FIFTH REPORT ON

The Condition of Higher Education in Ohio: **Advancing Ohio's Innovation Economy**

2012

Ohio

John R. Kasich, Governor
Jim Petro, Chancellor

University System of Ohio
Board of Regents

Ohio Board of Regents

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Chancellor, Ohio Board of Regents
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Ohio | University System of Ohio
Board of Regents

On June 27, 2012, the fifth report on *The Condition of Higher Education in Ohio: Advancing Ohio's Innovation Economy* was respectfully submitted to the Ohio Board of Regents for consideration. After review and discussion, the Report was unanimously approved.

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Sen. Peggy Lehner

Rep. Gerald L. Stebelton

Dear Governor Kasich, Speaker Batchelder, President Niehaus, Leader Kearney and Leader Budish,

Pursuant to the requirements of Ohio Revised Code section 3333.032, the Ohio Board of Regents is pleased to submit this fifth report on the Condition of Higher Education in Ohio. The report, entitled "**Advancing Ohio's Innovation Economy,**" comes out of the work of the Regents' Commercialization Task Force, the culmination of eight months of intense effort by thirty-two state leaders in technology commercialization, venture capital, finance and higher education. The Task Force was created in direct response to Governor John Kasich's call for increased job creation and economic growth in recognition that Ohio is in the process of recovering from one of the deepest economic recessions in modern times. To address this situation, the Ohio Board of Regents stands firmly with the Governor that Ohio must stimulate the development of a more competitive, high-growth economy that will generate the high-value, high-wage jobs of the future, requiring an ever-increasing supply of new products and services.

To achieve this goal the Board of Regents and Chancellor Jim Petro believe Ohio must establish a firm foundation of ongoing technology-intensive development, and grow a workforce with the requisite skills to promote and support technology commercialization statewide – in effect form the State of Ohio's plan for "technology commercialization 2.0", thus putting in place a plan to bring us to parity or beyond with other states' systems across the country.

It will be critical to devise effective solutions to address issues that inhibit the state from reaching its full innovative potential and achieving the commercialization success we seek. For instance, it is generally agreed that a vast majority of Ohio's higher education institutions (HEIs) research is not monetized through commercialization of its resulting technologies. We also know that in order for the state to compete successfully in the global innovation economy, industry-higher education collaboration must accelerate in the 21st century. The Commercialization Task Force was created for the expressed purpose of devising solutions to these and other issues; specifically charged with addressing five key areas that required investigation and analysis as framed by the following questions:

- How can Ohio-based companies make sound research and development (R&D) decisions when the basic scientific knowledge is expanding faster than conventional management systems can handle?
- How can the physical resources, knowledge and experience within university research groups best be channeled to industrial firms (both large and small) and vice versa?
- How can our university assets and faculty be effectively engaged so that intellectual property rights can be jointly developed and/or shared when industry and universities work collaboratively during the early/upstream stages of technology development?
- How do we provide an incentive to help us get the commercialization system moving in the right direction towards our goals?
- How can we leverage the research and commercialization ecosystem that the Ohio Third Frontier has created including leveraging a closer collaboration with the University System of Ohio and JobsOhio?

In addressing these five questions and preparing this Condition Report, *Advancing Ohio's Innovation Economy*, the Board of Regents and the Chancellor believe the Task Force has provided a road map for how Ohio can improve higher education-industry collaborations throughout the state with the expressed goal of promoting statewide and regional economic development and creating new high-value jobs for the benefit of all Ohioans. In preparing their recommendations, the Task Force identified seven themes which must be acknowledged and addressed if Ohio is to achieve the goal of increasing technology commercialization activity through industry and higher education collaboration. The threads of these seven themes are found in each of the Task Force's six sub-committee reports within this Condition Report. The seven key themes are as follows:

- Higher education leadership in the 21st century must promote an environment that supports industry-higher education collaboration in order to expand the technology commercialization pipeline;
- Ecosystems that support technology commercialization are essential and must be built collaboratively by industry, higher education, and government leaders;
- Accelerating technology commercialization requires a robust funding continuum from proof-of-concept to seed-stage to later-stage venture capital, and depends on both public and private support to insure its availability;
- Formal communication networks and databases are essential for sharing knowledge and identifying collaborative opportunities that otherwise may not be possible due to the complexity of accessing critical information;
- The next generation of technology innovation will come from today's students who should be exposed to an entrepreneurial curriculum, provided with real life experiences, and supported in promoting their intellectual property ideas;
- The innovation economy needs more than STEM expertise and the workforce continuum that is essential to promoting technology commercialization requires many different skill sets and;
- To successfully achieve the goal of promoting technology commercialization, industry, higher education and governmental leadership must work together to identify and track measurable outcomes.

The Task Force's study and analysis of these themes resulted in recommendations contained in this Report, which are summarized below. In the aggregate, the recommendations require joint collaboration between adademia, industry, and government.

1. **REMOVE BARRIERS**: Remove barriers within and among Ohio universities and colleges that restrict entrepreneurial activities and technology commercialization

2. **BUILD STATEWIDE AND REGIONAL ECOSYSTEMS**: Build statewide and regional ecosystems that support Ohio's technology commercialization pipeline

3. **PROMOTE GREATER STATEWIDE AND REGIONAL COLLABORATION**: Promote higher education, industry, government and community collaboration in support of statewide and regional economic development

4. **CREATE AN ENTREPRENEURIAL ENVIRONMENT**: Nurture an environment and promote changes that support, promote and reward entrepreneurial activity within Ohio's HEIs

5. **RESEARCH COOPERATION**: Facilitate higher education and industry research collaborations to more efficiently and effectively utilize our HEI resources to support and attract industry to Ohio

6. **GENERATE CAPITAL RESOURCES**: Develop initiatives that provide the capital resources necessary to support the Innovation Continuum and promote the growth of new industry

7. **PLAN FOR FUTURE WORKFORCE EDUCATION AND JOB SKILL TRAINING**: Develop a Workforce Commercialization Continuum—in conjunction with the Governor's Office of Workforce Transformation—that identifies current and future requisite jobs skills and proficiency

8. **DEFINE METRICS**: Identify, apply and track key metrics to measure Ohio's progress related to technology commercialization and job creation.

The Regents assert that this report reflects an accurate description of the status of commercialization within the state of Ohio. The report calls for significant change and will require legislative action, in addition it will require cultural changes within Ohio's HEIs. Because of the magnitude of the changes that are envisioned, these changes will require patience and adequate time for implementation.

What is also clear from the Task Force efforts is that Ohio does not need to start from scratch in building a world-class commercialization infrastructure. By any measure, Ohio has the intellectual capacity, the facilities, the industrial and higher education leadership and emerging growth industries necessary to compete on a global scale. What is needed is a unified vision across government, higher education and industry that will act as the catalyst to creating the partnerships necessary to accelerate and enhance commercialization in Ohio. Given the energy and enthusiasm experienced from the Board of Regents' constituencies engaged in this process, we are confident that the conditions are right to achieve this goal.

In forwarding this Condition Report to you, the Regents want to recognize and applaud the work of the Commercialization Task Force members and thank them for their efforts on behalf of the citizens of Ohio. We further look forward to the opportunity to meet with each of you to discuss these recommendations in detail and begin the conversation on the critical next steps needed to continue to move Ohio's commercialization process forward.

Respectfully Submitted,

Jim Tuschman
Chair, Ohio Board of Regents

Vinod (Vinny) Gupta
Regent, Chair of the Ohio Board of Regents' Innovation, Technology Transfer and Commercialization Task Force

Task Force Membership

Chair, Commercialization Task force

Vinny Gupta, Regent, Ohio Board of Regents

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Phil Brennan, CEO, Echogen Power Systems Inc.
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Executive Summary

FIFTH REPORT ON

The Condition of Higher Education in Ohio: **Advancing Ohio's Innovation Economy**

Executive Summary

The Governor's Vision

Governor John Kasich has identified job creation and sustainable economic growth as his administration's highest priority for the State of Ohio. Governor Kasich's focus on economic growth comes at a time when Ohio is in the process of recovering from one of the deepest economic recessions in modern times; in addition to the fundamental restructuring of the State's historical manufacturing economy. To address this situation, the Governor believes Ohio must stimulate the development of a more competitive, high-growth economy that will generate the high-value, high-wage jobs of the future, requiring an ever-increasing supply of new products and services. To successfully compete in an increasingly competitive global economy, the Governor believes Ohio must establish a firm foundation of ongoing technology-intensive development, and develop a knowledge-based workforce with the requisite skills to promote and support technology commercialization.

The Board of Regents' Response

In concurrence with Governor Kasich's vision for economic growth within Ohio, The Ohio Board of Regents and Chancellor Jim Petro—based on the work of the Kauffmann Foundation and a number of leading economists that found this country's job creation is driven by firms less than five years old—seek to more effectively engage the University System of Ohio in promoting greater collaboration with industry in order to achieve economic productivity, prosperity, and statewide and regional vitality. **By most measures Ohio lags the nation in these types of collaborations.** The Board of Regents and the Chancellor believe that for Ohio to compete successfully in the global innovation economy, industry-higher education collaboration must accelerate in the 21st century. The Regents and Chancellor are committed to improving higher education-industry collaborations throughout the state with the expressed goal of promoting statewide and regional economic development and creating new high-value jobs for the benefit of all Ohioans.

The Regents and Chancellor believe that for Ohio to successfully compete in the global innovation economy, there were five key areas that required investigation and analysis as framed by the following questions:

1. How can Ohio-based companies make sound research and development (R&D) decisions when the basic scientific knowledge is expanding faster than conventional management systems can handle?
2. How can the physical resources, knowledge and experience within university research groups best be incentivized and effectively channeled to Ohio industrial firms (both large and small) and vice versa?
3. How can Ohio's higher education institutions' (HEI) assets and faculty be effectively engaged along with Ohio-based industry partners so that intellectual property rights can be jointly developed and/or shared when industry and universities work collaboratively during the early/upstream stages of technology development?
4. How do we provide an incentive to help get the State's commercialization system moving in the right direction towards our goals?
5. How can we leverage and strengthen across the state and regionally the ecosystem the Third Frontier has created through a closer collaboration with the HEI?

Task Force Formation

Chancellor Jim Petro and the Ohio Board of Regents created the Regents' Technology Transfer and Commercialization Task Force – comprised of 32 leaders from higher education, industry and government – with the expressed mandate to propose a statewide commercialization ecosystem that will create jobs, promote economic growth, and/or increase wealth in Ohio by effectively and efficiently a.) Moving university-developed research into commercial applications, b.) Engaging university faculty in the support of the commercialization of industry-based research, and c) Encouraging industry, universities and colleges to jointly develop and commercialize new science, new technologies, and new products, with the ultimate goal of creating and attracting new businesses to Ohio, expanding existing Ohio businesses and making Ohio businesses more competitive on a global scale.

Identified Current Conditions

Over the past eight months, the Board of Regents' Technology Transfer and Commercialization Task Force has studied Ohio's Innovation Continuum (Figure 1 below) and determined that a multi-pronged strategy is required for the state to successfully compete with other states nationally and in the global innovation economy. Task Force members found Ohio must develop and promote a robust technology commercialization pipeline and the ecosystem to support it. In order to understand how best to accomplish this, the Task Force believes it important to understand the differences between "technology transfer" and "commercialization":

- **Technology transfer** refers to the process of transferring a technology or product developed at a university to an outside entity, usually a company.
- **Commercialization** refers to the process of taking a technology or product to market.

The Task Force found that at several of Ohio's HEIs the function of technology transfer does not clearly differentiate between these two functions, which leads to inefficiencies, confusion and less than optimal deployment and monetization of Ohio's technology assets.

Ohio's Innovation Continuum

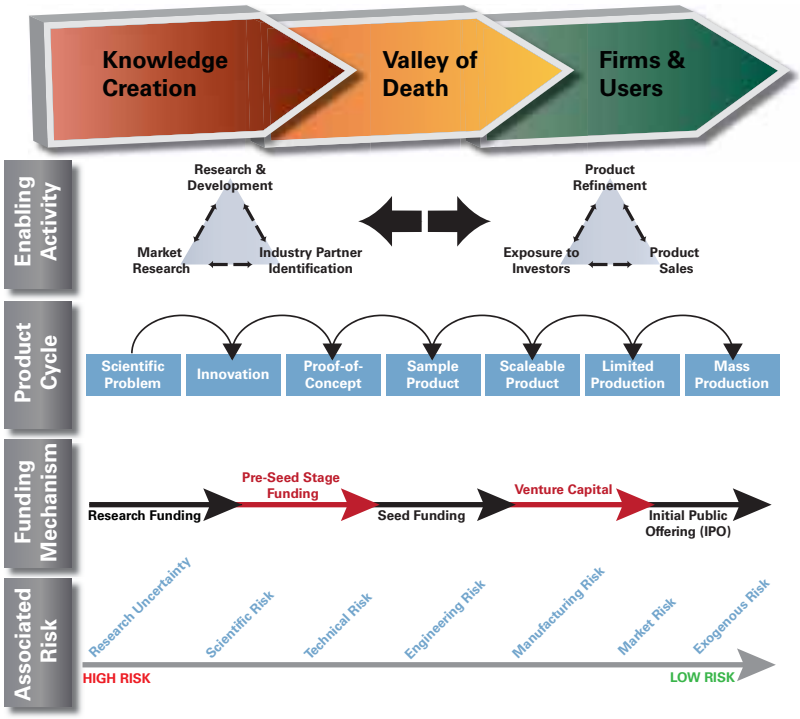


Figure 1

As the Innovation Continuum above depicts, success in creating a "virtuous" Innovation Continuum in support of technology commercialization activity requires synergistic research and development (R&D) relationships between HEIs and industry, and will also require the alignment of appropriate funding streams to support early stage technology development, pilot production and proof of concept, and full-scale commercialization of new technologies, products, and businesses.

Ohio's Challenges

The Technology Transfer and Commercialization Task Force's eight-month review of Ohio's Innovation Continuum has uncovered a major problem that dramatically reduces the State of Ohio's effectiveness in job creation. Specifically, it is generally agreed that a vast majority of Ohio's HEI research is not monetized through commercialization of its resulting technologies. The Task Force's research relies on the most recent annual licensing survey data from all U.S. universities collected by the Association of University Technology Managers (AUTM) demonstrating clearly that Ohio's universities rank well below the average for universities in other states when comparing both the gross return of commercialization revenue relative to the volume of research expenditures as well as the efficiency in which invention disclosures are converted into commercial applications.

In trying to understand why this was so, the Task Force sought out national benchmark data and learned that the state lagged behind many of its peers in promoting and supporting technology commercialization. Two specific studies the Task Force reviewed were the *Milken Institute's State Technology and Science Index* (1) and the *Ewing Marion Kauffman Foundation's State New Economy Index*. The *Milken Institute State Technology and Science Index* looks at 79 unique indicators that are categorized into five major components: 1) research and development inputs; 2) risk capital and entrepreneurial infrastructure; 3) human capital investment; 4) technology and science workforce; and 5) technology concentration and dynamism. It is perhaps the most comprehensive examination of state technology and science assets available today, and **in 2010 Ohio ranked 20th in research and development; but 29th overall—a "third-tier state."**

The *Ewing Marion Kauffman Foundation's 2010 State New Economy Index* measures 26 separate indicators to ascertain whether or not a state's economy is knowledge-based, globalized, entrepreneurial, information technology-driven and innovation-based. By this measure, **Ohio ranked in the middle of the fifty states at 25th overall, but only 38th nationally in terms of its "economic dynamism."**

Based on these nationally recognized indices the Task Force has concluded that Ohio cannot successfully compete in today's global economy without addressing these significant deficiencies, and Ohio's HEIs must redouble their efforts to more effectively leverage their existing research strength, academic entrepreneurial capacity and focus on forming new HEI-industry partnerships if the state is to achieve the Governor's vision of a high-growth economy that generates high-value, high-wage jobs in the coming years.

Ohio's Strengths

Although Task Force members found a number of challenges to promoting higher education technology commercialization, they also noted that Ohio has significant capacity which they believe must be more effectively leveraged. The AUTM data cited above further showed Ohio's "innovation" activity above average in terms of: a) the total annual volume of external funding garnered for academic research activities; b) the annual volume of university research funded exclusively by industry; c) the annual number of invention disclosures filed with university technology transfer offices; d) the annual number of patent applications filed; e) the number of U.S. patents issued to Ohio universities each year; and f) the annual number of new business start-ups spun off of university intellectual property.

