Commercialization of University Research

Response to a Request for Information from the Office of Science and Technology Policy and the National Economic Council

Prepared By

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The opinions and recommendations provided herein are solely those of Dr. Keith McDowell in his capacity as a senior leader in the administration of research and technology commercialization of the Nation's second largest university system. The document is not an official response approved by The University of Texas System.

INTRODUCTION

The Obama Administration innovation strategy as presented in *A Strategy for American Innovation: Driving Towards Sustainable Growth and Quality Jobs* captures the essential elements needed for America to compete globally.[1] Those elements are: invest in the building blocks of American innovation, promote competitive markets that spur productive entrepreneurship, and catalyze breakthroughs for national priorities. As a senior leader for research and technology transfer in America's second largest university system, The University of Texas System, I concur with the Obama plan and its action items and am pleased to offer additional specific suggestions in support of the plan and in response to a Request for Information from the Office of Science and Technology Policy and the National Economic Council. My comments and suggestions focus on the specific goal of enhancing and accelerating the commercialization of university research into the marketplace, with the given understanding that direct and additional investment in university research also leads to more products, jobs, and economic prosperity.

Commercialization of university research is a complex subject and requires an understanding of the contextual framework in which it exists – the innovation ecosystem. The innovation ecosystem is a complex and dynamic networked system with a layered architecture composed of physical, biological, and social systems. The parsing of the ecosystem into research, development, and other such enterprises as well as the parsing into entities such as universities, health science or medical centers, national laboratories, research institutes, and industry is the common practice for deconstructing the ecosystem and revealing its parts. Policies and regulations inform the ecosystem as well as "the power of place" in the language of the Association of University Research Parks (AURP).[2, 3]

Commercialization of university research must also be approached from the broad framework of how knowledge is transferred or diffused throughout the innovation ecosystem and at what point an innovation occurs that produces a potential commercial product. The linear pipeline model advocated by Vannevar Bush in his famous document *Science the Endless Frontier* has been a useful model,[4] but the quadrant model advocated by Donald Stokes in *Pasteur's Quadrant* is much closer to the reality of how one should parse the R&D enterprise as it relates to commercialization.[5] No matter how one chooses to view the framework in which commercialization occurs, the practical reality is that America has developed an extensive infrastructure for that enterprise that is the "envy of the world" and very successful.

Notwithstanding that success, improvements are possible and many are included in the Obama plan. To maintain American dominance in global competition, it is essential that the action items described in the Obama plan and those that result as a consequence of the Request for Information (RFI) take account

of several core principles fundamental to an innovation ecosystem and to the practical reality of what currently exists. Those principles follow with a description as to their meaning.[6]

1. **We must enhance the elements that currently comprise the innovation ecosystem, but recognize that a complete restructuring is not necessary.**

   The potential signs of trouble for America as described in the RFI and in many other documents and publications have led to a number of "urban myths" founded on anecdotal stories and reports based on asymmetric surveys and with little, if any, hard data. Public policy should not be based on such evidence. The reality is that university and regional innovation ecosystems are evolving with cultural leaps and practices that far outpace such dated misconceptions. Here are three of the most common urban myths related to the commercialization of university research.

   - *Universities through their technology transfer offices are more difficult to work with than other entities in the innovation ecosystem and are the slow step*. Contrary to perception, very little angst occurs during most negotiations and excellent deals are consummated every day that further innovation and commercialization. Negotiation of deals involves people and is a "people contact sport." Trying to change that dynamic is equivalent to changing the social laws of nature and is a futile exercise. Furthermore, such notions as "one-size-fits-all" deal structures or faculty "free agency" models sound plausible as a means to enhance technology commercialization, but in fact are known from experience to have little positive effect in a mature technology commercialization operation.

