "Socioeconomic Data for Understanding Your Regional Economy: A User's Guide."

Dr. Reamer received a Master of City Planning and a Ph.D. in economic development and public policy from the Massachusetts Institute of Technology, Department of Urban Studies and Planning.

JONATHAN SALLET

Jonathan Sallet has combined a career in technology, public policy, politics, and the law.

Mr. Sallet served in the Clinton/Gore Administration as Assistant to the Secretary and Director of the Office of Policy & Strategic Planning of the Department of Commerce, focusing on economic and technology policy. He was a member of the small group of Administration officials who met regularly with Vice President Al Gore to work on the telecommunications issues that became the Telecommunications Act of 1996; he headed the first White House working group on the deployment of educational technology.

Mr. Sallet's professional training is in the law. A graduate of the University of Virginia School of Law, he clerked for Associate Justice Lewis F. Powell, Jr., and Judge Edward Tamm of the United States Court of Appeals for the District of Columbia Circuit. He was a partner in the law firms of Jenner & Block and Miller, Cassidy, Larroca & Lewin. He is a senior adjunct fellow, Silicon Flatirons at the University of Colorado School of Law; and a member of the advisory board of the American Antitrust Institute. Mr. Sallet served as editor-in-chief of the Virginia Law Review and graduated from Brown University.

ROBERT SAMORS

Robert J. (Bob) Samors currently serves as associate vice president for research, innovation and STEM education and director of innovation policy at the Association of Public and Land-grant Universities (APLU). In that position, Samors is the lead representative for APLU on information technology (IT), intellectual property, and economic development policy. He also serves as the project director for the APLU-Sloan National Commission on Online Learning. In addition, Samors works closely with APLU's Congressional Affairs staff on federal technology policy issues in Congress and the Executive Branch.

Prior to joining APLU, Samors served for seven years as the associate vice president for federal relations for the University of North Carolina system, opening the UNC Washington Office in April 1999. Prior to joining UNC, he was the assistant vice president for research in the University of Michigan Washington office. Samors has also worked for APCO Worldwide (formerly APCO Associates), a Washington consulting firm, and Senator Larry Pressler (R-SD). He holds a masters in public policy from the Kennedy School of Government at Harvard University and a B.A. in economics from Brown University.

MARC STANLEY

Mr. Marc G. Stanley has served as director of the Technology Innovation Program (TIP) at the National Institute of Standards and

Technology (NIST) since December 31, 2007. He was appointed acting director of TIP on September 10, 2007. He also serves as a U.S. governor on the Israel-U.S. Binational Industrial Research and Development (BIRD) Foundation Board of Governors and as the American director on the Trilateral Industrial Development (TRIDE) Executive Committee.

Mr. Stanley served as the director of the Advanced Technology Program (ATP) since June 2003. He was the acting director of ATP from 2001 to 2003 and served as the associate director for ATP from 1993 to 2001.

Before coming to NIST, Mr. Stanley was the Associate Deputy Secretary of the U.S. Department of Commerce (DoC) by Presidential appointment. He served as counselor to the NIST Director, as a consultant to DoC's Technology Administration, and as Assistant Secretary for Congressional and Intergovernmental Affairs at DoC.

Mr. Stanley earned a B.A. from George Washington University and a Bachelor of Law degree from the University of Baltimore.

JEAN TOAL EISEN

Jean Toal Eisen was recently named deputy director of the Office of Policy and Strategic Planning at the Department of Commerce. Previously she served as senior advisor and deputy policy director for chairman Daniel K. Inouye on the Senate Committee on Commerce, Science, and Transportation. During the 110th Congress, the committee was responsible for shepherding the enactment of 35 significant pieces of legislation into law, including the America COMPETES Act, a reform of America's consumer product safety laws, the first legislative improvement to automobile fuel economy standards since the 1970s, and the Broadband Data Improvement Act. Previously, she served the committee as senior professional staff member with primary responsibilities for staffing the Democrats on space, science, and technology-related issues. She has worked on legislation on such diverse subjects as NASA, NIST, NSF, commercial space, developing the scientific workforce, the Internet, fire fighting, earthquake and wind hazards, and computer security. A South Carolina native, Ms. Toal Eisen began her career on the Hill as staff assistant then researcher for Senator Ernest F. Hollings. She also worked as a computer network administrator before joining the staff of the Commerce Committee in June 1997. Ms. Toal Eisen earned a baccalaureate degree in mathematics and philosophy from Yale.