Specifically, Ohio's public universities are currently ranked sixth nationally in total research funding. The grand total for annual R&D expenditures in FY 2010 at all Ohio universities was $2.01 billion based on the most recent national data published by the National Science Foundation. And, largely owing to Ohio Third Frontier incentives, industry-financed research at the state's public and private universities doubled between 2003 and 2009 to nearly $160 million – well above the national average per state of just over $60 million. In fact, for FY 2010 Ohio State University once again ranked second nationally among all universities in terms of industry-funded research with $120 million in annual R&D expenditures from industrial sponsors, as reported by the National Science Foundation.

The Task Force also made note of the Ohio Third Frontier (OTF), a signature program, which was initiated in 2002 to create jobs and advance Ohio's economic competitiveness through industry and university technology commercialization. Since its creation, OTF has developed a successful national paradigm for public-private partnerships that enables the state's institutions of higher education to work effectively with industry for successful technology transfer and eventual commercialization. As a result, OTF has won voter approval for funding in two different elections.

Critical elements of the OTF model include:

- Basic and applied research specifically directed toward the ultimate goal of commercialization;
- Research Scholars Program that has invested $153 million in 26 endowed chairs to pursue use-directed research and commercialization at Ohio's public and private universities;
- Entrepreneurial Signature Program that supports six regional networks of entrepreneurial services and capital to accelerate the growth of early-stage technology companies[1];
- Pre-Seed Fund Capitalization Program to increase the availability of professionally managed capital and associated services to accelerate the growth of early-stage technology companies; and
- Long-term state support with an emphasis on leveraging additional federal and private resources;

Task Force members strongly assert that incentive programs such as the OTF are critically important for the state's achievement of its long-term economic development goals. This assertion is based on documented OTF outcomes: a) nearly 80,000 jobs generated; b) $7 billion in leveraged funds from federal agencies and industrial firms; and c) more than 700 companies created, attracted, or capitalized since OTF's inception in 2002.

1 The Entrepreneurial Signature Program organizations are being evaluated as part of the competitive review of the funding requests submitted in response to the FY 2012 *Entrepreneurial Signature Program Continuity Initiative* RFP opened on December 9, 2011 and the program, as a whole, will continue to be evaluated as part of the FY 2013 strategic planning process for the Ohio Third Frontier.

Successful implementation of the Task Force's recommendations will require that the state build upon OTF and fully utilize the OTF resources to commercialize new technologies and create new businesses. To do so, the Task Force recommends that Ohio build strong statewide and regional economies, supporting the business sector to successfully compete globally. OTF's strategy of building statewide and regional ecosystems *(Figure 2)* is essential to a strong "Innovation Continuum."

Comprehensive Ecosystem for Sustainable Economic Growth

Figure 2

In addition to the importance of establishing a direct link with the Ohio Third Frontier, the task force unanimously supports the well-established concept of using financial incentives to begin to establish a robust, statewide technology commercialization pipeline. With the addition of the proposed Commercialization Incentive Program (CIP), currently under consideration as a draft request for proposals, there would be an immediate kick-start to the recommendations contained in this report. By employing the carefully crafted CIP incentives the state would be able to create early momentum for the changes outlined in the present study and begin to shape the behaviors necessary for success.

Public & Industry Input

The public forums sponsored by the Task Force subcommittees confirm that Ohio possesses many of the requisite skills and assets to thrive in a 21st century technology-driven, knowledge-based economy. However, the University System of Ohio and the State of Ohio must build the infrastructure and business climate required to accelerate the commercialization of emerging technologies so that these new businesses can thrive and compete in world markets. The Task Force believes that for Ohio to achieve sustainable economic growth in the 21st century in highly competitive growth industries, the University System of Ohio and the State of Ohio must jointly invest in the critical infrastructure necessary to support and promote the creation of intellectual property (IP) in science and technology, and must support the subsequent commercialization of that IP.

Public forum attendees frequently commented that: (1) investment in incubators, innovation centers and research parks was an effective approach to creating platforms for promoting industry and higher education partnerships; and (2) incubators and innovation centers are essential to the goal of supporting statewide and regional economic development.

Task Force members also concluded that the development of statewide and regional ecosystems will enhance the state's competitive position by enhancing the ability of universities to recruit and retain faculty and to support the emergence of faculty-initiated emerging technology companies by ensuring the sufficiency of – human, infrastructure, capital and financial resources that will be necessary to help new businesses grow and prosper.

Other national studies[2, 3] have determined that linking innovation assets—including people, institutions, capital and infrastructure—is essential to creating robust, localized ecosystems that can turbo-charge a state's or a region's economy. These studies have further found that successful in-

2 A forum entitled Catalyzing University Research for a Stronger Economy was convened by the U.S. Commerce Department in February, 2010 on how to use academic research to create new jobs and new products. The forum concluded that, in general, universities deserve high marks for the quality of their research but need significant improvement for moving those innovations into the marketplace; however, it was also noted that other players, not just the universities, bear responsibility for filling the voids in the innovation ecosystem that make it difficult to get academic inventions to the point where businesses or venture-capital firms will invest in them.

3 Universities across the nation are currently engaged in many activities that promote innovation, entrepreneurship, and the commercialization of research results, and they are committed to working collectively to implement the recent recommendations made by the National Research Council of the National Academies in its October, 2010 report, entitled Managing University Intellectual Property in the Public Interest. This study represents the most up-to-date and comprehensive national analysis of how U.S. academic institutions currently manage the intellectual property produced by their faculty and students as well as the impact of the incentives that influence faculty behavior in pursuing innovations.

dustry-higher education collaborations[4] are dependent upon the existence of these comprehensive ecosystems for the provision of the requisite financial, managerial and business development services and resources that are essential to supporting start-up companies that are based on emerging technologies. The importance of developing these ecosystems statewide is a strategy that many members of the Task Force feel is essential if Ohio is to maximize the research engines it has created and supported throughout Ohio's HEIs.

Recurring Themes

The Task Force identified seven recurring themes, which they believe inform this Condition Report's findings and recommendations and need to be addressed if the Regents and Chancellor's goal of increasing technology commercialization activity through industry and higher education collaboration is to be achieved. The threads of these seven themes are found in each of the sub-committee reports within this Condition Report. They provide the framework for the Task Force's summary recommendations. The seven key themes are as follows.

1. Higher education and industry leadership in the 21st century must promote an environment that supports industry-higher education collaboration in order to expand the technology commercialization pipeline;

2. Ecosystems that support technology commercialization are essential and must be built collaboratively by industry, higher education, non-government organizations (NGO) and government leaders;

3. Accelerating technology commercialization requires a robust funding continuum from proof-of-concept to seed-stage to later-stage venture capital, and depends on both public and private support to ensure its availability;

4. Formal communication networks and databases are essential for sharing knowledge and identifying collaborative opportunities that otherwise may not be possible due to the complexity of accessing critical information;

5. The next generation of technology innovation will come from today's students who should be exposed to an entrepreneurial curriculum, co-ops and internships, provided with real life experiences, and supported in promoting their intellectual property ideas;

6. The innovation economy needs more than STEM expertise; the workforce continuum, which is essential to promoting technology commercialization, requires many different skill sets; and

7. To successfully achieve the goal of promoting technology commercialization, industry, higher education and governmental leadership must work together to identify and track measurable outcomes.

4 Michael M. Crow, President of Arizona State University, is pioneering the foundational model for the "New American University" that is committed to academic excellence, inclusiveness, and maximum societal impact. Three of the eight objectives for the New American University are directly relevant to the present study and should be embraced by all universities:
1. Become a force for societal transformation;
2. Pursue a culture of academic enterprise and knowledge entrepreneurship; and
3. Conduct use-inspired research.

The Task Force's summary recommendations and proposed implementation steps are intended to help focus near-term resource allocation decisions and efforts to address these seven themes. In the aggregate, these recommendations require joint collaboration between academia, industry, and government *(Figure 3)*. The summary recommendations complement the individual subcommittee recommendations identified in the body of the Condition Report. Collectively, the Task Force believes its recommendations represent a road map for how Ohio can strategically reposition itself to successfully compete in the innovation economy and to become a regional and global market leader.

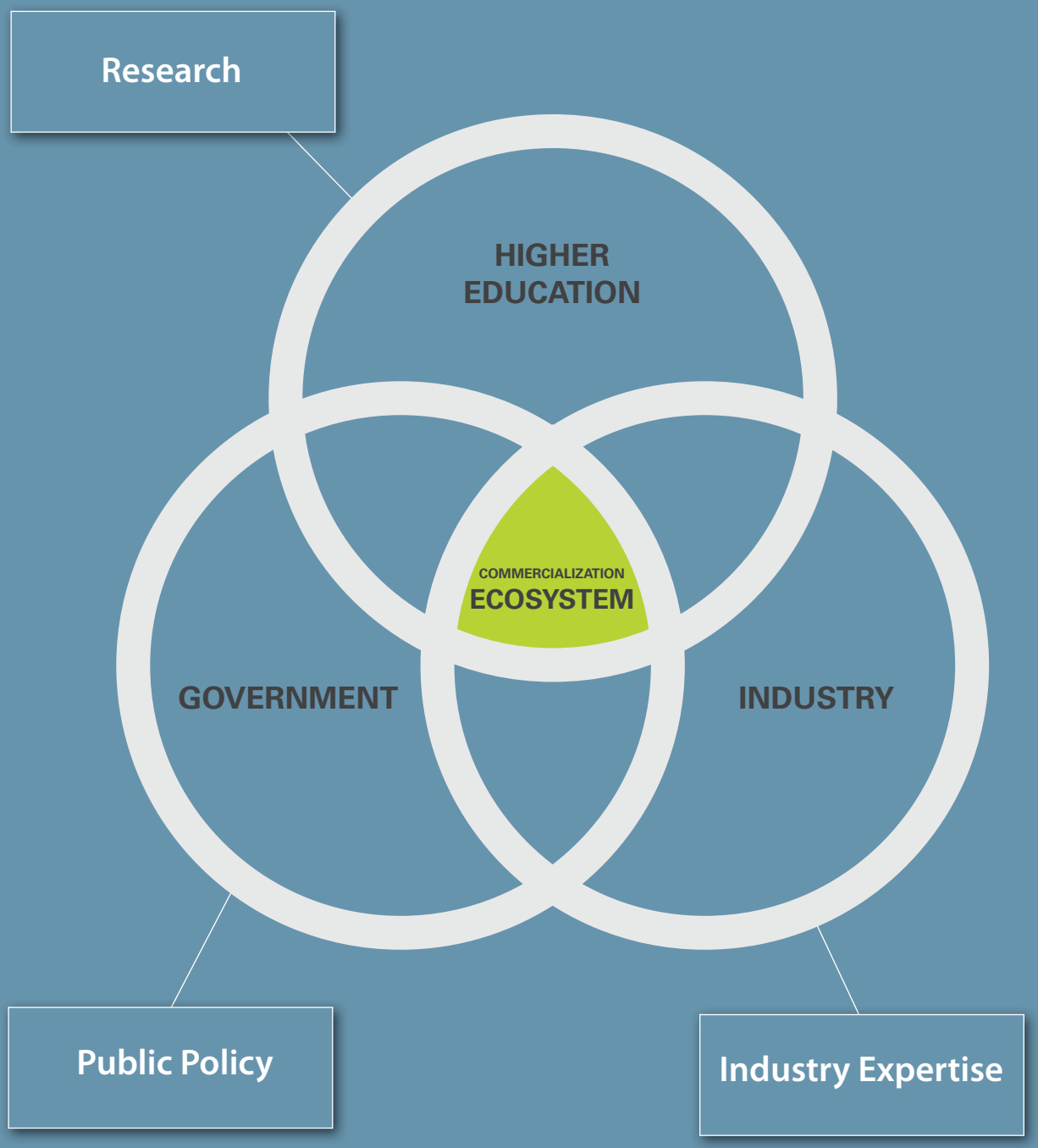
These Task Force summary recommendations are more explicitly articulated in the six subcommittee reports, but the essential findings and recommendations are summarized below. The Task Force members assert that these recommendations, if implemented, will have a powerfully positive impact on Ohio's economy and the quality of life for all Ohioans. The specific subcommittee recommendations are as follows:

SUMMARY RECOMMENDATIONS: PROPOSED IMPLEMENTATION STEPS

ACTION TITLE	DESCRIPTION	IMPLEMENTATION STEPS
Capital Continuum	Ohio should support development of investment capital, from proof-of-concept, to pre-seed and seed-stage funds, to early-stage (Series "A" and "B") venture funds; employing capital from both public and private sources. Concurrently, Ohio should promote statewide and regionally based "first institutional funds" to focus on HEIs and industry technologies with commercial applications.	Maintain and expand Ohio Third Frontier seed-stage funding and the six Entrepreneurial Signature Programs; maintain and expand the Ohio Fund; develop incentives to attract "first institutional" and later-stage external funding to Ohio; expand opportunities for Ohio universities, colleges and private industry to invest in Ohio generated IP, and provide incentives for third-party angel and pre-seed investors.
University Incentive Systems	HEIs, in consultation with the Board of Regents should develop strategies that promote a "culture of entrepreneurship"—i.e., curricular and innovation—on university and college campuses by rewarding and incentivizing entrepreneurial activities by faculty, and developing user-friendly approaches to commercialization of HEI-based technologies.	HEIs' leadership must recognize and link applied research, the creation of intellectual property, and commercialization activities within the promotion and tenure review process; eliminate barriers to intra- and inter-university research collaboration and restructure university technology transfer and commercialization practices by creating user-friendly industry agreements, developing research information portals, and encouraging industry collaborations earlier in the technology development continuum.
University Entrepreneurship Programs	HEIs should allocate additional resources to expand entrepreneurial programming and curricular activities, including, but not limited to, providing rigorous STEM curricular options on campus and online and by providing more opportunities that can be accessed by students, staff and faculty who have an interest in entrepreneurship.	Ohio's 4-year universities and 2-year community colleges should expand their entrepreneurial curricula, collaborate with corporate partners to offer expanded student internships, and cooperative experiences, promote meaningful business plan competitions, and develop experiential learning opportunities with start-up companies.

Figure 3

Ecosystems that support technology commercialization must be built collaboratively by industry, higher education, and government leaders.



ACTION TITLE	DESCRIPTION	IMPLEMENTATION STEPS
State Policy Support for Entrepreneurial Activities	In order to successfully leverage the broad-based diversity within Ohio's HEI research platforms, the state should encourage the development of statewide and regionally based strategies that are focused on the knowledge-based economy, and the state should support the adoption of policies and procedures that incentivize the recruitment and retention of high-tech businesses, and the talent to run them. The state should work with Ohio's Congressional delegation[5] to organize federal support of commercialization and identify key representatives from industry, higher education and government, including the Board of Regents, to lead and champion this critical initiative at both the state and regional level.	The Chancellor and Board of Regents should work with university and industry leaders, the Third Frontier and JobsOhio, to (a) promote the formation of public-private partnerships statewide; (b) work with universities, community colleges, industry and government to review state laws; (c) identify opportunities to incentivize private investments in technology commercialization activities; (d) promote statewide and regionally based economic development strategies that target and/or leverage existing statewide and regional resources; and (e) collect and disseminate data to measure the state's competitiveness in the global innovation economy.
Workforce Development: Linking Research Universities and Community Colleges in the Technology Commercialization Process	The State of Ohio must better align Ohio's HEIs and PreK-12 education with the emerging needs for both STEM and skilled workers with new competencies and attributes in order to support Ohio economic recovery and growth through increased commercialization in targeted technology and industrial sectors.	Ohio's HEIs should establish a statewide goal to increase the pipeline of STEM graduates over the next ten years, and should take responsibility for working directly with PreK-12 systems to increase the pipeline of graduating high school seniors who are qualified in the STEM disciplines. The Governor's Office of Workforce Transformation, in collaboration with OBR and the Task Force Subcommittee on Workforce, should develop a Workforce Commercialization Continuum that identifies current and future requisite jobs skills and proficiencies and, in partnership with Ohio's HEIs, should develop strategies to train and provide Ohio's current and future workforce at the PreK-12, community college, and university level. OBR and the Ohio Third Frontier should work collaboratively to develop internships and other experiential learning opportunities for students to develop the necessary skills to compete in the global innovation economy. This will require engagement of industry with a demand for new interns, particularly as part of OBR's pending Co-op and Internship fund.

5 The Ohio Delegation, particularly Senators Brown and Portman, is requested to strongly encourage key federal agencies (including HHS (NIH), DOE and DoD (DARPA, DTRA, DHS)) to require and or incent rapid commercialization of research results where appropriate. In particular, the SBIR/STTR programs now in effect do not achieve desired commercialization results, in part because they do not adequately encourage participation by universities and university researchers. More effective use of the 2.5% of all research funding that currently goes to support these programs could be made by establishing a different mechanism.