   - *Universities focus exclusively on patenting and license revenue as their strategy*. To the contrary, universities use a diversified and differentiated set of strategies tailored to fit the situational needs of given technologies and negotiations. While some universities are better practitioners of the art, all are engaged in adapting strategy to achieve a best and optimal operational practice in a changing world. The University of Texas System and its practices are a great example of adaptation in action. UT System has a University of Texas Technology Management Council (UTTMC) comprised of all technology transfer personnel across fifteen very diverse academic and health institutions located in distinct regional ecosystems. UTTMC meets several times a year to review current practice and current topics and Special Interest Groups conduct monthly conference calls using case studies as the vehicle. A Commercialization Council and an Incubator Council meet regularly to review the spectrum of activities, policies and strategies. To claim that universities are single-mindedly fixated on patents and licensing revenue is nonsense and ignores the massive transformation in culture and practice occurring on our campuses.

- *A vast treasure of untapped commercializable inventions is sitting on shelves in university laboratories.* This urban myth requires a nuanced understanding of the innovation ecosystem and the differences among discoveries, inventions, and innovations that have market potential. In many ways it is a surrogate for those who want to speed up the clock on technology development – to somehow systematize or accelerate innovations from raw scientific knowledge. It also conflates many issues related to entrepreneurship, technology transfer, commercialization, and economic development through startup formation into a single conundrum. Let's be clear: no such treasure exists! Most of the putative commercial innovations have been evaluated – even if poorly done – and dropped for good reason. On the other hand, there is a very complex innovation ecosystem in place that does indeed have some viscosity toward the creation and movement of innovations to the marketplace. The possibility for enhancements through policy changes and targeted funding are very real. We describe some of those possible changes below.

2. **We must recognize that a layered architecture for the innovation ecosystem is the most robust and adaptable one with a potential for emergent properties.**

   The layered architecture of systems of systems plays out in several ways. For example, specific discoveries coalesce to form invention disclosures which collectively lead to advanced systems that make up a holistic product such as a space shuttle or a computer. Physical, biological, and social systems merge to form Facebook. Innovations can be both incremental and disruptive at various levels of scale and purpose. It is not always, or even usually, a linear pipeline. Grand challenges are equally as important as are unplanned advances. This layered architecture of the innovation ecosystem requires tiered approaches for change.

3. **We must increase the connectivity of the elements that make up the ecosystem in order to increase complexity and take advantage of the convergence in modern research. Complexity begets disruptive innovations at the convergence frontier.**

   The goal should not be to force fundamental change in the elements of the innovation ecosystem that already exist – diversity is essential to being adaptive, but to connect and build bridges that permit evolution of the ecosystem. Public-Private partnerships that connect universities, national laboratories, and industry are a key strategy. Those partnerships should recognize "the power of place" or location and involve regions and local government. Transformational change leading to an environment for disruptive innovations with commercial potential and leadership in the 21st century world economy requires a connected and layered ecosystem.

4. **We must empower people to innovate through independence and incentives, not constraints.**

Disruptive innovation requires a path with open gateways, not a sequence of gatekeepers. Export control, dual-use technology, and immigration policies and practices currently constrain innovation and are examples of gatekeeper systems, not open gateways. On the other hand, open innovation experiments such as the practices at Proctor and Gamble[7] and the Netflix contest[8] demonstrate the power of gateways. Specific to university faculty, the SHIFT Award in the NIH SBIR program is designed to transition faculty to a small business concern.[9] It is a gateway program providing transitional funding and an example of how to employ the gateway approach instead of gatekeeping.

Many have argued in the past decade that the federal research grants infrastructure favors "me too" science and leads to incremental, not disruptive, innovation.[10] It is a gatekeeper system. The current publisher-driven system for reporting research through scientific publications is an expensive gatekeeper system that is slow, restricts access to scientific knowledge, and is not in sync with 21st century information sourcing via the Internet. Furthermore, our innovators have become choked by bureaucracy. According to a study by the Federal Demonstration Partnership, faculty researchers now spend 42% of their time on the administration of grants instead of productive research and innovation.[11] This is not empowerment to innovate!

5. **We must incentivize targeted research and development on grand challenges of importance to humankind at a sufficient scale to get the job done.**

One of the best ways to sustain an adaptive innovation ecosystem that is layered and connected while contributing to societal needs is to fund grand challenge research. The appropriate scale begins with programs such as the Clinical and Translational Science Award (CTSA).[12] Equally important is the emerging concept of innovation hubs or the "lablet" model.[13] This model should be funded and expanded as described below.