JIM TURNER

Jim Turner is currently director of energy policy at the Association of Public and Land-Grant Universities. He was recently chief counsel of the House Committee on Science and Technology, with over 30 years of experience as a congressional staff member working on technology and

energy policy. He graduated from Georgetown, Yale, and Westminster College. He was a Clinton Presidential Transition Team member for the Department of Commerce.

Jim is a trustee of the University of Virginia's engineering school (UVA/SEAS) and academic vice chair of the President's Advisory Board at Carnegie Mellon University, H. John Heinz III College. He serves on the board of directors of Scientists and Engineers for America, Oak Ridge Associated Universities, and the American National Standards Institute (ANSI) and the Board of Advisors for MIT Press's journal Innovation. He chairs UVA/SEAS's Advisory Board for the Science, Technology, and Society program and provides Washington coordination for the joint MIT/UVA Washington Summer Internship program. He is a member of Innovation Clusters Taskforce at Science Progress of the Center for American Progress.

Turner has received standards medals from ASME, ANSI, and ASTM, as well as awards from the World Standards Day, The Association of University Technology Managers, the American Society for Engineering Education, the Virginia Engineering Foundation, the Federal Patent Lawyer Association, the Technology Transfer Society; the National Institute of Building Sciences, the Federal Laboratory Consortium; and the Semiconductor Industry Association. He is an Honorary Fellow of the American Society of Civil Engineers and a Fellow of the U.S. Metric Association. He also served on the Presidential Transition Teams for the Obama and Clinton Administrations.

CHARLES WESSNER

Charles Wessner is a National Academy Scholar and director of the Program on Technology, Innovation, and Entrepreneurship. He is recognized nationally and internationally for his expertise on innovation policy, including public-private partnerships, entrepreneurship, early-stage financing for new firms, and the special needs and benefits of high-technology industry. He testifies to the U.S. Congress and major national commissions, advises agencies of the U.S. government and international organizations, and lectures at major universities in the United States and abroad. Reflecting the strong global interest in innovation, he is frequently asked to address issues of shared policy interest with foreign governments, universities, research institutes, and international organizations, often briefing government ministers and senior officials. He has a strong commitment to international cooperation, reflected in his work with a wide variety of countries around the world.

Dr. Wessner's work addresses the linkages between science-based economic growth, entrepreneurship, new technology development, university-industry clusters, regional development, small-firm finance and public-private partnerships. His program at the National Academies

also addresses policy issues associated with international technology cooperation, investment, and trade in high-technology industries.

Currently, he directs a series of studies centered on government measures to encourage entrepreneurship and support the development of new technologies and the cooperation between industry, universities, laboratories, and government to capitalize on a nation's investment in research. Foremost among these is a congressionally mandated study of the Small Business Innovation Research (SBIR) Program, reviewing the operation and achievements of this $2.3 billion award program for small companies and start-ups. He is also directing a major study on best practice in global innovation programs, entitled *Comparative Innovation Policy: Best Practice for the 21st Century*. Today's meeting on *Growing Innovation Clusters for American Prosperity* forms part of a complementary analysis entitled *Competing in the 21st Century: Best Practice in State & Regional Innovation Initiatives*. The overarching goal of Dr. Wessner's work is to develop a better understanding of how we can bring new technologies forward to address global challenges in health, climate, energy, water, infrastructure, and security.

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