ACTION TITLE	DESCRIPTION	IMPLEMENTATION STEPS
Ecosystem Development	Working collaboratively, industry and higher education leadership – with the support of government – must develop a comprehensive profile of the resources required, including the financial, managerial, and technical resources that will be required to sustain a statewide and regionally-based ecosystem, essential to supporting university and industry activities throughout the State of Ohio.	The OhioThird Frontier must promote a user-friendly industry/academia interface by examining how the Entrepreneurial Signature Programs might be improved or enhanced in order to create an environment of shared purpose; and to align the values and expectations both of industry and higher education. HEI leadership, in partnership with industry and government leaders, must work to integrate and/or develop the infrastructure and the systems essential for building and supporting entrepreneurial activity (early stage collaborations, master agreements, expert databases, Small Business Development Centers (SBDC) activities, etc.) within the Ohio Third Frontier, and to collaboratively devise incentives to encourage industry/HEI collaborations.
Incubator Capacity	HEIs should provide incubator capacity where faculty and industry collaboration can occur and where start-up companies can find a nurturing environment.	Ohio's HEIs should identify opportunities to partner with community colleges to create or expand incubator capacity and should take the lead in developing collaborative strategies to support early stage start-ups and joint ventures. Given the inherent flexibility in the community college business model, four-year universities should make it a priority to collaborate with community colleges to promote technology commercialization. Government should develop and offer incentives supporting universities and community colleges entering into such collaborations.
Program Metrics	Annual data collection and publication of performance metrics should be central to the state agencies and to the universities that support and promote economic development and that make decisions regarding the application of critical resources, including human, facilities or capital resources.	Implementation of these recommendations should include the development of a data collection system—built in cooperation with the appropriate state agency(s)—with the appropriate benchmarks to measure the effectiveness of state and university policies and practices to build the innovation pipeline and support Ohio's technology commercialization strategies of recruiting and retaining high-paying jobs in key industrial sectors. Data sets should measure the state's capacity to support innovation, innovation development activity, and the impact (outputs) of those activities on the state, Ohio's HEIs and statewide and regional economic growth. Best practices should be shared among Ohio colleges and universities.

ACTION TITLE	DESCRIPTION	IMPLEMENTATION STEPS
Updated Industry Agreements	Ohio's HEIs should seek long-term relationships with key corporate partners, governed by updated general umbrella agreements. These agreements should be sensitive to proprietary interests, emphasize strategic partnerships, goals, strategies, evaluation and timelines; not just licensing revenues and/or service agreements.	To promote industry and higher education collaboration and to achieve high-value and high-impact relationships, Ohio's HEIs should standardize industry material transfer agreements (MTAs) and licensing agreements to be more "user" friendly; university offices of Technology Transfer should seek to improve their overall efficiency, work to identify and encourage key industry strategic partnerships and promote the development of comprehensive relationship agreements that facilitate faculty-industry interactions.
Portals and Enhanced Communications Networks	Ohio should develop institutional portals and communication networks to advertise HEI faculty IP, research strengths and activities and to promote strategies to make it easier for industry to interact with faculty who have an interest in working with industrial partners. The state, in partnership with Ohio's HEIs, should implement a strategic communication plan for defining state policies, procedures and support systems intended to advance the commercialization of university technology.	The Ohio Board of Regents (OBR), in collaboration with Ohio's HEIs, should establish business engagement portals for each university and college, in order to market their patent portfolios and to share and promote their respective research capabilities. The OBR and HEIs must develop strategies for advertising and promoting faculty research interests and expertise, and work cooperatively with key industries to facilitate their introduction to and interaction with key faculty. The state should also consider a policy of providing a benefit for industries to invest cash resources in university research and development to further strengthen industry-higher education collaboration throughout the state.

Conclusion

The Task Force's findings and recommendations can be summarized as follows:

1. **REMOVE BARRIERS**: Remove barriers within and among Ohio universities and colleges that restrict entrepreneurial activities and technology commercialization

2. **BUILD STATEWIDE AND REGIONAL ECOSYSTEMS**: Build statewide and regional ecosystems that support Ohio's technology commercialization pipeline

3. **PROMOTE GREATER STATEWIDE AND REGIONAL COLLABORATION**: Promote higher education, industry, government and community collaboration in support of statewide and regional economic development

4. **CREATE AN ENTREPRENEURIAL ENVIRONMENT**: Nurture an environment and promote changes that support, promote and reward entrepreneurial activity within Ohio's HEIs

5. **RESEARCH COOPERATION**: Facilitate higher education and industry research collaborations to more efficiently and effectively utilize our HEI resources to support and attract industry to Ohio

6. **GENERATE CAPITAL RESOURCES**: Develop initiatives that provide the capital resources necessary to support the Innovation Continuum and promote the growth of new industry

7. **PLAN FOR FUTURE WORKFORCE EDUCATION AND JOB SKILL TRAINING**: Develop a Workforce Commercialization Continuum—in conjunction with the Governor's Office of Workforce Transformation—that identifies current and future requisite jobs skills and proficiency

8. **DEFINE METRICS**: Identify, apply and track key metrics to measure Ohio's progress related to technology commercialization and job creation.

Given the results of this task force study and recognizing the fact that communities compete globally in a world built on statewide and regional economies, the path forward is clear: Ohio must develop strong statewide- and regionally based partnerships that bring industry, higher education and government together with statewide and regional organizations to build the infrastructure necessary to support the Task Force's recommendations. The resulting economic development plans need to be focused on growing technology commercialization as well as creating new business start-ups and high-paying, quality jobs statewide. The Task Force believes that this can best be accomplished statewide and regionally, as it is understood each region possesses its own unique set of strengths that will allow it to optimize its efforts to secure both public and private resources.

Finally, in order to ensure that Ohio is successful in growing its technology commercialization pipeline, the Task Force recommends that feedback loops be developed that measure the state's, as well as each region's, effectiveness in leveraging existing capacity to promote high-value economic impact. The feedback loops will need to measure innovation capacity, activity, impact and time-to-commercialization. The units of measure can be tailored to a specific region or may be summarized at a statewide level, depending upon the purpose for or use of those metrics.

Task Force members stress that the recommendations articulated within the present study are achievable given the resources that exist statewide and given the capacity already in place that can support and foster a robust technology commercialization pipeline.

Task Force Findings & Recommendations

FIFTH REPORT ON

The Condition of Higher Education in Ohio: **Advancing Ohio's Innovation Economy**

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Introduction

Governor John Kasich has identified job creation and sustainable economic growth as his administration's highest priority for the State of Ohio. As a direct consequence, the current higher education budget provides both the authority and the funding for the Chancellor of the Board of Regents to pursue Ohio's economic development goals.

The Governor's economic policies are predicated on the recognition that communities compete globally in a world built on statewide and regional economies relying on a continual supply of educated people and new discoveries. As understood by many, both the nation's and Ohio's economic prosperity is derived from our ability to introduce new, value-added products and services into the marketplace. Technological innovation resulting from basic and applied research produces many of these value-added products. Success in this arena is increasingly dependent upon the ready availability of a vast infrastructure that includes a highly skilled workforce, state-of-the-art scientific expertise, manufacturing and fabricating capabilities, and the technological capabilities typically found on the campuses of our nation's great institutions of higher learning. Since the highly developed research platforms at Ohio's institutions of higher education represent an enormous state investment, the current challenge is how to engage Ohio's university and college faculty members in the pursuit of commercially directed research activities.

To develop and maintain a well-established foundation for economic growth—and create communities that support an entrepreneurial culture—the Governor believes Ohio requires sound public policies carried out within a broadly based political consensus – engaging federal, state, and local government entities in support of new economic development collaborations across the state.

The Governor's Task Force on Diversifying the New York State Economy highlighted the importance of these alliances recently. In its 2009 report, that New York Task Force referred to a study sponsored by the Alliance for Regional Stewardship and undertaken by the American Association of State Colleges and Universities and the National Center for Higher Education Management Systems:

"Titled 'Tools and Insights for Universities Called to Regional Stewardship,' the study highlights a growing body of evidence that communities compete globally in a world built on "regional economies" and that the success of industries embedded in these regional economies is linked to smart people and new discoveries, specifically to those attributes that are most closely associated with universities and other institutions of higher learning. The study noted that regions with world-class universities have a competitive advantage in recruiting and retaining the talent that corporate America is realizing more and more is the new raw material of the 21st century.

While the concept of universities as economic engines in their local communities is not new, the idea that regional economic success is more dependent on industry-higher education collaboration is a still-developing theme. For these collaborations to flourish, location matters.

The Alliance for Regional Stewardship study strongly suggests that to attract and retain the next generation of technology innovators, state, county, and local governments must enter into partnerships with their local universities to promote their collective economic wellbeing. The study proposes the concept of regional stewardship: the imperative that building sustainable places that will attract and retain the next generation of technology innovators requires a healthy economy, livable communities, collaborative governance, and social inclusion. It calls on public policy makers and higher education leadership to understand the importance of these attributes in promoting their competitive advantage. But the presence of a major university does not guarantee economic prosperity; communities will be able to compete successfully only through cooperation and commitment by all parties – universities, corporations, and government – to foster a collaborative environment.

As the New York Task Force report acknowledged, *"ideas are the essential raw materials of the 21st century economy" and that "the intersection of intellectual, human, and financial capital with new ideas, entrepreneurs, and networks is critical for economic growth."* The Ohio Board of Regents and the Chancellor have concluded that for Ohio to compete in the global innovation economy and achieve economic productivity, prosperity, statewide and regional vitality, Ohio's HEIs must improve the effective exchange of ideas, knowledge, and technology between higher education and the business community – with support from state and local government.

Accordingly, the 32 member Board of Regent Technology Transfer and Commercialization Task Force with representatives from higher education, industry and government has worked diligently over the course of the past eight months to develop a comprehensive plan of action, encompassing best practices from around the state and nation, in order to promote statewide and regional economic growth statewide. The path forward is clear: industry-higher education collaboration must be signifi-

cantly enhanced if Ohio is to compete successfully in the 21st century global economy. In order to accomplish this goal, the Task Force believes it is important to understand the differences between "technology transfer" and "commercialization."

- **Technology transfer** refers to the process of transferring a technology or product developed at an HEI to an outside entity, usually a company.
- **Commercialization** refers to the process of taking a technology or product to market.

When these distinctions are understood and managed, the Task Force found Ohio's HEI technology transfer processes were more efficient, industry-higher education collaborations were more productive, and technology commercialization start-up activity more evident. By building on this key finding, the Regents' Technology Transfer and Commercialization Task Force believes the ***Advancing Ohio's Innovation Economy*** report findings and recommendations provides a set of strategies that promise to bring Ohio out from under the cloud of economic recession to a new period of growth and prosperity.

The Critical Issues and Questions

In undertaking its work, the Task Force identified a number of questions that it believed needed to be addressed if Ohio is to achieve its goals of promoting an environment of enhanced higher education-industry collaboration. These questions served as the starting point for framing the Task Force's Report on the Condition of Higher Education for improving the collective execution of research commercialization activities among Ohio's universities and colleges and may be expanded as it consults with interested parties throughout the state.

The initial questions the Task Force would like to see answered are as follows:

1. What current Ohio programs and new activities should be implemented to define emerging technologies and technological opportunities given the diversity of research capabilities within the State's universities?

2. What academic programs can be established to better prepare our graduates for economic impact in Ohio, including those emanating from our junior colleges?

3. What type of social network must we build to promote and enhance sustainable industry higher education collaborations? How can we use contemporary Internet technologies to foster this network?

4. What strategies are best suited for aligning statewide goals for university-industry collaboration with institutional goals given the variation among Ohio's universities and colleges?

5. Are there specific policy or legislative changes that the Task Force might recommend to help foster long-term partnerships between universities and industry?

6. What are the available practices and benchmarks that the Task Force might recommend that will result in progress and objective assessment of Ohio's research commercialization activities?

7. How can universities that are most successful at generating research dollars be rewarded for directing those resources more efficiently to increase commercialization activities?

8. How do we enlist the influential champions of these practices across sectors – higher education administration and faculty, business leaders, entrepreneurs, investors, government administrators, elected officials – to advance these ideas among their peers?

9. Are there readily identifiable partnerships, or better, immediate "deals" that the Task Force can identify to achieve some early successes?

To address these and other questions the Task Force formed six subcommittees: Academia, Industry, Government, Capital, Workforce, and Technology. Each subcommittee was charged with the responsibility to study its respective areas and identify the key questions that must be addressed in order to further promote technology commercialization through enhanced Industry-Higher Education partnerships.

Each subcommittee was further asked to note the key challenges facing each sector with regard to promoting technology commercialization and develop a set of recommendations for how they should be addressed. The final charge was to develop implementation recommendations and metrics for success.

Initial Findings: Challenges & Strengths

The Task Force in reviewing the Association of University Technology Managers (AUTM) most recent report found Ohio's "innovation" activity above average in terms of: a) the total annual volume of external funding garnered for academic research activities; b) the annual volume of university research funded exclusively by industry; c) the annual number of invention disclosures filed with university technology transfer offices; d) the annual number of patent applications filed; e) the number of U.S. patents issued to Ohio universities each year; and f) the annual number of new business start-ups spun off of HEI intellectual property.

Specifically, Ohio's public universities are currently ranked sixth nationally in total research funding. The grand total for annual R&D expenditures in FY 2010 at all Ohio universities was $2.01 billion based on the most recent national data published by the National Science Foundation. And, largely owing to Ohio Third Frontier incentives, industry-financed research at the state's public and private universities doubled between 2003 and 2009 to nearly $160 million – well above the national average per state of just over $60 million. In fact, for FY 2010 The Ohio State University once again ranked second nationally among all universities in terms of industry-funded research with $120 million in annual R&D expenditures from industrial sponsors, as reported by the National Science Foundation.

Additionally, during Fiscal Year 2011 Ohio's universities created 34 new start-up businesses, executed 197 new technology licenses, generated $40.9 million in license income, processed 984 invention disclosures, and filed 592 new applications for U.S. patents, as recently reported by AUTM. Such performance is 36% above the national average in terms of new business start-ups coming out of its universities and nine more start-ups than Ohio might be expected to produce using AUTM's calculation of one new start-up generated for each $90.8 million in R&D expenditures.

The Task Force also noted that Ohio had some significant resources that were best in class. One of these signature economic development programs is the Ohio Third Frontier (OTF), initiated in 2002 to create jobs and advance Ohio's economic competitiveness through technology commercialization. While administrative oversight of the program has been established in statute to be the purview of the Ohio Third Frontier Commission and staff of the Ohio Department of Development, the OTF itself, by majority vote of the electorate, has been made a permanent part of the Constitution of the State of Ohio.

Five-Year Measures of Technology Transfer Proficiency and Investment

Chart key: Invention Disclosure Forms (IDF), Million (MM), Full Time Equivalent employment (FTE)

		Ohio	US	Ohio v. All US	California	Ohio v. Cal	Texas	Ohio v. Texas
PROFICIENCY	IDFs/$1 MM Research	0.45	0.39	17.5	0.45	1.5	0.34	15.8
	Deals/IDF	0.19%	0.26%	-25.7%	0.16%	19.8%	0.26%	-38.0%
	Gross Return	2.7%	5.3%	-49.5%	8.0%	-66.5%	1.5%	50.8%
	Startups/$100 MM	1.33	1.16	14.2	1.27	4.3	0.99	9.6
INVESTMENT	% IDFs pursued	0.46%	60.5%	-24.2%	70.3%	-34.7%	47.2%	16.2%
	FTEs/$100MM Research	2.10	1.92	9.2	1.89	10.9	1.97	-1.6

Proficiency measures

IDFs/$1 MM Research: *Invention disclosures received per $1 million research expenditure.*

Deals/IDF: *Percent of inventions that are subject of ultimate commercial transactions (e.g., license and option agreements).*

Gross Return: *Gross commercialization revenue relative to the research expenditures.*

Startups/$100 MM: *Number of startup companies formed (or "spun-off") per $100 million of research expenditure.*

Investment

% IDFs pursued: *Percentage of inventions for which a patent application is filed.*

FTEs/$100MM Research: *Number of full-time licensing professionals employed per $100 million of research expenditure.*

The most critical elements of the OTF model include:

- Basic and applied research specifically directed toward the ultimate goal of commercialization;
- Research Scholars Program that invested $153 million in twenty-six endowed chairs to pursue directed research and commercialization at Ohio's public and private universities;
- Entrepreneurial Signature Program that supports six regional networks of entrepreneurial services and capital to accelerate the growth of early-stage technology companies;
- Pre-Seed Fund Capitalization Program to increase the availability of professionally managed capital and associated services to accelerate the growth of early-stage technology companies;
- Long-term state support with an emphasis on leveraging additional federal and private resources;
- Active guidance from representatives of state government along with the external peer reviewers hired by the state and who are experts in the disciplines; and
- The highest possible standards of accountability and oversight for achieving positive outcomes.