Some concern has been expressed that fundamental, basic research will be squeezed out by such large scale funding programs. While random acts of progress through independent-researcher, exploratory R&D are important to the innovation equation and critically important to the storehouse of scientific knowledge, targeted work on grand challenges in the context of Pasteur's Quadrant often leads to breakthroughs at the fundamental, basic research level that spurs a burst of innovations.

6. **We must remember that innovation leading to economic prosperity at the expense of our values is not progress.**

   Society must define the core values that will be protected as we march forward along the innovation curve that is exponentially and qualitatively changing our world. Who will benefit from the advances? Do we turn ourselves into the Borg from Star Trek using enhanced memory from imbedded data storage devices and the ability to broadcast our thoughts via wireless implants? What happens when the complexity of computers reaches such a level that they become self aware? What happens to privacy when personalized medicine becomes the order of the day? Does anyone doubt that such advances will occur in the next few decades? Are we ready for this transformational change? What does it mean for current policy?

The Bayh-Dole model as realized through university ownership of intellectual property and the advent of university technology transfer offices is the gold standard around the world for the transfer of knowledge leading to commercialization of university research. While technical and legal issues related to intellectual property and the performance of specific technology transfer offices on given deals can be vexing at times to participants, we emphasize again that these elements are not ultimately determinant of the commercialization of university research, no matter the volume of rhetoric to the contrary. These issues are being resolved in the normal course of evolution and growth of the enterprise.

> ***Recommendation: We strongly urge and recommend that OSTP and NEC focus on policy and funding changes that affect commercialization per se including economic development through startup company formation and the broader and more important issue of accelerating innovation and forming "communities of innovation."***

We further elucidate this recommendation in Parts I and II below.

Over the past decade many reports, white papers and letters have been generated containing lists of action items needed to enhance the commercialization of university research. Examples include *Rising Above the Gathering Storm* (RAGS),[14] *Science as a Solution: An Innovation Agenda for the next President*,[15] Licensing Executive Society letter to President Obama of 28 February 2009,[16] and *The Power of Place 2.0: The Power of Innovation*.[3] There is general conformity in the lists and the Obama innovation plan captures many of the items. Unfortunately, little action has occurred to either implement or fund most of the items, notwithstanding the America Competes Act authorization legislation. We don't need yet another information gathering exercise that produces little or no results.

Recommendation: We strongly urge OSTP and NEC to review extant lists of action items on commercialization of university research and implement them immediately.

From these lists of recommended action items, there are two that we emphatically endorse.

Recommendation: Eliminate the link to university intellectual-property licensing in "private use" restrictions in university facilities – IRS Revenue Procedure 97-14.

As a result of this IRS procedure, universities are severely restricted in forming sponsored research agreements with industry. In simple terms universities are not able to "pre-value" future intellectual property created from an agreement if the research is performed in facilities constructed through tax-exempt bonds. Universities are unwilling to enter into agreements that put the tax-exempt status at risk since the cost could be very large. Many potential industry partners are unwilling to sponsor research if such intellectual property terms are not spelled out in advance. Although the nexus of intellectual property valuation to tax-exempt bonds through the IRS is difficult to comprehend, this Revenue Procedure is a major deterrent to university-industry collaborative and innovative R&D. It is imperative that it be changed!

Recommendation: Adequately fund and staff USPTO to carry out its mission.

The backlog of patent applications at USPTO is not acceptable. It demoralizes innovators, sacrifices valuable momentum, and undermines responsiveness to the compelling reality that time to market is a crucial ingredient for successful and competitive commercialization of university research.