The Task Force members believe programs such as the Third Frontier are critically important for Ohio to achieve its long-term economic development goals based on the nearly 80,000 jobs generated, almost $7 billion in leveraged funds attracted to Ohio from federal agencies and industrial firms, as well as more than 700 companies created, attracted, or capitalized since its inception in 2002.

Successful implementation of the recommendations by this Task Force will require that the State build upon the success of the Ohio Third Frontier initiative and that the State fully utilize the Third Frontier resources to commercialize new technologies and to create new businesses. "The Task Force members believe this can be best accomplished by building on Ohio's key industry sectors that were identified by the Battelle Total Partnership Practice (BTPP) as the state's current industry strengths and technology capabilities:

1. Alternative Energy
2. Biomedicine
3. Advanced Materials
4. Instruments and Controls
5. Aerospace
6. Defense

And the eight growth opportunity areas in which Ohio is well positioned for future growth were identified by Battelle as:

- Advanced Materials
- Aero-Propulsion Power Management
- Fuel Cells and Energy Storage
- Medical Technology
- Sensing and Automation Systems
- Situational Awareness and Surveillance Systems
- Software Applications for Business and Healthcare
- Solar Photovoltaics

These technology-intensive areas represent Ohio's best opportunities for market growth over the next three to five years and the Task Force has concluded that several sectors are key areas where the resources and needs of the state, the skill sets and strengths of our universities and colleges, and the future needs of our society as a whole intersect to give Ohio the potential to becoming a global leader. For Ohio's key business sectors identified by the Third Frontier to compete successfully, the state must build strong regional economies that can compete globally; and the Ohio Third Frontier

must be a partner with Ohio's HEIs in order to successfully implement its strategy of building strong statewide and regional ecosystems statewide, which are essential to the innovation continuum.

While the Task Force recognized the accomplishments of Ohio's colleges and universities and the significant accomplishments of the Third Frontier, the evidence was equally clear that there is more that can and must be accomplished. Industry, higher education, and government officials acknowledge that the state is not taking full advantage of existing economic development programs and/or its entrepreneurial capacity for the benefit of spurring economic growth. The Task Force's eight-month review of Ohio's Innovation Continuum uncovered significant deficiencies that dramatically reduces the State's effectiveness in job-creation. Specifically, the AUTM research the Task Force reviewed showed that Ohio's universities rank well below the average for universities in other states when comparing both the gross return of commercialization revenue relative to the volume of research expenditures as well as the efficiency in which invention disclosures are converted into commercial applications.

In trying to understand why this was so, the Task Force sought out national benchmark data and learned that the state lagged behind many of its peers in promoting and supporting technology commercialization. Two specific studies the Task Force reviewed were the *Milken Institute's State Technology and Science Index* (1) and the *Ewing Marion Kauffman Foundation's State New Economy Index*. The *Milken Institute State Technology and Science Index* looks at 79 unique indicators that are categorized into five major components: 1) research and development inputs; 2) risk capital and entrepreneurial infrastructure; 3) human capital investment; 4) technology and science workforce; and 5) technology concentration and dynamism. It is perhaps the most comprehensive examination of state technology and science assets available today, and in 2010 Ohio ranked 20th in research and development; but 29th overall – a "third-tier state."

The *Ewing Marion Kauffman Foundation's 2010 State New Economy Index* measures 26 separate indicators to ascertain whether or not a state's economy is knowledge-based, globalized, entrepreneurial, information technology-driven and innovation-based. By this measure, Ohio ranked in the middle of the fifty states at 25th overall, but only 38th nationally in terms of its "economic dynamism."

Based on these nationally recognized indices, the Task Force has concluded that Ohio cannot successfully compete in today's global economy without addressing these significant deficiencies, and Ohio's HEIs must redouble their efforts to more effectively leverage their existing research strength, academic entrepreneurial capacity and focus on forming new higher education-industry partnerships if the state is to achieve the Governor's vision of a high-growth economy that generates high-value, high-wage jobs in the coming years.

The Task Force's initial findings are corroborated in the six subcommittee reports, which are the result of Task Force member research, public forums and expert testimony taken from across the state over the course of the last eight months. The full subcommittee reports are appended to this Condition Report, and what follows is a high level summary of each of the subcommittee reports highlighting their key findings and recommendations.

Summary of Findings by Subcommittee

Academia Subcommittee

GENERAL BACKGROUND

To improve its economic situation, Ohio must develop a competitive, high-growth economy that generates the high-value, high-wage jobs of the future. The success of technology transfer, commercialization and entrepreneurial activities within Ohio's HEIs and their partnering private institutions of higher education play significant roles in developing our high-growth economy. Despite several regionally successful technology transfer, commercialization and entrepreneurial initiatives in Ohio, the Academia Subcommittee found that institutional barriers stand in the way to further success.

Members of the Academia subcommittee believe success depends upon overcoming these obstacles and on developing a vast infrastructure that includes a highly skilled workforce, state-of-the-art scientific expertise, manufacturing and fabricating capabilities, and technological capabilities to commercialize technology incubated at our universities. The scale of this infrastructure exceeds the resources of most single organizations, so our research universities – as well as our community colleges – must collaborate with and develop strategic partnerships with industry and government.

FINDINGS

The Academia subcommittee sought to uncover current and identify best practices for building strategic academia/industry partnerships in Ohio and nationwide, and to provide guidance for improving the quality and quantity of these collaborations at the state level. Information on current and best practices – based on a number of key questions asked – was compiled between January 2012 and April 2012 from recent economic reports, interviews and two public forums held in Columbus and Cleveland.

1. *What are the most important factors and practices leading to the timely and successful commercialization of university-based technologies?*

   Functions of technology transfer and commercialization must be clearly defined. When these roles are not clearly differentiated it leads to inefficiencies, confusion and less than optimal deployment and monetization of Ohio's technology assets and may prevent or discourage new company formation.

   Significant investment of capital, talent and infrastructure is required on behalf of the academic institution. Successful technology transfer and commercialization activities do not occur by accident. Success in this endeavor requires significant and intentional investment by the institution.

   Academic institutions must champion, promote, and take pride in their contributions to the economic development of their region and State. They are helping support their graduates' ability to remain and be productively employed in Ohio. Economies have grown out of those institutions and neighboring regions that have fully embraced technology transfer and commercialization.

   The importance of top-down commitment – including the board of trustees – was revealed as very important in higher education ecosystems with a strong track record of successful commercialization. Subcommittee members recommend strong institutional leadership is essential to providing a consistent message of the importance of entrepreneurial activity from the top down. They further recommend that the Board of Regents meet with HEI boards of trustees to underscore the importance of institutional leadership in promoting technology commercialization and entrepreneurial activities across the entire state of Ohio.

   Relational, rather than transactional, interactions with industry are essential. The most productive technology transfer arrangements are founded on relational rather than transactional interaction, i.e., the goals of both the academic and industrial institutions are aligned and cultivated over time rather than operating as an independent series of research-for-pay transactions.

   It is important for academic institutions to leverage regional strengths. When individual campuses that have embraced entrepreneurship are able to connect regionally, the results are amplified and help to build a regional attitude that encourages idea generation and start-up activity. The regional strengths also extend beyond HEI-to-HEI relationships; they must leverage the broader ecosystem of company formation vehicles, pre-seed/early stage capital, economic development groups such as the Third Frontier's Entrepreneurial Signature Program groups and the Edison incubators.

The best academic institutions to work with are the ones that welcome industry partners at all levels, from president to students. The technology transfer goals at each level of institutional leadership, from faculty to president, must be aligned. Misalignment at any level may compromise the relationship between an institution and a company.

Sharing assets including supercomputers, high-end storage, high-end instruments, engineering software, prototyping equipment and test equipment can be dealmakers. Universities often have access to resources that are out of reach for smaller companies. Ready access to expensive or high-end equipment is often a major incentive for companies to investigate academic partnerships.

2. *What is the current state of Ohio's productivity in terms of commercialization? What are aspirational statewide goals?*

These findings and limitations have a direct effect on Ohio's ability to compete in the regional and global economy when compared with other states throughout the country. As the following chart demonstrates, Ohio is at a competitive disadvantage when comparing statewide capacity, activity and impacts with other states throughout the country. Academia subcommittee members believe that metrics such as the *Kauffman Foundation's 2010 State New Economy Index* supports their perspective that the University System of Ohio, in partnership with industry and government, must undertake fundamental change if Ohio is to achieve the goal of increasing university sponsored technology commercialization and facilitating high quality jobs.

2010 State New Economy Index – Ohio's Rankings

Managerial / Professional / Technical Jobs 22	High-Wage Traded Services 15	IPO's 30	Online Agriculture 32	Patents 28
Workforce Education 38	Export Focus Mfg/Service 26	Entrepreneurial Activity 32	Broad Band Telecom 30	Industry R&D Investment na
Immigration Knowledge Workers 9	Foreign Direct Investments 22	Inventor Patents 27	Health IT 26	Alternative Energy Use 18
Migration U.S. Knowledge Workers 23	Job Churning 39	Online Population 32	High-Tech Jobs na	Alternative Energy Use 34
Manufacturing Value-Added 19	Fastest Growing Firms 25	E-Gov't. 21	Scientists & Engineers 20	Venture Capital na

BARRIERS TO SUCCESS

3. *What are the current limitations, practices, and barriers regarding academia-industry collaboration in Ohio?*

a. **Too much focus on technology push rather than developing a deeper understanding of marketplace needs.** Faculty engaged in academic research is often disconnected from marketplace needs. Including industry input in the early stages of research planning can have a significant and positive impact on the research plan and outcome.

b. **Competition between institutions hinders progress.** Collaborative efforts, as evidenced by the Entrepreneurship Education Consortium and Jumpstart Higher Education Collaboration Council, generally result in greater efficiency and effectiveness. Future funding made available by the Board of Regents should have collaboration conditions or incentives.

c. **Academic institutions do not move at the speed of business.** The timeframe for accomplishing projects in academia is often too slow for industry, especially with regard to research. Faculty, with little or no industry experience, need to be cognizant of this fact and to be more timely and responsive to the needs of industry.

d. **The conflict of interest policies may be too strict or interpreted too strictly at public universities.** Conflict of interest policies tend to discourage progress. Creating vehicles within or adjacent to the universities that can remove these conflicts, or relaxing aspects of these policies, will allow university and industry partners to align their goals and accelerate the commercialization process.

e. **There is a lack of easily accessible 'prototyping' money.** Technologies often need additional prototyping after initial proof of concept testing. The time it takes to raise additional funding can compromise industry interest. An easily accessible pool of money can accelerate the prototyping process, keeping industry engaged and increasing the probability of technology transfer.

f. **Entrepreneurial resources spread too thin.** Entrepreneurial resources are often underfunded, leading to a decreased capacity for timely and effective technology transfer. More important is the need for connecting entrepreneurial talent to the technology pipeline and structuring standard agreements that allow for entrepreneurs to more immediately understand the commercial implications of a partnership with the institution, so that they can determine if they should be investing their time in the partnership.

g. **There is a lack of academia/industry integration in many departments within Ohio's colleges and universities.** Both parties in many successful academia/industry partnerships make an effort to integrate the people on both sides into their everyday functions. Collaborations are much more successful when students, academic researchers and industry contacts make arrangements to integrate critical functions into a shared space e.g. working in the same facility.

h. **Faculty is not rewarded/compensated for the work necessary to patent/commercialize.** Research faculty who engage in entrepreneurial activity are generally not rewarded for filing invention disclosures, forming a start-up or reaching out to industry; and in fact, the opposite was true, department chairs often discourage this type of behavior because the opportunity cost results in less time for research. Also, the tenure structure of most departments in Ohio's colleges and universities does not consider entrepreneurial success to be an important factor, leaving little motivation to engage in entrepreneurial activities besides personal satisfaction and potential long-term gain.

i. **There is often a desire for a stronger entrepreneurial culture within Ohio's HEIs.** For tech transfer to operate efficiently and effectively, it must grow out of a campus environment that celebrates and encourages an entrepreneurial culture. This culture can grow and thrive on campuses of all sizes and characters, but it is most fertile when it grows organically from the strengths and passions of the institution and its leaders.

j. **Undergraduate/Graduate students are generally not being taught the skills to perform this function and are not yet experienced enough to assume a leadership role in commercializing technologies.** Exposure to entrepreneurship is minimal for most undergraduate and graduate students. Although programs are present on nearly all campuses, they are not effectively advertised or integrated into the required curriculum, which seldom includes entrepreneurial classes or experience for undergraduates. This results in college graduates entering the workforce with little awareness of the entrepreneurial process or how to effectively work with academic institutions from the industry standpoint.

There is an experience gap between successful tech transfer and successful commercialization at many universities. One of the most difficult steps in the commercialization process is finding an individual with adequate market and industry experience to champion a product or idea. After the technology transfer office at a university has successfully protected an idea and developed a prototype, there is often an experience gap in completing the necessary steps to achieve commercialization.

RECOMMENDATIONS

1. *What are the strategies for increased success in the future and what are the best metrics for evaluating progress?*

a. **Strengthen tech transfer and commercialization practices**

When speaking with representatives from industry on how to improve commercialization out of academia, the subcommittee heard two related complaints over and over: it is far too slow and too complicated to get technology out of institutions. The subcommittee recommends the following steps:

I. **Strengthen practices within tech transfer offices** – the first step to making institutional policies and practices more friendly to the commercialization process is to begin with the offices already dedicated to these goals. The subcommittee recommends the following as concrete first steps:

- Focus on building long-term strategic relationships with corporate partners. It is imperative that institutions build partnerships that are relational in nature rather than exclusively transactional;
- Attract more commercialization expertise to campuses to complement the strengths of the technology transfer officers;
- Develop standardized, transparent process for inventors to work with the institution;
- Create clear standardized commercialization agreements for industry partners;
- Encourage early and aggressive involvement of campus officials to find the best ideas and move them into the process; and
- Establish an affiliated organization that can monetize and/or commercialize the IP.

II. **Break down barriers to collaboration** – big or small, all of our institutions, and all their academic departments within, have the ability to participate in commercialization activities. In order to make it easier for entrepreneurs to work in partnership with researchers, departments and institutions toward successful commercialization, the subcommittee recommends the following to begin breaking down existing barriers:

- Increase opportunities for researchers to interact with industry, both formally and informally;
- Revise interdepartmental policies that discourage cross-disciplinary research and IP development by incorporating institutional success metrics; and
- Institutions with limited resources should develop regional partnerships with other institutions to enable full-scale entrepreneurial programs, similar to the Northeast Ohio Collegiate Entrepreneurship Program in Northeast Ohio which helps coordinate the entrepreneurial resources of some of the region's small liberal arts colleges or the Lorain County Community College GLIDE Edison Technology Incubator and Innovation Fund.

b. **Fill the funding gap**

Universities need to be very deliberate about planning for sustainability of their programs. While securing funding will always be a central issue to commercialization, across the spectrum of interviewees there were some very specific themes that began to emerge regarding the role of the academic institution in funding. Specifically, there was a belief that academic resources could have an outsized impact on entrepreneurs within their campuses if targeted at filling the funding stages that were less attractive to industry. While recognizing that resources are tightening on campuses, the subcommittee recommends the following to help have the biggest impact on growing commercialization:

- Increase funding in underserved stages, particularly prototyping.
- Actively develop more and more robust seed and venture funds available to small businesses.
- Develop proof of concept centers to give researchers the infrastructure needed to bridge the "valley of death." Thought should be given to how these resources could be maximized through specialization towards specific industries that are strong in each region.
- Have the institutions provide real estate and access to equipment and talent free of charge in an effort to accelerate the commercialization as well as to reduce the amount of external funding required at the earliest stages.

c. **Incentivize entrepreneurship**

To begin to better align the benefits and rewards, the subcommittee recommends the following: (a) offer tangible incentives to researchers; (b) actively increase beneficial opportunities for student involvement; and (c) foster a whole culture of entrepreneurship on campuses.

d. **Tangible incentives for researchers**

Despite the many benefits, entrepreneurial actions are not recognized in consideration of tenure at most universities. Faculty had much less incentive to pursue commercialization than the strategic desire of their institutions. However, an institution's desire to pursue commercialization through the research of its professors needs to be balanced against the overall mission of the academic institution to discover and teach knowledge. In order to balance these two goals, the subcommittee recommends the following:

- Allow expanded credit toward tenure and/or promotion for research commercialization
- Clarify and standardize the incentives policy for faculty who successfully license their IP and make sure the information is well understood.
- Assist faculty members in developing the skills to start a business.

e. **Increase student involvement**

As more and more students are becoming interested in doing entrepreneurial work, our academic institutions need to make sure we are supporting them by offering opportunities before and after graduation.

- Require corporate partners to offer students opportunities on joint projects with appropriate supervision and oversight.
- Develop more experiential learning opportunities for students to work with start-ups before graduation, including co-ops and internships.
- Develop more relationships with companies to actively place students in jobs/internships where they can gain experience and perhaps a job upon graduation.
- Embed foundational pieces of entrepreneurship education into the curriculum for all majors.
- Promote business plan competitions with meaningful preparation, awards and follow-up benefits such as mentoring, space and access to capital.
- Offer competitive full and partial tuition 'Entrepreneurship Scholarships' for promising students who plan to study and engage in entrepreneurship, akin to athletic scholarships.

f. **Actively foster a strong culture of entrepreneurship**

A prerequisite for Ohio's institutions to become leaders in technology commercialization is the creation of a strong culture of entrepreneurship on and around campuses. While no single policy change or program can create a culture on its own, the subcommittee believes the following steps represent a good start for our institutions:

- Inclusion of commercialization in institutions' strategic priorities;
- Invest to make sure there is a full support network including capital, facilities and training;
- Ensure there is a dedicated centralized infrastructure for commercialization on every campus, outside of the business college so that all programs have access;

- Increase opportunities for researchers to interact with industry, both formally and informally;

- Cultivate buy-in from faculty, even those not involved in commercialization, through intentional engagement and support from the administration;

- Measure the leadership on their institution's performance against the key metrics identified, from there, the goals will cascade down to permeate the organization; and

- Reach out to the alumni base. Alumni entrepreneurs are a source of financial support and can also serve as mentors, counselors, coaches, competition judges and internship sources. Dartmouth College was an early pioneer of this approach and has a well-established network of alumni entrepreneurs.

MEASURES OF SUCCESS

Number of institutions using standardized processes	Increase industry-higher education collaborations
Companies launched/longevity	Successful measure of university based technology commercialization activities
Jobs created	Support for statewide economic development
Number of strategic partnerships	Demonstration of industry-higher education collaboration
Number of student competitions	Promoting the next generation of Ohio entrepreneurs
Research dollars awarded	Support for basic research – a building block to applied research
Deals/year	Successful measure of university-based technology commercialization activities
Number of faculty trained and engaged in entrepreneurial teaching and promotion	Demonstrated commitment of university leadership to promoting entrepreneurialism
Number of institutions offering tenure credit for commercialization	Demonstrated commitment of university leadership to promoting entrepreneurialism

Industry Subcommittee

GENERAL BACKGROUND

The Industry Subcommittee recognizes the contributions of Ohio's HEIs to regional economic growth, their efforts to sustain an innovation ecosystem, and their ability to help companies be more competitive in national and global markets.

The objective of the subcommittee was to gather information from companies based on their experiences of working with universities in Ohio and elsewhere. Information was sought on a broad range of industry-university interactions, including:

- Licensing of university intellectual property by companies,
- Faculty and student entrepreneurship and creation of spin-off companies,
- Collaborative research partnerships involving scientists and engineers from both industry and academia,
- Industry participation in university-based research centers,
- Engagement of industry by academic institutions in research strategic planning, curriculum development and other activities related to the academic core mission,
- Industry use of specialized equipment and other physical assets of higher education institutions, and
- Talent and workforce develop across technology sectors.

The Industry Subcommittee was interested in understanding the characteristics of successful and unsuccessful collaborations, as well as industry's view of critical barriers to partnering. Finally, it focused on areas where incentives might be successful to promote greater collaboration, and where policy changes and other interventions might enhance performance.

FINDINGS

The Industry subcommittee sought input from industries in sectors typically thought of as technology- or innovation-based, such as advanced energy, biomedical, flexible electronics, and aerospace. The Industry subcommittee also consulted with companies from traditional sectors, such as automotive manufacturing, machine tools, building products and petroleum-based products. These sectors are increasingly technology-intensive and represent a significant share of employment in the state.

Three regional public forums invited senior executives from large and small companies, and start-up companies, to share their perspectives and experiences in collaborating with universities. Forums were held in March 2012 at The University of Toledo, Kent State University, and the University of Cincinnati.

Companies collaborating with higher education institutions viewed them as important stakeholders in their work. The discussion with industry was framed as an effort to understand "the voice of the customer." The subcommittee intentionally positioned Ohio private-sector firms as a customer of the primary outputs of the state's universities and colleges: knowledge (created though scientific or engineering research) and talent (embodied in graduating students entering the workforce).

The following findings evolved from the three regional discussions and included additional input came from the Association of Public and Land-grant Universities (APLU).

1. **Building a foundation of shared purposes, values and expectations is essential for successful industry-university collaborations.** Participants reported multiple situations in which partnerships were initiated with good intent, only to encounter roadblocks as the objectives and interests of each party diverged (e.g., conflicting priorities, timetables, incentives, cultural practices, etc.).

    a. **It is critical for universities to clearly define and communicate the purpose of industry collaborations, including the interest for technology commercialization.** Success often followed when companies and academic institutions became more familiar with one another and were able to define a shared, common purpose, as part of their overall framework of collaboration.

b. It is important for all partners to:

   i. **Emphasize long-term relationships** and mutual benefits from collaboration;
   ii. **Be thoughtful and transparent** about milestones and the definition of success; and
   iii. **Be clear** about the assets each partner brings to the collaboration.

2. **Leveraging regional assets for high-value and high-impact collaborations should be a top priority** to achieve the maximum impact from industry-university partnerships. Industry, recognizing the need for global competitiveness views local collaborations as key to effective business success and regional economic growth.

   a. From the perspectives of both a) ease of managing the collaboration and b) cultivating potential sources of talent, Ohio companies find value in working with universities close to home (but also must engage the best partners and will find them where needed).

   b. Industry and academic partners must be more creative about structuring projects and long-term relationships to enhance their benefits for all parties.

      i. For instance, a company brings its "stranded technologies"—intellectual property or technologies that don't contribute to its core business or are being commercialized—into a university partnership for development.

   c. Regional clusters provide powerful organizing frameworks for collaborations.

   d. Combining the state's industry base, emerging capabilities and university assets provides growth opportunities in a number of key technology areas.

BARRIERS TO SUCCESS

3. **Developing a user-friendly interface for companies seeking to create partnerships would help academic institutions significantly lower barriers to collaboration.** Currently significant effort by industry is required to understand where high-value collaboration opportunities exist at an academic institution.

   a. Companies identified significant challenges to building successful university partnerships such as,

      i. Identifying research expertise and areas of excellence on campus,

      ii. Finding "guides" to help navigate through the system,

      iii. Coordinating across the range of activities they want to engage in (research, other kinds of faculty engagement, accessing students, using equipment, etc.) and,

      iv. Frequently having to "start from Square One" with every new agreement or new partner.

RECOMMENDATIONS

1. Build a university innovation ecosystem characterized by rich networks and multiple connection points with industry. Develop a range of mechanisms to engage partners and coordinate their use.

2. Promulgate policies on campus to facilitate and encourage industry collaborations (e.g., access to campus equipment and infrastructure, support for faculty consulting and industry sabbaticals) and reward resulting behavior.

3. Support alignment of curriculum with talent needs of industry.

4. Be willing to explore creative/flexible approaches for collaborations.

5. Continue to take advantage of and leverage regional industry strengths and cluster networks as part of university strategic research planning.

6. Incorporate regional innovation-based economic development goals as a factor in technology commercialization strategy.

7. Develop strategies to enhance business acumen of faculty, staff and students engaged in industry collaborations.

8. Make universities more "customer-friendly" and easier to navigate for potential industry partners.

9. Create a central portal on the university website and single point-of-contact for companies seeking to engage in technology partnerships.

10. Create a guide to areas of research expertise and equipment availability within university.

11. Standardize and simplify rules of engagement between university and industry.

12. Make use of master agreements, standard templates and other mechanisms to lower administrative burden of collaboration.

MEASURES OF SUCCESS

Measuring performance on an ongoing basis is a critical part of determining whether progress is being made toward the goal of creating more high-value and high-impact industry-university collaborations. The Industry Subcommittee believes that while much of the effort needed to enhance the climate for productive collaborations is qualitative in nature, changes in culture and practice will be reflected in measurable outcomes. The table below identifies a set of metrics that capture the improvement in the innovation ecosystem.

Metric	Quantitative/Qualitative Measure(s)
Industry-sponsored research expenditures	Total expenditures and resulting from OH partnerships
Research agreements with industry	Total number (overall and OH companies), total dollar value, and resulting impacts
Campus equipment /infrastructure use by industry (for example; technical assistance, testing, and work-for-hire)	Total projects (overall and OH companies); total dollar value; resulting impacts
Start-up creation from university technology	Total number; total follow-on financing to companies and employment growth
Start-up/small company support from university incubators, accelerators and other programs	Total companies assisted; dollar value of support; resulting impacts
Faculty/staff engagement in industry research collaborations	Total number of projects; number of participants; number of companies (overall and OH companies); total dollar value
Faculty/staff participation in industry support activities (consulting, board participation, etc.)	Total number of engagements (overall and OH companies); types of activities; hours spent
Industry engagement in non-research campus activities (visiting committees, advisory councils, mentoring programs, adjunct teaching, etc.)	Total number of activities; number of industry participants

Government Subcommittee

GENERAL BACKGROUND

To improve its economic situation, Ohio must develop a competitive, high-growth economy that creates high-value and high-wage jobs. State government should play a pivotal and vital role as an advocate for and a partner with industry and higher education to catalyze strong economic growth.

While state government may not lead this endeavor, it must maintain a balanced public-private partnership to provide incentives for risk-taking by developers of innovative technology commercialization initiatives, including developers of new business enterprises.

State government also must continue to meet expectations within a dynamic, globally competitive innovation and commercialization ecosystem by: a) ensuring appropriate and reasonable regulation; b) developing policies and support activities that lead to an educated workforce; c) building appropriate infrastructure to advance systems; and d) supporting commercially directed scientific research that leverages the assets of Ohio's HEIs, our state's private universities and colleges, and public-private partnerships like the Ohio Third Frontier (OTF).

The Government subcommittee sought to uncover best practices for how state and local government entities could:

- Provide an environment supportive of technology start-up activity;
- Focus on economic development strategies for high-technology opportunities;
- Seek to leverage public resources to achieve economic development priorities;
- Identify lead agencies with responsibility for working with higher education and industry entrepreneurs;
- Provide economic incentive platforms; and
- Support portals for information sharing and connectivity.

FINDINGS

The Government subcommittee compiled information on best practices from recent economic reports; interviews conducted with OTF program directors, incubator center directors and university technology transfer officers; surveys of current stakeholders in government, industry and higher education; and public forums. The following questions were asked of the interview participants whose responses are summarized below:

1. *Does the state have the necessary strategic view of research strengths, industry needs and potential future commercial opportunities to inform actions that will create sustainable job growth and wealth creation for Ohio?*

   Ohio must develop a dynamic mechanism to provide ongoing state policy support for entrepreneurial activities. The Ohio Board of Regents (OBR) in collaborations with Ohio's universities and colleges should facilitate the development of statewide and regionally based innovation, commercialization and entrepreneurship plans that promote the state's knowledge-based economy; as well as adopt policies and procedures to incentivize the creation, recruitment and retention of high-tech businesses and the talent to run them.

   The OBR should identify key representatives from industry, higher education and government to lead and champion this critical initiative at both the state and regional level.

   The OBR should work with the Ohio Third Frontier Commission and Advisory Board, the Ohio Department of Development, and other state and local agencies to review state laws and regulations for their ability to incentivize private investments in technology commercialization activities and streamline commercialization processes; to promote statewide- and regionally based economic development strategies that target and/or leverage existing statewide and regional resources; and to collect and disseminate data to measure progress.

2. *Are inter-institutional capabilities being appropriately exploited to make Ohio more competitive for the creation, retention and attraction of companies; the attraction of investment capital; and for securing funding from federal agencies?*

   Ohio needs to better align its higher education system, research universities and community colleges, with the emerging needs for skilled workers with new competencies and attributes to support Ohio economic recovery and growth through increased commercialization in targeted technology and industrial sectors.

   State government, in collaboration with industry and higher education, should develop a **Workforce Continuum of Commercialization** that identifies current and future job-requisite

skills and proficiencies. State government must work with the higher education system, including both the community colleges and the research universities, in order to develop strategies to train workers to meet Ohio's current and future workforce needs.

3. *In what manner might state government assist the universities in developing the right balance of transactional interactions and long-term relationships with Ohio business and industry in order to facilitate sustainable commercialization?*

   Ohio's universities need to establish long-term relationships with key industry partners to promote industry/higher education collaboration to achieve high-value and high-impact outcomes.

   State government should assist Ohio's HEIs by standardizing general umbrella agreements to emphasize strategic partnerships, industry material transfer agreements, and licensing agreements to be more "user friendly."

   University offices of technology transfer and research officers should identify and encourage key industry strategic partnerships and interactions.

   Comprehensively review its statutes, rules and regulation that govern the commercialization process (specifically, intellectual property and conflict of interest laws) to ensure maximum flexibility while protecting the interest of all parties involved.

4. *What can state government do to assist universities in leveraging additional federal agency and industry support for research activities directed toward commercialization?*

   State government should develop a dynamic statewide commercialization ecosystem. The Ohio Third Frontier's Entrepreneurial Signature Program should lead organizations statewide to promote a user-friendly industry/academia interface by developing a foundation of shared purpose, values and expectations between industry and higher education that will leverage statewide and regional assets for high-value, high-impact collaborations.

   Work collaboratively with industry and higher education leadership should develop a comprehensive view of resources – financial, managerial, and technical – required to sustain a region-based ecosystem essential to supporting university and industry start-up activities.

   Partner with University leadership and industry to integrate and/or develop the infrastructure and systems essential to building supporting entrepreneurial activity, including master agreements, patent, and license and start-ups, within OTF.

5. *Are there critical infrastructure components that state and local governments need to develop in order to facilitate the spinning off of more new business start-ups from university intellectual property?*

   Government should support the development of multiple sources of funding from proof-of-concept, to seed funds to early stage venture capital from both public and private sources because a well-defined capital continuum is critical for the development of university intellectual property.

   Incentivize the development of statewide and regionally based "first institutional funds" to focus on university and industry technologies possessing relevant commercial applications.

   Sustain Ohio Third Frontier funding that is focused on promoting proof-of-concept and seed-stage funding; promoting venture capital formation by providing state incentives for third-

party angel and venture capital investors who are interested in university and industry based intellectual property; and developing new incentives for co-investments from universities and the private sector in Ohio-based emergent technologies.

6. *Are there actions that state and local governments can take to encourage university faculty to become more actively involved in the commercialization process?*

   State and local governments should support programs that encourage HEIs to provide incubator functionality where faculty/industry collaboration can take place and start-up companies can find a nurturing environment.

   Ohio's research universities should identify opportunities to partner with community colleges to expand incubator capacity and develop collaborative strategies to support early stage start-ups and joint ventures. Given the flexibility of the community college business model, four-year universities should seek opportunities to collaborate with them to promote their technology commercialization processes.

7. *Has the state created the necessary portals and/or pathways for industry and the venture capital community to access the intellectual assets and technological capabilities of Ohio's colleges and universities?*

   State government should take the lead to develop communication networks to centrally advertise university intellectual property, as well as faculty research strengths and activities.

   Promote strategies that make it easier for industry to interact with faculty who has an interest in working with industrial partners.

   Implement a strategic communication plan, **in partnership with the higher education system**, for defining state policies and procedures, and support systems to advance the commercialization of university technology.

   Ohio colleges and universities should develop strategies for advertising and promoting faculty research interests and expertise; work with key industries to facilitate their introduction to and interaction with faculty; and collaborate with state government to develop technology-based portals to facilitate industry-faculty collaboration.

8. *How will state government know if Ohio's newly designed and newly implemented policies for the development of a vibrant, globally competitive commercialization ecosystem are actually working as planned?*

   Accurate and timely collection of program metrics is an essential element of properly maintaining the commercialization ecosystem. Data collection and publication of commercialization performance should be central to the state agencies and universities that support and promote economic development and make decisions about the application of critical resources – human, facilities and/or capital. Software platforms and CRM tools already exist within the Ohio Third Frontier's regional Entrepreneurial Signature Program that can be easily leveraged to accomplish this goal.