PART I: Promising Practices and Successful Models

The Ewing Marion Kauffman Foundation has coined the phrase "think global, act local." AURP speaks of "communities of innovation."[3] Many others talk of "innovation clusters" and "regional innovation ecosystems." The clear consensus is that America needs regional or community innovation ecosystems with research universities as a defining element coupled strongly to a critical mass of other entities such as industry, national laboratories, and local or state government. Supporting infrastructure such as incubators, small business development centers, entrepreneurial training programs, venture capital and angel networks, and tax incentive programs are essential to the ecosystem. History shows that no single structure or pathway to a structure yields success. It can take a decade or more to reach sustainability. Any funding program designed to bootstrap or accelerate regional innovation ecosystems must account for these factors. Texas displays a rich variety of regional innovation ecosystems and is

representative of the significant experimentation with such models around the United States. We review several Texas ecosystems to illustrate promising practices and successful models.

The story of Austin, Texas, is illustrative of both the structural elements of a regional innovation ecosystem and the dynamics that produced it. In this case the story begins with people: namely George Kozmetsky, the civic leaders of the city of Austin, and state government leaders. Kozmetsky, a co-founder of Teledyne Inc., was the visionary and the leader. He served for sixteen years as the dean of the McCombs School of Business at UT Austin and is credited as the driving force for forming the famous IC^2 institute in 1977, the world renown business plan competition "Moot Corp" in 1984, the Austin Technology Incubator (ATI) in 1989, and the Texas Capital Network, Inc. in 1989. With his leadership, Austin won the competition for the Microelectronics and Computer Technology Corporation in 1982 and subsequently SEMATECH. Austin continues to be a regional innovation ecosystem with national and global prominence. IC^2 has operations ranging from Mexico, South Korea, and India to Egypt and Portugal. ATI has spun out nearly 200 startup companies in its twenty-year history with a significant focus today on clean technology. The famous masters' degree program in technology commercialization at UT Austin has developed world leaders in the field for over a decade. Intern programs bring undergraduate and graduate students into direct contact with startup companies and technology transfer offices in the U.S. through experiential learning. Students across the country are demanding such entrepreneurial programs and many varieties exist. We advocate for a "practicum model" in Part II.

The response by UT System to RAGS was swift and transformative. In 2006 UT System embarked on a $2.56 billion program entitled the Competitiveness Initiative.[17] The Initiative was reviewed in the summer of 2009 and commitments and expenditures of over $3 billion were identified. Norman Augustine, author of the RAGS report, stated that "It's one thing to have a plan and it's another to make it happen. Texas has made this happen." A comprehensive report on the Initiative from the 2009 review can be found on the UT System website.[18] The Competitiveness Initiative and its detailed implementation is a model for understanding the larger ecosystem in which the commercialization of university research exists.

The State of Texas, through its Legislature and Governor, has taken a lead in forming programs to both commercialize university research and engage universities in the formation and mentoring of startup companies. The Texas Emerging Technology Fund (TETF) and the Cancer Prevention and Research Institute of Texas (CPRIT) are prime examples.

TETF is comprised of three components: 1) an equity investment fund for startup companies associated with universities, 2) a matching grant fund for specific commercialization-related endeavors

including proof of concept, and 3) a research superiority grant fund with matching requirements to attract outstanding faculty to Texas who have a history of commercialization activities. TETF to date has invested about $271 million in approximately 130 awards. Faculty members hired through the superiority component are forming startup companies and generating options, licenses, and patents. A major component of the TETF legislation was the creation of seven Regional Commercialization and Innovation Centers (RCICs). RCICs are serving as the nucleation point for the expansion and enhancement of regional innovation ecosystems.

CPRIT is the response by Texas to a societal grand challenge that reflects a competitive advantage of Texas and the desire to enhance that advantage. Central to that competitive advantage is the Texas Medical Complex (TMC) in Houston anchored by the UT M. D. Anderson Cancer Center as well as major programs in Dallas – Fort Worth at UT Southwestern Medical Center and in San Antonio. TMC is the world's largest health and medical complex. CPRIT is authorized at $3 billion for ten years with a yearly outlay of $300 million. Translation and commercialization of university research to the clinic and the marketplace are major themes of CPRIT. Specific funding for commercialization activities are part of the CPRIT mix and details of the multi-faceted program are available at the CPRIT website.[19] CPRIT is an example of targeted funding at the state level that takes advantage of existing infrastructure to build a community of innovation complete with all the essential elements needed.

Texas Governor Rick Perry challenged public universities in 2007 to significantly enhance their commercialization activities. The Board of Regents of The University of Texas System responded by endorsing commercialization activities of faculty members as measures for both tenure and promotion decisions, when appropriate. They further required that System institutions include commercialization of university research as part of their mission statements. UT System licensing and commercialization experts worked for a year to develop a standard licensing template for the physical sciences and one for the life sciences. These templates have been adopted by State organizations such as TETF as the starting point for technology transfer negotiations. UT System responded to the Governor by creating the program *Ignite Texas!* – a multi-faceted and ongoing program to accelerate the commercialization of university research. *Ignite Texas!* includes the Texas Ignition Fund to be described below; *Ideas on Fire!* – an online entrepreneurial training program for faculty; formation of a Commercialization Council and an Incubator Council; and creation of a multi-campus office of technology commercialization entitled South Texas Technology Management (STTM) to manage the commercialization of university research from The University of Texas Health Science Center San Antonio, The University of Texas at San Antonio, the University of Texas at Brownsville and the University of Texas at Pan American. STTM is

an experiment to test the viability of a single office for multi-campus, geographically and culturally differentiated institutions.

The Texas model is an example of the vibrant and transformational nature of what is occurring in the commercialization of university research in America. Specific examples of both programs and strategies are so numerous, and in many cases still experimental, that simply listing them is a considerable task.

Bootstrapping innovation ecosystems

The histories of innovation ecosystems show a multitude of pathways to bootstrap or nucleate them and further that there are many sustainable models or structures that emerge. While a major research university at the core is typically important, other models are succeeding. A significant case in point is occurring in South Texas at the border with Mexico. Following the passage of NAFTA legislation, many Fortune 500 companies placed manufacturing facilities on both sides of the border with parts being made on the Mexican side and assembly occurring on the U.S. side. The resulting jobs created a rising middle class in a rather poor area housing over two million people. The pressure to attend college fueled the growth of The University of Texas at Brownsville (UTB) and The University of Texas at Pan American (UTPA).

Today, both campuses have a modest research-expenditure portfolio of about $10 million per year each. On the other hand, UTB purchased a defunct mall (approximately 600,000 square feet) and converted it into the International Technology, Education and Commerce Campus (ITECC). In 2003 UTB opened a business incubator at ITECC, the International Innovation Center, which has mentored the formation of nearly 70 companies, none from university intellectual property. But the university-sponsored infrastructure is in place and ready for that eventuality. At UTPA a Rapid Response Manufacturing Center, specifically tailored to the needs of Fortune 500 companies, has been created including a business incubator. The first university spinout company, FibeRio, recently enjoyed several injections of capital and won a silver award at the 2010 World's Best Technology Showcase.

Although modest by some metrics, the South Texas region exemplifies how a regional innovation ecosystem can grow for reasons that are understandable after the fact, but likely not predictable at the beginning. Texas has a number of such examples showing the diversity of growing innovation ecosystems including the greater El Paso community and the Permian Basin community. The University of Texas at Permian Basin with a research portfolio of about $5 million per year recently had two startup companies participate in a national webinar seeking venture capital. These Texas examples and many

others beg the question of how one bootstraps an innovation ecosystem and how big and fully formed the ecosystem must be to trigger federal funding.

Metrics for success

Measuring success through metrics is an ongoing issue for technology commercialization. AUTM and APLU have major efforts underway to address the issue. There are many concerns and we list some of them to capture the essence of the debate.