   Ohio should develop a data collection system with the appropriate benchmarks to measure the effectiveness of state and university policies and practices to build the innovation pipeline and support Ohio's "smart growth" strategies of recruiting and retaining high-paying jobs in key industrial sectors. Data sets should measure the state's capacity to support innovation, innovation activity, and the impact or outputs of those activities on the state, the higher education system and regional and statewide economic growth.

BARRIERS TO SUCCESS

What impediments do state and local governments need to eliminate in order to enhance the future development of Ohio's technological base?

Collaboration among Ohio universities and colleges with Ohio business and industry would be significantly enhanced if state government considered incentives to reduce or eliminate barriers to collaboration:

i. Provide incentives for industry to sponsor university research and license university technology.
ii. Create policies and incentives for companies and academic institutions, faculty, staff and students to encourage small, young companies to interact with universities.
iii. Ensure there is sufficient risk capital available to support efforts by new and small firms to commercialize university technologies.
iv. Develop policies to encourage commercialization of academic research that ends up as industry-assigned rather than university-assigned patents.
v. Focus more resources on evaluating commercial potential of academic research outputs rather than on efforts to increase the amount of basic research.
vi. Focus efforts to encourage academic entrepreneurship on fields in which academic research is of greater importance to technical advance in industry.
vii. Fund a best practices analysis and report of early stage investing to establish and maintain seed and other early stage venture capital assistance programs designed to help launch quality ventures.
viii. Fund a best practices analysis and report of institutional technology transfer, commercialization, and academic entrepreneurship conflict of interest policies and practices to ensure that academics' personal financial interests in research and commercialization outcomes pose no real or perceived conflicts or commitments that may erode public trust and confidence in scientific integrity and objectivity.

RECOMMENDATIONS

1. The Chancellor and Board of Regents should work with HEI and industry leaders to facilitate the development of statewide and regional plans promoting the state's knowledge-based economy, and incentivizing recruitment and retention of high-tech businesses and talent.

2. Better align its higher education system with the emerging needs for skilled workers.

3. Develop a Workforce Continuum of Commercialization that identifies current as well as tomorrow's job-requisite skills and proficiencies.

4. Identify and encourage key academic/industry strategic partnerships and interactions with user-friendly processes and incentives.

5. Develop multiple sources of funding from proof-of-concept, to seed funds, to early-stage venture capital from both public and private sources by supporting existing programs (Ohio Third Frontier) and incentivizing investors.

6. Encourage HEIs to provide incubator functionality where faculty/industry collaboration can take place, and start-up companies can find a nurturing environment. Directly connect the commercialization activities of higher education across Ohio to the Ohio Third Frontier's regionally deployed Entrepreneurial Signature Program (ESP).

7. Develop communication networks that advertise university intellectual property as well as faculty research strengths and activities.

8. Enhance data collection and publication of commercialization performance.

MEASURES OF SUCCESS

Metric	Quantitative/Qualitative Measure(s)
New industry-higher education strategic partnerships	Support for industry applied research needs within public universities and colleges
Number of strategic partnerships	Demonstrated commitment to industry/higher education collaboration
Deal flow/year	Successful measure of university-based technology commercialization activities
New capital investment dollars/year	Demonstrated ability of new technology commercialization activity to attract capital
New industry incentive programs	Support for industry-higher education collaborations
New research incentive programs	Support for faculty-based technology commercialization initiatives
Companies launched	Successful measure of university-based technology commercialization activities
Jobs created	Support for statewide economic development

Capital Subcommittee

GENERAL BACKGROUND

The Capital subcommittee focused on the need for capital to fund start-ups, venture and later stage capital, and considered all forms of debt and equity financing in Ohio.

The committee solicited public comments on the following three questions:

1. Does Ohio have sufficient capital to finance new technology-based start-ups in Ohio?

2. Does Ohio have enough capital at each stage of company development?

3. What improvements need to be made to strengthen Ohio's capital infrastructure?

This report summarizes the information collected and identifies the critical need to expand the available pool of capital in Ohio for professional investors to provide follow-on[6] funding after pre-seed and seed opportunities are financed in part by the Ohio Third Frontier.

6 "Follow-on" funds are subsequent private equity funds established after the investment period of a prior fund.

The Capital subcommittee had insufficient time to address all of the complex issues relative to these important questions, the completed answers of which would help policymakers plan to fill the first institutional money gap for our Third Frontier companies:

1. How many viable deals that received Third Frontier or Ohio Capital Fund investments are unable to get follow-on financing due to a lack of "first institutional money" in Ohio?

2. How much investment capital is needed by stage (Series A, B and C) for opportunities currently in the pipeline?

3. How much investment capital will be needed as our universities continue to commercialize and spin out technology companies?

4. How much investment capital is necessary for the diverse and divergent financial requirements of information technology, life science, energy, and material science companies?

FINDINGS AND BARRIERS TO SUCCESS

The subcommittee used a 2010 report (and a preliminary 2011 update) by Michael Camp, head of the Entrepreneurship Center of the Fisher College of Business, at The Ohio State University, titled "Developing a Strong Foundation for Growth," and numerous individual interviews of public and private investment and economic development officials on the topic of the adequacy of seed and early stage capital in Ohio for technology-focused start-ups to arrive at its conclusions. The subcommittee also hosted two public forums, in Columbus and Cleveland, with entrepreneurs, angel investors, professional investors, educators, and other stakeholders on March 27 and March 30, 2012, respectively.

The Capital subcommittee extracted the following high-level findings by combining the aforementioned information resources:

1. Forum participants were pleased with progress made by the Ohio Department of Development and Ohio Third Frontier to help industries develop more globally competitive products, and foster formation and attraction of new technology-based companies.

   Participants were adamant that the state should stay committed to these programs, especially the Entrepreneurial Signature Program (ESP) and the tax credit program that supports individual investors who have fostered investments in pre-seed and seed stage opportunities.

2. There is sufficient capital for pre-seed and seed companies in the OTF program.

As was shown by this chart, there is variation in the amount of capital from year to year, the general trend illustrates a significant improvement in dollars invested in pre-seed and seed stage start-ups in Ohio over the period 2004-2011.

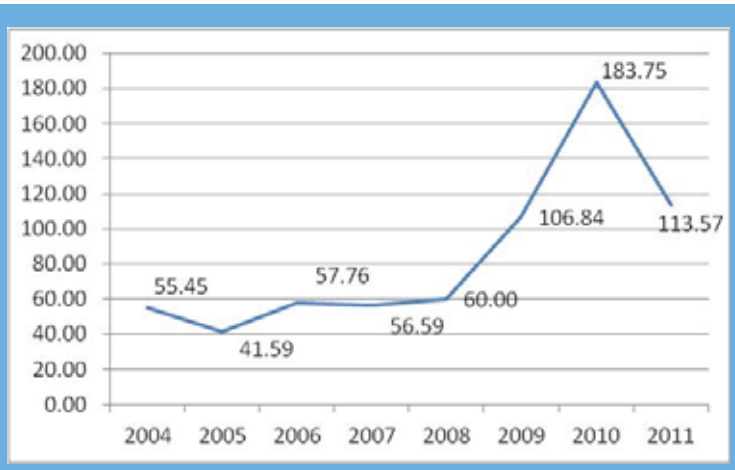


Table 1: Ohio Pre-Seed/Seed Stage Venture Investment by Year in $ Millions, from J. Michael Camp Preliminary 2011 Venture Capital Report.

There is concern that the 2011 drop in pre-seed companies might be indicative of a new negative trend.

3. However, our start-up companies may not have access to sufficient professional investors or venture capital investors in Ohio to assure growth.

Venture capital is important because these professional investors bring a rigorous approach to understanding markets, access to other venture capitalists, and organized recruitment of resources necessary to build companies. These resources include access to proven executive leadership talent, experienced consultants, and experienced product development and manufacturing skills – all of which increase the probability of success for new commercial enterprises.

One venture capitalist at the Columbus public forum said he had 42 pre-screened deals – none of which could find financing. Similarly, in the Cleveland public forum, two participants indicated that each of their firms had 6-to-8 deals that were having difficulty finding venture financing.

All of the professional investors noted a shortage of venture firms in Ohio with investable capital. Several venture capitalists noted the real reason for the shortage of capital is a dearth of limited partners who are willing to invest in Ohio-based venture capital firms. Limited partners do not invest in Ohio-based firms for two reasons: (1) they are more comfortable investing in traditional firms on the East and West Coasts, and (2) Ohio or Midwest-based venture firms are too small.

4. Ohio needs to expand the pool of capital available for professional investors to foster development of Ohio-based venture capital firms. One program, the Ohio-Midwest Fund sponsored by the Ohio Public Employees Retirement System (OPERS), should be considered by other public employee pension systems.

OPERS' Ohio-Midwest Fund invests in smaller, high quality, venture capital and private-equity funds in the region. This program could be expanded and partially address the shortage of capital.

The first two Ohio-Midwest funds were established in 2005 and 2007 with $50 million each. The Columbus office of Credit Suisse/First Boston managed the funds. In 2011, OPERS approved a plan for an additional $100 million fund managed by Permal Capital Management of Boston. Although $200 million aggregate investment sounds like a large investment, it is only 0.274 percent of OPERS' total investable assets of approximately $73.2 billion.

It is easy to see how expanding the OPERS program to the four other major public employees' pension funds—State Teachers Retirement System, State Employees Retirement System, Ohio Police and Fire, and Ohio Highway Patrol—could make a significant amount of capital available for nurturing start-ups in Ohio. In total, the investment assets of these five funds were approximately $163 billion in 2011. If all five public pension funds created similar funds based on 0.137 percent of their investable assets (about half the percentage used by OPERS), that would create a fund of funds of approximately $220 million.

5. The retirement systems and many of Ohio's universities should more broadly embrace the notion of the "double bottom line" or "economically targeted investment." Briefly stated, this means they should invest in venture capital funds to secure a competitive rate of return while achieving an important economic goal, such as creating jobs or fostering the development of high technology companies within a region.

OPERS has recognized this concept and states in its 2012 report: "This fund-of-funds initiative was created to provide returns for OPERS members, but also to encourage business growth within Ohio and the surrounding region. Since its inception, the Ohio-Midwest Fund has helped support more than 2,800 jobs and generated more than $160 million of investments in Ohio and Midwestern companies."

6. The Ohio Board of Regents is in a unique position to develop and foster this notion of double bottom line investing among Ohio's leading universities by supporting the continuation of the OTF's work. Ohio's academic institutions and universities also can help foster an expanded pool of investors by:

   A. Investing in venture capital funds or funds-of-funds as a way of leading by example and legitimizing their encouragement of B and C below.
   B. Using their clout to encourage Ohio-based private companies, family offices and for-profit entities to invest with the goal of the double bottom line and;
   C. Leading the effort to encourage the other four state pension programs to create similar programs.

The Capital subcommittee was encouraged by the partnership announced April 5, 2012, between Ohio University and The Ohio State University to create a joint commercialization funding model. The universities intend to be anchor investors in a $100 million fund directed at early stage funding of technology ventures. Even with this development, however, the committee feels there is overwhelming need for additional capital.

7. Both the Columbus and Cleveland forums called for the continuation and expansion of the Ohio Capital Fund, a fund-of-funds established in 2006 by Ohio legislators to increase private investment in Ohio companies in the seed or early stage of business development. The Ohio Capital Fund has a commitment of $150 million from private resources to invest in qualified venture capital funds. As of early 2012, the fund is fully invested in 24 partnerships including: 8 Ohio-based firms, 12 regional firms, and 4 national firms and; is waiting for refunding by Ohio legislators.

Thus far, venture capitalists backed by the Ohio Capital Fund have financed 64 Ohio-based companies. About half of their investments have been Series A investments – the first institutional money that start-ups urgently need. The following chart illustrates the number of deals by round and by type of company:

	Seed	A	B	C	Growth	Total
Med/Bio	5	12	5	1	1	**24**
IT	12	14	3	2		**31**
Energy		3	1			**4**
Materials		4				**4**
Other	1					**1**
Total	**18**	**33**	**9**	**3**	**1**	**64**

The effort by the Ohio Capital Fund is a good start, and the program is credited with creating 2,176 jobs and utilizing their $82.3 million investment to attract a total $498 million for Ohio companies.

8. Ohio needs to do a careful quantitative analysis of the on-going capital needs of our technology start-up companies. At a minimum, there is a need to know the amounts needed by stage and deal type, and to build on the excellent work already underway by The Ohio State University Fisher School of Business.

   The **2010 Ohio Venture Capital** report clearly articulates the concern expressed by many participants in our forums: *"The long term availability and accessibility of follow-on capital is a key piece of any thriving entrepreneurial ecosystem. As the number of Ohio pre-seed and seed-stage companies grow … the estimated demand for follow-on venture capital balloons."*

The authors of the Venture Capital report created a simple follow-on model that estimated Ohio will need $5.0 billion over the period 2010-2020, or about $500 million a year, on average annually. Further, the model estimated that about $280 million per year is needed for seed and early stage companies over the same time period. There is conservatively at least a $30 million annual shortfall in funding necessary for seed and early stage companies.

RECOMMENDATIONS

1. The Ohio Third Frontier (OTF) and the Ohio Capital Fund (OCF) programs directed at pre-seed and seed technology company formation should continue. It also is essential that Ohio legislators move forward with the OCF expansion.
2. Efforts should be made to establish several Ohio-based venture funds to invest first institutional rounds of capital in the state's and early stage companies.
3. Additional limited partner investors, such as OPERS' Ohio-Midwest Fund, should invest in Ohio venture funds. The Ohio Board of Regents, and Ohio colleges and universities are in a unique position to encourage Ohio-based non-profit foundations, family offices and private and public for-profit entities to invest with the double bottom line goal of economic development.
4. Fund the economic analysis of appropriate centralized annual reporting on venture cap.

MEASURES OF SUCCESS

Metric	Quantitative/Qualitative Measure(s)
Total venture university start-ups attracting capital investments in Ohio start-ups	Ability to attract investors to support Ohio-based technology commercialization activity
Total follow-on funding by Ohio venture and out-of-state venture capital funds	Ability to attract external investors to support Ohio based technology commercialization activity
Continue and further improve the annual Ohio Venture Capital report	Provide Funding for the production of the report and assist in convening of the six regional ESP and interested professional investors with the Fisher School to improve the annual report
Attract external investors to support Ohio-based technology commercialization activity	Total of co-investments in venture backed Ohio based companies from outside the state of Ohio
Annual level of angel and pre-seed and seed stage investments in Ohio technology based start-ups	Ability to attract critical capital essential to supporting technology commercialization activity
Engage universities in new ways of helping to form venture capital funds as a way of contributing to job growth and economic development	Annually measure university participation/investment in Ohio-based venture capital funds.
Engage universities in outreach to new sources of limited partners among: non-profit foundations, family offices and private and public for-profit entities	Create a task force of university personnel to create and implement a plan to reach-out to non-profit foundations, family offices and private and public for-profit entities as potential investors in Ohio-based venture capital funds
Engage Ohio's pension plans to expand the model of the Ohio Midwest Fund of Funds	Create a group of appropriate university personnel and other interested parties to meet with the Chief Investment Officers of Ohio's pension plans to discuss the investment of their funds in a similar fund of funds. Report back to the Regents task force on a quarterly basis.

Technology Subcommittee

GENERAL BACKGROUND

The technology subcommittee started its analysis from the following premise and explored the subsequent questions: research assets (including specialized laboratories and equipment) of Ohio's higher education institutions are the raw material of commercialization. **However, it is generally agreed that a vast majority of Ohio's HEI research is not monetized through commercialization of the resulting technologies.** A number of factors should be addressed that may influence the commercial value of those research assets. Then, the activities that support the transfer and translation of research into commercial opportunities should be reconsidered. Can policies and practices be applied at the research enterprise level to maximize the commercial value of the research assets, and improve the likelihood that an increasing amount of research and associated resources will contribute to a thriving Ohio economy?

FINDINGS

The findings and recommendations presented in this report are based on the following questions asked and information collected from State Science and Technology Institute (SSTI) Research, open innovation conference call, a public forum held on April 26, 2012, at the University of Akron, and the Kauffman Foundation.

Culture Change:

1. How can higher education institutions better communicate institutional research priorities to assure faculty and industry that commercially relevant research pursuits are valued?

2. How can higher education institutions better educate and enable faculty and industry partners with policies and resources that will make them successful in these pursuits?

3. What reward systems and incentives do higher education institutions need to create to drive the interest of their faculty to engage industry, support start-ups and to pursue use-inspired research?