- Failure can be success! Taking risks means some failures will occur, but that is success overall. It is very easy in this game to be trapped by one-dimensional thinking.
- What enterprise or activity are we trying to measure in order to determine success? Is it the research enterprise, the development enterprise, the innovation enterprise, technology transfer with respect to converting invention disclosures into patents and licenses, university engagement with respect to a community, economic development through the formation of startup companies, economic prosperity through either wealth creation or jobs, and so forth? All of these are part of the greater innovation ecosystem and play in some part to the commercialization of university research. Each has its own role to play and metrics appropriate to one are not necessarily appropriate to another.
- Differentiation in the nature of metrics. We have inputs, outputs, and outcomes. But an output for one part of the innovation ecosystem is an input to another part.
- Transactional measures versus portfolio measures. To date, success has been measured mostly by transactional measures (number of patents, licenses, startup companies) rather than portfolio or asset measures (clean energy targets, relationship building with the industry, growth of commercial enterprises).
- Garbage in equals garbage out. For example, AUTM data are self-reported, not all universities report on an equal footing, and some universities don't report at all.
- AUTM data do not reflect the full spectrum of activity. AUTM is one of our Nation's most important assets and the work they do to report university technology transfer activity is essential. However, the AUTM reports capture only part of the activity. For example, in UT System over 80% of the startup companies in System incubators are not reported to AUTM because of the tight definition used by AUTM for a university spinout company. The 18 companies reported to AUTM in the latest report by UT System does not include all 25 that

fit the AUTM definition, nor does it remotely capture the fact that UT System is engaged with over 250 startup companies at present.

- The ranking conundrum. Funding, policy and decisions are often based on one's rank on a given metric, no matter the quality of the data or the appropriateness of the comparison.
- We must beware of becoming what we measure.
- Quantitative metrics are only one aspect – the "story" in its full richness can be equally or even more compelling. Success comes in many forms.

While the traditional metrics for success in specific enterprises such as technology transfer are appropriate and we must continue to use them, America is faced with a compelling need to develop a comprehensive instrument to measure the success of the commercialization of university research, taking cognizance of the issues raised above. It would be fair to say that such an instrument(s) does not currently exist.

> ***Recommendation: OSTP, NEC or PCAST undertake and fund a study to both tease out the complexity of the metrics issue and to provide a framework for developing instruments capable of reflecting success in the commercialization of university research.***

Changes in public policy and funding

The PCAST report entitled *University Private Sector Research Partnerships in the Innovation Economy* captures a major element required for the commercialization of university research: public-private partnerships.[20] Such partnerships take many forms and can be created through numerous mechanisms. In this document we focus on federally funded "lablets" or "innovation hubs" as the best model. The case for innovation hubs comes from many quarters with a focus on energy.[13] Some have argued that innovation hubs or lablets are an appropriate federal response to the putative demise of basic or long-term research in industrial R&D laboratories.[21] Indeed, the disappearance of Bell Labs is the poster child for making the case. We recommend and advocate for innovation hubs.

Innovation hubs are envisioned to be entities comprised of about 100 researchers funded at $25 million per year with an initial startup cost of about $10 million. In our opinion the elements of the concept and the argument for innovation hubs are contained in the following points.

- Discovery-to-innovation institutes melding interdisciplinary research, education, outreach, and practice.

- Partnerships comprised of all innovation entities (universities, national laboratories, industry) with each contributing resources, but with the federal government being the principal financial supporter. The hubs function at the top of a layered architecture for the innovation ecosystem and can be dismantled into their component entities at the end of their lifecycle. The presumption is that the component entities will reassemble into other hubs. There is also the presumption that the lifecycle is driven by performance, not the need to exist.
- A focus on trans-disciplinary grand societal challenges requiring transformational STEM fields to affect the global and knowledge economy of the twenty-first century. Specific industry needs should also be factored into the equation.
- Geographically dispersed and distributed institutes to make use of all resources and consequently enhance all elements and regions of America. Such dispersal allows for formation of connected "dream teams" that mirror the essential structure of the Manhattan Project.
- Experiential learning for undergraduate and graduate students from STEM fields, business, medicine, law, social sciences and creative arts.

While innovation hubs are an essential part of the innovation equation and important to incentivizing connectivity, hubs that are distributed or dispersed across a number of regional innovation ecosystems require that such ecosystems exist with sufficient infrastructure and are appropriately distributed geographically. Such infrastructure requires a federal program complementary to the hub program, but with a significant match from state and regional entities. The Texas Medical Complex and support from CPRIT are an example of such local support that could serve as a base and match. Finding a mechanism to marry innovation hub funding with regional innovation ecosystem funding could be critical. In that regard we point OSTP and NEC to the community of innovation recommendations made by AURP.[3]

Recommendation: Competitive funding for innovation hubs or "lablets" should be significantly increased.

Recommendation: Competitive matching funding to create or enhance regional communities of innovation should be considered.

PART II: Proof of Concept Centers

The phrase "proof of concept center" (POCC) is not a term of art in the world of technology commercialization, although it appears in several reports. Quite frankly, we do not advocate for use of

the phrase. It is ill-defined and specifies a very narrow part of the equation with respect to moving discoveries along the path to commercialization. Although no phrase has clearly emerged to describe the important concept implied by POCC, we prefer the phrase "innovation center." We describe that concept below. One must also ask the question of when an innovation center or POCC has become sufficiently large and encompassing that it *de facto* becomes a university research park. Clarity in distinguishing structure and function in a community of innovation is essential to informing public policy.

Proof of concept is an essential stage in the commercialization process and helps bridge the notion of the "valley of death" along the technological axis. We define "proof of concept" (POC) as being that point at which a nascent idea for an innovation/invention derived from a research discovery first occurs, typically in a university research laboratory. Almost no funding exists currently in the United States to pursue proof of the concept or nascent ideas. Recognizing that fact, UT System and its Board of Regents approved a $2 million investment in the Texas Ignition Fund (TIF) in late 2007 – a POC fund. With the first round of funding occurring in July of 2008, TIF has fully distributed the funds in 45 awards which to date have resulted in the formation of 23 startup companies in under two years! Without doubt, TIF has enormously accelerated and enhanced the commercialization of university research in Texas – a result similar to that found by the Deshpande program at MIT. As a result of that success, the Texas Emerging Technology Fund – a state investment fund sponsored by the Texas Legislature – will shortly announce a similar POC fund providing $1 million to each of its seven Regional Centers for Innovation and Commercialization. We strongly urge the Federal Government to develop programs that provide such POC funding. Supplemental funding to research grants would be one such mechanism. There is no doubt that the POC gap in funding is a major deterrent to commercializing university research.

> ***Recommendation: Create supplemental POC funding programs as part of the apparatus of federal research grants.***

Underlying Conditions and Infrastructure

What is an innovation center? Is it a single entity, a cluster of entities, or even simply a new name for a university research park? When does an innovation center become a university research park or is it a truly distinct concept? What are its functions? SkySong in Phoenix, Arizona, with Arizona State University as the core research university, is an example of a newly formed center.[22] SkySong portrays itself as an innovation center offering the following services:

- Technology transfer
- Direct investment

- Seed capital
- Entrepreneurial training
- Global acceleration
- Student entrepreneurship

I personally consider SkySong to be an enhanced business incubator. BioDesign at Arizona State University is closer to my version of an innovation center and I describe it below.

For me an innovation center is a place where actual innovation occurs in the narrow sense of adding commercial value to an invention disclosure or invention concept. In that sense an innovation center engages in use-driven R&D to produce a commercially scalable product, service, or process. It bridges the technology gap from disclosed invention to commercial invention. While startup companies could be the instrument, I would narrow the focus to one of a university center populated by university personnel as the principal organization. Co-location with industry partners as occurs in the Centennial Park at North Carolina State University is a strong variation. Innovation centers could serve as an experiential learning laboratory for students as described below.

Innovation centers represent a paradigm shift for universities toward performing developmental research, often directly as a surrogate for industry through sponsored research agreements. There are significant issues associated with this shift and some consider the shift a breakdown in the historical and traditional mission of universities. Many including the author believe that this shift is inevitable, has mostly already occurred, and, when properly understood through the Practicum Model described below, represents a new and enhanced version of the traditional mission. Federal funding for such innovation centers will be critical to their growth in America as a component of the innovation ecosystem.