4. What policies would encourage higher education institutions to successfully recruit new faculty that are predisposed to pursuing commercially relevant research and set expectations that such activity is part of the faculty's formal or informal contract with the institution?

Portfolio Management:

1. How can higher education institutions be more effective in assessing the commercial potential/relevance of their research assets?

2. What portals/pathways can higher education institutions create for industry and the venture capital (VC) community to gain working knowledge of their research assets and provide useful feedback on their commercial relevance?

3. How might information technology and social media tools improve the transparency of assets, and the engagement of the industry and Venture Capital (VC) communities in the process of evaluating and accessing higher education assets for potential commercial relevance?

4. Would Ohio's competitive advantage improve with increased interactivity and marketing of the inter-institutional research portfolios and capabilities?

5. How could institutions effectively work together in bundling assets across institutions to create potentially stronger commercial opportunities?

Industry Engagement:

1. What new strategies and best practices can be widely adopted for creating forums that bring the higher education, industry and VC communities into regular contact to explore opportunities and facilitate an increase in the number, intensity and durability of relationships that influence research objectives and lower barriers to successful commercialization?

2. How can industry be engaged as a primary participant in establishing intellectual property strategies during the research process so the resulting intellectual property portfolio is of maximum value?

3. What organizational structures and approaches that exist outside the normal "comfort zone" of both higher education institutions and industry might help effectively catalyze commercialization activity when platforms of interesting and potentially valuable intellectual property (IP) know-how are identified?

4. How do Ohio's higher education institutions best take advantage of "open innovation," and what does it take for institutions, individually and collectively, to become providers of choice for industry seekers?

BARRIERS TO SUCCESS

There is general agreement that Ohio's higher education institutions have the breadth and depth of resources to meet the commercial needs of companies within and outside the state. These resources include: 1) the research portfolios of the institutions; 2) faculty and staff; 3) specialized facilities and equipment; and 4) campus ecosystems where the spirit of inquiry is continually refreshed by new young students who are regularly introduced to the process of research, technology transfer and commercialization.

Industry views these assets as having the potential to make meaningful contributions to new product development, launch new companies, be responsible for day-to-day problems solving and provide the much-needed talent for commercialization and company growth.

The ultimate commercial relevance of higher education resources to industry involves a cost-benefit analysis that must be made by each firm attempting to access those resources. Three elements are critical to the decision:

1. *Awareness:* Can a company readily identify the resources that are of value?
2. *Access and engagement:* Is there a way to efficiently connect to those resources?
3. *Timeliness of action:* Will negotiation and deliverables occur in a timeframe that is responsive to the market-driven demands of the business partner?

RECOMMENDATIONS

Recommendations flowing from these findings address the key elements and fit into the inquiry categories of "culture change", "portfolio management" and "industry engagement." These recommendations fall under two broad headings: 1) business engagement portals, and 2) engagement incentives.

1. Business Engagement Portals

The University System of Ohio (USO) must assure a comprehensive infrastructure (portals) that facilitate business engagement among its universities and colleges. Examples of such portals include the University of Toledo Innovation Enterprises, the University of Akron and Youngstown State University research foundations, and The Ohio State University Industry Liaison Office. The Subcommittee recommends strongly that the USO must provide financial support at a critical level to assure a successful build-up of the current infrastructure or launch new ones as well as their sustainability. Further, the level of USO investment must recognize the desire and willingness of the USO institutions to participate in the technology commercialization processes aggressively via liberal IP processes for industrial partners, who in turn are willing to make investments at certain thresholds for accelerated technology development.

Creating the appropriate "front door" for businesses and investors to access the research and associated resources of Ohio's higher education institutions is seen as a critical element by both universities and industries to increase the commercial relevance of the USO technology assets.

Portals should be separate and distinct from technology transfer offices, focusing on communicating institutions' assets, building relationships among relevant faculty and industry scientists, and facilitating collaborative research and commercialization opportunities between the university and industry.

When developing the portal structure, it is important to create policies and practices that distinguish commercialization practices in the two scenarios: 1) development of technology with active industry/business investments, and 2) commercialization of pre-existing IP.

Near-term goal: Establish a basic level of functionality of USO-funded business engagement portals at each of the colleges and universities of the University System of Ohio that have a track record of research expenditures and/or commercialization activities that reach certain thresholds.

Basic levels of functionality should include:

a. A clearly defined and well-advertised structure that businesses, investors and economic development intermediaries can easily identify;
b. The capability to describe and actively market key institutional resources, raising the general awareness and transparency of the opportunity;
c. An organizational structure that has sufficient autonomy to act in the best interests of the commercialization partnerships;
d. The capability to provide education and networking events that regularly engage businesses, investors, faculty, staff and students to discuss shared interests and improve the ability to form working collaborations; and
e. Core staff with industry knowledge and experience who can understand business needs and effectively relate them to institutional capabilities.

Intermediate-term goal: Establish structured regional and state-wide coordination among institutional business engagement portals. These structured partnerships should be established to facilitate the following.

a. Provide a dedicated source of funding to support translational projects that bridge research and commercialization;
b. Update core technology transfer policies and practices to lower the transaction cost of obtaining IP, especially focusing on reducing negotiation time;
c. Establish state-wide networks that effectively use students to advance commercialization projects and build effective connections between companies and faculty; internships co-ops, practicums;
d. Pursue open innovation methods that increase the frequency and sophistication of interactions between seekers and solvers to include advanced data base techniques, marketplaces and even IP auctions;
e. Support these techniques with educational efforts that promote intelligent risk-taking among collaborators;
f. Strive to integrate the business engagement activities of institutions at least within regional clusters;
g. Extend relationships to include appropriate economic development intermediaries that represent industry interests and have a vested interest in helping build industry and academia relationships to advance commercial interests;
h. Consider statewide collaborations in critical, highly competitive fields (e.g., diagnostics and therapeutics); and
i. Focus on mutually beneficial and long-term relationships, not short-term, one-off projects; with a goal to engage multiple companies in a pre-competitive environment (safe zone) where problems and solutions are shared openly (focused institutes, statewide and regional hubs, sand pit exercises and other mechanisms that facilitate a disciplined problem/solution dialogue).

2. Engagement Incentives

Systemic changes like those described above will improve the processes by which commercialization partnerships are pursued, and will improve both the quantity and quality of these interactions. However, the formation of these collaborations may require additional incentives on both sides of the partnership.

Industries and businesses

Near-term goal: Create a policy providing benefits for industries to invest cash resources in university research and development. Require the engagement of technology stakeholders from both USO campuses and industries to execute accelerated project agreements instead of relegating execution of these agreements to third parties or offices/officers not involved in the technical projects.

Higher education

Near-term goals:

a. Each USO institution should strongly and clearly communicate an institutional policy that embodies the critical role of use-inspired research pursuits, collaboration with business, and the formation of new enterprises for the advancement of the institution, and regional and statewide economic development.

b. Significantly increase the opportunities for students to be engaged in industry projects at the institutions and at companies. Promote the importance of these opportunities as a critical gateway to employment.

Intermediate goal: Engaging in commercialization activity, collaborating with industry or working to create start-up enterprises with tangible outcomes must merit the same types of rewards for faculty as peer reviewed publications, teaching and professional service.

MEASURES OF SUCCESS

Metric	Quantitative/Qualitative Measure(s)
Number of inquiries translated to preliminary follow-up, such as phase 1 pilot studies for scalability and alignment of business goals	Measure of industry-higher education collaborations
Number of students who are employed via entrepreneurial internships and co-op experiences by the engaged industry partners	Demonstrated commitment of university leadership to promoting entrepreneurialism
Invention disclosure forms (IDFs)/$1 million in research: Invention disclosures received per $1 million research expenditure	Demonstration of university productivity related to technology commercialization activity
Gross Return: Gross commercialization revenue relative to the research expenditures	Demonstration of university commitment to technology commercialization activity
Start-ups/$100 million: Number of start-up companies formed (or "spun off") per $100 million of research expenditure	Demonstration of university commitment to technology commercialization activity
Percentage of IDFs pursued: Percentage of inventions for which a patent application is filed	Demonstration of university commitment to technology commercialization activity
Number of non-faculty research and development personnel on campus who are engaged in active technology commercialization efforts	Demonstration of university commitment to technology commercialization activity
Full-time equivalents/$100 million in research: Number of full-time licensing professionals employed per $100 million of research expenditure	Demonstration of university commitment to technology commercialization activity

Workforce Subcommittee

GENERAL BACKGROUND

The Ohio Commercialization Task Force was organized to explore how Ohio colleges and universities can effectively work with industry to accelerate the pace and impact of tech transfer and commercialization by leveraging growth opportunities identified by Battelle within eight manufacturing-dominated technology areas that have significant commercial opportunities for Ohio industry.

The Workforce Subcommittee agreed early on to: 1) determine the ability of Ohio's higher education system to meet industry demand for workers in the eight industry sectors recommended in the Battelle report (**http://www.thirdfrontier.com/BattelleReport.htm**) that are crucial to successful commercialization, and 2) explore with employers which emerging competencies they seek from new hires; how the workforce and competencies needed might vary across the stages of the commercialization continuum; and how industry and higher education can more effectively collaborate to meet future workforce needs in a timely manner. The subcommittee explored the importance of STEM (Science, Technology, Engineering and Mathematics) and other professional and skilled workers throughout the processes of commercialization, proposing a linear model of commercialization to facilitate discussion between Ohio industry and higher education leaders.

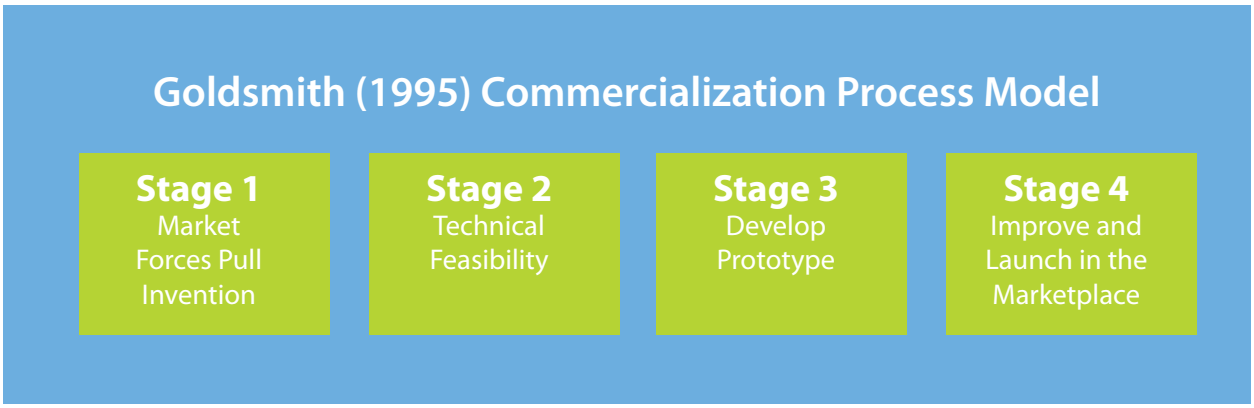
FINDINGS

Literature Review:

1. What Is Meant by the Commercialization Process and Why Are STEM Workers Important to Its Success?

A review of academic literature as well as the rationale given for new national and state strategies reveals two fundamental points: 1) innovation creates opportunities for commercialization, which is key to strong economic growth; and 2) the supply of STEM workers is a necessary but not sufficient factor to drive innovation and application of existing technology in new ways that produce market growth.

The process or continuum of commercialization is thought to be linear, beginning with idea generation to market launch of the new product or technology-based opportunity. This model was used in our industry forums, and participants were asked to discuss what occupations, competencies and skills might be unique at each stage.



Stage 1: Market Forces Pull Invention: This is a research phase across technical market and investment areas. Research is both basic and applied, and shaped by market demand. This phase may survey existing technology and assess market possibilities, and professional and capital needs.

Stage 2: Technical Feasibility: A working model is developed, preliminary production is worked out and safety and environment features are assessed. In other areas, market characteristics are identified (customers and volume) and seed capital is raised.

Stage 3: Develop Prototype: Materials and processes are identified, the technology is tested and production methods are developed.

Stage 4: Improve and Launch: Production system is built, and field support developed. Introduction to market, response analyzed and customer relationships developed. Establish business functions, hire, and train and execute contracts.

Other commercialization studies[7] provide insights about workforce development strategies needed to accelerate commercialization projects. In the early 1970s, extensive studies of successful commercialization found that five factors explained commercialization success. In descending order of importance:

1. Understanding customer needs;
2. Paying attention to marketing and publicity;
3. Performing development thoroughly;
4. Taking advantage of external scientific experts; and
5. Extending greater authority to senior-level innovators.

Five behavior factors required of the workforce to accelerate commercialization:

1. Thinks critically and in terms of both technical and human systems;
2. Listens and develops relationships with customers;
3. Works with individuals from many different disciplines;
4. Utilizes translational skills;
5. Communicates effectively in many different environments.

Scientists, engineers and supporting technicians have long been accepted as critical to the dynamic flow of new ideas emerging from structured research and development R&D activities within corporations and higher education, and are heavily supported by federal policy and funding. Anthony Carnevale, director of the Georgetown University Center on Education and the Workforce, argues that STEM students completing certifications, 2- and 4-year degrees and beyond, are now in demand to support the wide array of ways in which commercialization now occurs. However, "STEM workers are no longer the only ones responsible for introducing new and innovative technology and products… that function is leaving the confines of the lab and moving into the realm of design, customization, marketing, and distribution."

7 Amadi-Echendu, J.E. & R.T. Rasetlola. "Technology Commercialization Factors, Frameworks and Models." IEEE International Technology Management Conference. 144-148; Cellucci, Thomas A. "DHS Implements Commercialization Process." U.S. Department of Homeland Security Science and Technology. 1-8; "Commercialization Framework—Filling Functional Gaps." Ohio Third Frontier.
1, http://thirdfrontier.com/CommercializationFramework.htm

Beginning with a 2007 U.S. Bureau of Labor Statistics publication, Standard Occupational Classifications, (SOCs), are aligned with each of the four elements of STEM:

U.S. STEM Employment 2011		
	Jobs	Placement of Total
Scientists (Less Social Scientists)	963,043	13.4%
Computer (IT)	3,763,253	52.0%
Engineering	1,598,139	22.2%
Engineering Technicians	771,601	10.7%
Math	118,374	1.6%
Total	**7,187,410**	**100.0%**

1. **Science** – Natural scientists, including: life scientists, physical scientists, and natural science technicians.

2. **Technology** – Information technology or computer-related occupations, which are *about half of all STEM employment.*

3. **Engineering** – Use of science to solve practical problems, including engineers, drafters and technicians as well as engineering technicians – second only to IT workers in STEM industries.

4. **Mathematics** – Narrowly defined as: actuaries, mathematicians, operations research analysts, and statisticians – a small percentage of STEM workers.

Nationally and by a large margin, IT and engineering, and engineering technician occupations are the primary job opportunities in STEM careers:

- In 2010, there were 7.6 million STEM workers in the United States, representing about 1 in 18 workers.
- STEM occupations are projected to grow by 17.0 percent from 2008 to 2018, compared to 9.8 percent growth for non-STEM occupations.
- STEM workers command higher wages, earning 26 percent more that their non-STEM counterparts.
- More than two-thirds of STEM workers have at least a college degree, compared to less than one-third of non-STEM workers.
- STEM degree holders enjoy higher earnings, regardless of whether they work in STEM or non-STEM occupations.

2. **What are the gaps in demand and supply of STEM and other occupations that are important to industry in support of its growth strategy built around increased commercialization, and how well Ohio's higher education system meets that demand?**

U.S. vs. Ohio STEM Employment 2011				
	U.S.		Ohio	
	Jobs	Placement of Total	Jobs	Placement of Total
Scientists (Less Social Scientists)	963,043	13.4%	26,978	10.7%
Computer (IT)	3,763,253	52.0%	137,881	54.6%
Engineering	1,598,139	22.2%	58,388	23.1%
Engineering Technicians	771,601	10.7%	26,343	10.4%
Math	118,374	1.6%	3,043	1.2%
Total	7,187,410	100.0%	252,633	100.0%

STEM Employment in Ohio is estimated to be 252,633 in 2011, growing 1 percent annually, and is dominated by IT professionals. This is because IT is used throughout business organizations to support IT-enabled infrastructure.

Ohio's economy mirrors the nation in terms of the composition of STEM disciplines. However, Ohio ranks 23rd among states (and District of Columbia) in the concentration of STEM jobs, only 3.9 percent of all jobs in Ohio versus 4.1 percent for the nation: Michigan, the exception among our neighboring states, ranks 8th with 4.8 percent of all jobs in STEM occupations.