Innovation centers cannot exist and are not sustainable long term unless they are imbedded in communities of innovation. What are the elements of a community of innovation from the perspective of university engagement in the community? There are a number of elements including the following:

- A university commercialization business plan starting with a strategic plan for the office of technology commercialization.
- A university knowledge transfer plan that encompasses all channels for the movement of knowledge outward from the university.
- A practicum or experiential-learning environment for students.
- Access to a POC fund.

- A communications pipeline to investment funding for startup companies.
- An entrepreneur-in-residence program. They are useful and could be federally funded as part of a broader community-of-innovation funding package.
- An incubator for startup companies with the full complement of mentoring and shared services. Federal funding could be critical to seeding such 21st century incubators that are not traditional real estate models.
- An innovation center.
- A university research park.

The Purdue Research Park is an example of a successful community of innovation.[23]

> ***Recommendation: a program to fund innovation centers coupled to communities of innovation or university research parks should be initiated by the federal government.***

Elsewhere, we have advocated for a Practicum Model or experiential learning laboratory as a model and rationale for university engagement in commercialization as reflected in university contributions to a community of innovation described above.[6] While theoretical learning has long been the purview of universities, the 21st century and the students themselves demand that universities also provide experiential learning as a *sine qua non* for workforce development. The elements for a practicum model include the following:

- Involvement of students in all parts of the university commercialization enterprise as both students in degree programs, hired student employees, and interns.
- Entrepreneurial programs for students and faculty.
- Commercialization degree programs similar to the Master of Technology Commercialization at UT Austin. Degree programs with an option in technology transfer management would be useful.
- Practical experience for STEM students that serves to attract students to STEM fields and provide added value entering the STEM workforce.
- Trans-disciplinary communication among students in siloed disciplines preparing them for careers in real-world scenarios.
- A mechanism for involvement of alumnae as partners and sponsors.

- A mechanism for industry involvement through sponsored research agreements addressing industry needs (undergraduate capstone engineering courses on steroids in some manner) and through interactions with the future workforce.

Recommendation: a program to fund the Practicum Model for students should be initiated by the federal government as part of the education of the STEM workforce.

Successful Practices

An example of a successful innovation center created by the author is the Alabama Innovation, Mentoring and Entrepreneurial (AIME) center at The University of Alabama in Tuscaloosa, Alabama. This center was one of the first innovation centers formed and incorporates many of the functions required.[24] The AIME process is as follows: university invention disclosures are triaged by a team including students from various disciplines. Those disclosures with commercial potential but with a need for market analysis or additional R&D are submitted to AIME. Intellectual property or inventions from external sources are also considered. AIME houses a permanent R&D staff who work with faculty and student teams to pursue development of the invention, often by introducing new innovations. Industry sponsored development also occurs at AIME. The Bama Technology Incubator provides a home for companies spun out from AIME R&D.

The Biodesign Institute at Arizona State University and its related Impact Accelerator couple with SkySong to form a new community of innovation in Tempe, Arizona.[25] The function of Biodesign is similar in many ways to AIME and is an example of an innovation center in the sense of this document. Quoting from one of their pamphlets, "Biodesign's leadership team encompasses skills in science, medicine, engineering, computing, strategy, communication, and business to ensure that its research yields a clear societal benefit as rapidly as possible." The pamphlet further states that "It has infused its programs with a focus on interdisciplinary teams and accountability to deliver practical solutions." The Biodesign Institute is an example of use-driven research in Pasteur's quadrant. As opposed to the macro-challenge approach of a hub or lablet, Biodesign represents smaller-scale challenges, but with a thematic research focus, collected together into a single entity having an overarching approach to commercialization of university research. The concept and approach is worthy of consideration and replication.

Success Metrics

The issue of metrics for success is similar to that described in Part I; however, there are several metrics specific to innovation centers and communities of innovation that we describe in the following points.

- Traditional economic development metrics are appropriate. These include the success ratio of startup companies as a result of mentoring from the community, the number and size of successful regional companies, their rate of growth, and the number of jobs in different categories formed in the community.
- The growth of innovation clusters in specific sectors.
- The downstream success of the Practicum Model in forming a community of entrepreneurs and innovators.
- The successful careers of graduates whose experiential learning was enhanced by the centers.

Endnotes

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