- Ohio would have to add 44,516 more STEM jobs (or 17 percent) to its economy in order to rank among the top 25 percent of states.
- Ohio is expected to lag the nation in STEM job growth, potentially widening the gap. Ohio is projected to grow STEM jobs by 3.8 percent over the next four years while the nation's growth rate is 5.6 percent. Ohio needs to grow an additional 15,276 STEM jobs just to keep pace.

Northeast Ohio and Dayton

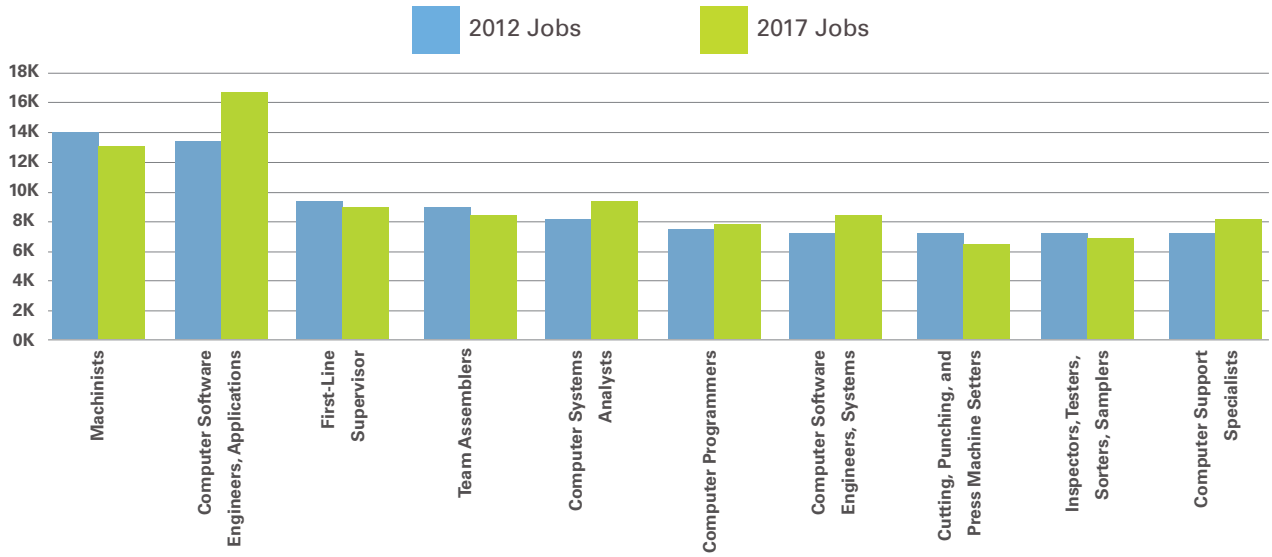
Scientists are a small part of the region's STEM employment; biomedical engineers, and biochemists/biophysicists are expected to grow 24 percent and 17 percent respectively, in the next five years. Chemists, while a strong base historically, are expected to decline in number.

IT jobs, which will grow 5 percent by 2017 and pay an average of $26 an hour, are available for graduates **of both 2- and 4-year institutions**. The Dayton region's IT jobs are a greater percent of all jobs, reflecting its greater importance to that region's economy than the Cleveland region. It is important, however, not to confuse *industries* with *occupations*. Studies conducted by the Northeast Ohio Software Association between 1999 and 2008 indicate that two-out-of-three IT occupations and jobs in northeast Ohio were outside of the traditional IT industry sector.

In the Northeast Ohio and Dayton regions, the only occupation that exceeds the national proportional average is that of chemical engineer. Some other engineering occupations, as a percentage of all jobs, are significantly smaller than for the nation as a whole. Civil and electrical engineers are the largest number of workers in the Cleveland region but no growth is expected in overall demand for engineers.

On the other hand, Dayton's economy demands a greater numbers of engineers. The need for chemical and electrical engineers is twice what it is for the nation. The low employment of scientists and in engineering occupations is the result of an Ohio mix of industries that is less focused on innovation and commercialization to drive its growth.

Increased Dependence On STEM Workers in Battelle's Six Industry Sectors: For these industries alone, this chart includes the 10 occupations with the largest number of jobs in Ohio in 2012. While machinists have the most jobs in 2012, by 2017, computer software engineers and applications will dominate employment in Battelle's six manufacturing-heavy industry sectors. **By 2017, Ohio's STEM employment in these six sectors will contribute 11 percent of all jobs, compared with 3.9 percent for all Ohio industry.**



Of the top 25 occupations by size of employment in the six industry sectors shown in the table, six are STEM and five are IT. While many of the traditional jobs in manufacturing will decline over the next few years, all STEM occupations are growing. **The growing importance of IT to advanced manufacturing and distribution systems is a focus of workforce need that merits further inquiry.** One of the best practices in industry/higher education partnership is the Regional Information Technology Engagement Board (RITE) in Northeast Ohio. While IT top leadership from all industry comprises the board, the region's headquartered Fortune 500 manufacturers dominate the composition and reflects the growing importance of IT to their business models.

3. Do Ohio colleges and universities graduate enough STEM majors to meet the demand for annual job openings?

For Ohio, the difference between the projected annual job openings (net the addition needed to address worker turnover) and the number of students completing 2- or 4- degrees, satisfies annual demand. The shortage worsens, however, if we determine the mismatch between specific IT jobs and qualifications (certifications, degree, skills and competencies and work experience) that employers are seeking and the array of IT majors among our graduates.

Occupational Grouping	Gap
Computer Systems	-2,471
All Other Engineering Technology	-3
Electrical/Electronic Engineering	59
Mathematics	59
All Other Engineering	67
Physics/Astronomy	99
Chemical Engineering	122
Forestry & Conservation	172
Agricultural/Food Services	184

There appears to be a slight surplus of graduates in the other STEM occupational categories. However, this assumes; that there is a perfect match of the skills of graduates with skills sought by employers, which employers attending the public forums verify is not the case; that all graduates will seek employment in STEM occupations. This is far from accurate. Nationally, only about half of STEM graduates choose or remain in STEM occupations, according to a recent study of college students.[8]

Conclusions: Ohio's economy lacks the technology-intensity needed to significantly drive growth in scientist, engineering and mathematical occupations. Further, IT jobs are half of all STEM employment across industries. The majority of these jobs are in industries, alike advanced manufacturing that depend on IT to run all aspects of their business, from front office to production, distribution and sales of their products.

Industry Subcommittee Forums:

Leaders from the six Battelle-targeted industries were invited to participate in two industry forums to respond to questions and dialogue in an effort to better align Ohio's higher education system with the emerging needs for workers, and the new competencies and attributes they will likely need in order to support Ohio's economic recovery and growth.

The forums were conducted March 12, 2012, at Wright State University and March 13, 2012, at Lorain County Community College. Industry subcommittee's critical questions posed to participants:

1. How can Ohio's universities and colleges become better partners with industry to drive increased commercialization?

2. What are the occupations, STEM and other, that drive innovation and commercialization within your industry?

3. How can higher education dramatically increase the supply of entrepreneurial talent needed to grow Ohio's share of industries with promising futures?

Understanding the Gap & How Well Ohio Higher Education Meets Industry Demand

1. STEM workers require much more than technical expertise acquired in college courses: employers look for students and job seekers who have business and leadership skills; can demonstrate relevant work experience, especially in their industries; possess problem-solving skills; and work well in team-based environments.

2. Lack of connections between industry and higher education contributes to the gap. Addressing the gap can begin with better data at state level on the nature of the gap, and creation of work experiences during college that employers help design and support.

Understanding the Skill Needs Throughout the Commercialization Continuum

3. **Invention Pulled by Market Forces**, STEM workers are important (engineering, physics, modeling and simulation, and chemistry); **Technical Feasibility**, engineers and scientists are important; **Develop Prototype**, workers need to understand production and product life cycles; they also need business and marketing skills; and **Improve and Launch**, non-STEM skills become more important, but students must understand the technology and how to work with customers.

8 Anthony Carnevale; et. al., STEM, Center on Education and the Workforce, Georgetown University, December, 2011

4. **A Possible Fifth Stage of Commercialization, Taking Production to Maximum Scale** By 2015, U.S. companies producing for U.S. consumption are projected to reach a point of indifference between producing their products off-shore versus on shore. This creates a future opportunity for Ohio early-stage commercial successes to continue producing for U.S. markets if industry and higher education can create the right mix of smart people working with smart machines to be price-competitive with off-shore sources.

RECOMMENDATIONS

Our research and industry forums confirm the importance of STEM and other occupations to Ohio's economic recovery and to advancing the pace of commercialization.

Ohio industries employment base is one which does not require knowledge of science, engineering and mathematics compared to the nation overall. This helps explain why STEM jobs in Ohio lag the nation and many other states in percent of all jobs and future growth rates.

The lack of demand for STEM workers, at least in part, accounts for the appearance that Ohio is producing a sufficient number of graduates annually based on expected job openings. However, national data reveals that only half of STEM graduates actually enter STEM jobs upon completion of college or university programs.

From the supply perspective, Ohio faces a tremendous challenge in: 1) expanding the enrollment in STEM majors or minors over current levels of enrollment and completion; and 2) aligning the curriculum and experiential learning components of STEM education to better reflect the preparation that industry deems necessary to future commercialization and industry vitality.

Improved alignment of demand and supply of STEM workers and other identified occupations or competencies, requires Ohio to:

1. Multiply and enhance partnerships between industry and higher education to address the alignment of demand and supply of workforce needed to drive innovation, entrepreneurship and commercialization, especially opportunities in the six industry sectors that are prominent economic drivers of the Ohio economy.

2. Enhance the abilities of higher education to work with industry, public workforce systems and others to:

    - Build the pool of STEM and other career-focused youth and transitioning adults for college entry;
    - Prepare STEM and related programs that respond to industry needs and competencies used in hiring; and
    - Connect industry internship and other work experiences and job opportunities with students in Ohio's higher education system.

3. Enhance student enrollment in STEM career education; improve retention and completion numbers and rates; and increase numbers and placement rates of students into gainful employment, especially within the six industry sectors and STEM or other occupations viewed by industry as vital to increasing the pace of commercialization in Ohio.

MEASURES OF SUCCESS

Metric	Quantitative/Qualitative Measure(s)
Increase pipeline of STEM workers from Ohio colleges and universities by 10 percent per year for the next 10 years	Demonstrated commitment of the University System of Ohio to supporting statewide goal
Ensure that 75 percent of STEM students have access to an industry/higher education jobs collaboration	Demonstrated commitment of the University System of Ohio to supporting statewide goal
Create an online forum by December 2013 at which professors and students can interact with industry on research problems	Demonstrated commitment to industry/higher education collaboration
Internet portal for sharing curriculum is operative and an outreach/marketing campaign is underway by December 2013	Demonstrated commitment to industry/higher education collaboration
Proposal for a program for industry to create short-term exchanges for interested professors presented to Regents and industry partners by December 2012	Demonstrated commitment to industry/higher education collaboration
Proposal for a program to subsidize start-up companies in their use of Ohio college and university students as interns and co-ops, or part-time employees presented to Ohio Board of Regents and Ohio Department of Development by December 2012	Demonstrated commitment of university leadership to promoting entrepreneurialism
Ohio Board of Regents sets date of June 30, 2012, to complete data analysis started by this investigation to more thoroughly document the STEM gap within Ohio by building comparative analysis for all Jobs Ohio regions	Demonstrated commitment of the University System of Ohio to supporting statewide goal
Regents and the Office of Workforce Transformation collaborate to design a research program designed to begin to provide answers to questions that will be posed by the continued work recommended throughout this section	Demonstrated commitment of the University System of Ohio to supporting statewide goal
Number of collaborations created and staffed by college or university with support of the Regents; evidence of joint activities to increase high school grads and transitioning adults that elect to pursue career opportunities in STEM	Demonstrated commitment to industry/higher education collaboration

Metrics Subcommittee

BACKGROUND

The Metrics subcommittee reviewed the recommendations of the 6 subcommittees of the OBR Technology Transfer and Commercialization Task Force and concluded that Ohio's future economy will be built on the capabilities of its people, businesses and institutions of higher education. For Ohio to be successful, the individual subcommittee reports determined Ohio will need to create new knowledge, promote technological advances, and create economic value that will benefit the citizens of the state. Metrics subcommittee members further determined that the University System of Ohio must foster innovation, which will be the lynchpin of a sustainable state-supported economic development policy that will make Ohio competitive in the 21st century global economy. As the preceding studies have determined, for economic policies to be sustainable, they must be measurable. The Metrics subcommittee has worked with the six individual subcommittees to develop metrics that are intended to capture the (1) *Economic Impact*, (2) *Knowledge-Based Activities*, and (3) the *Knowledge-Based Capacity* of Ohio's innovation economy in order to understand what is driving it and where to focus state energies in the future to achieve even greater economic performance.

Data collected in each of these categories is intended to measure the sustainability of the economic development engine; the effectiveness of the University System of Ohio; and state policies and practices to build the innovation pipeline; and the raw materials available upon which to build the knowledge-based economy, respectively.

Economic Impact to promote Ohio's technology commercialization efforts in support of economic development statewide:

- Jobs
- Sales
- Wages by Occupation
- Incomes
- Manufacturing Exports

Knowledge-Based Activities to leverage research and technology platforms:

- Master Agreements
- Start-up
- IPO
- Small Business Innovation Research – SBIR I & II
- Corporate R&D Relative to Sales
- Patents
- Medical Devices & Biotech Drug Approvals
- Technology Licensing

Knowledge-Based Capacity to assess the state's competitiveness and ability to provide the necessary resources and environment to attract and retain an educated workforce and entrepreneurs:

- Investments
- Education
- Engineering Degrees
- Population
- Housing

Continually analyzing these three categories (Economic Impact, Knowledge-Based Activities, and the Knowledge-Based Capacity) can provide important clues of where improvements can be made to optimize state resources year by year and assess if progress is being made. And while this report will not analyze each of the metrics listed in the report, the Metrics subcommittee has identified 10 key metrics for further review. These specific metrics were selected because they help frame Ohio's relative competitive position and provide both quantitative as well as qualitative data; and points of time and longitudinal data that will highlight the following:

- **State vs Nation:** Demonstrate whether Ohio leads or lags the national trend-line data
- **Ohio Year-to-Year Trend:** Demonstrates Ohio's relative position change year-to-year
- **Ohio Year-to-Year Change:** Demonstrates Ohio's relative annual performance

MEASURES OF SUCCESS

The following ten metrics represent what Task Force members as a whole confirm are illustrative of the type of analytical work the state will need to do going forward in order to monitor its progress and determine if its policies and resource allocation decisions are having the impact intended. Given the scarcity of resources and the number of policy changes recommended, the Task Force strongly encourages a lead agency be identified to own this process.

Metric	Quantitative/Qualitative Measure(s)
Increased total value of industry investments in Research & Development	Demonstrated commitment to university/industry collaborations
Share of U.S. Venture Capital	Measure of Ohio's national competitiveness to attract venture capital
Venture Capital	Measure of Ohio's capacity to invest in technology commercialization statewide
STEM Job Comparison	Measure of capacity to compete in the global innovation economy
Patents	Measure of Ohio's innovation activity
Inventor Patents	Measure of Ohio's innovation activity
Initial Public Offerings	Measure of Ohio's innovation activity
Entrepreneurial Activity	Measure of Ohio's innovation activity
IT Jobs	Measure of Ohio's innovation activity
Manufacturing Exports or some other manufacturing economic activity indicator	Measure of Ohio's success in competing in the global economy

Task Force Recommendations

The Technology Transfer and Commercialization Task Force has concluded that for Ohio to improve its current economic situation, the state must stimulate the development of a more competitive, high-growth economy that will generate the high-value, high-wage jobs of the future. The Task Force's research determined that the technology transfer, commercialization and entrepreneurial activities within the University System of Ohio can have a significant impact on the overall economic health of the state. But despite several regionally successful technology transfer, commercialization and entrepreneurial initiatives in Ohio, there exists institutional barriers to further success.

The public forums sponsored by the Task Force subcommittees confirmed that Ohio possesses many of the requisite skills and assets to thrive in a 21st century technology-driven, knowledge-based economy; however, the University System of Ohio and the State of Ohio must build the infrastructure and business climate required to accelerate the commercialization of emerging technologies so that these new businesses can thrive and compete in world markets. The Task Force asserts that for Ohio to achieve sustainable economic growth in the 21st century in highly competitive growth industries (e.g., Advanced Materials, Aero-Propulsion Power Management, Fuel Cells and Energy Storage, Medical Technology, Sensing and Automation Technologies, Situational Awareness and Surveillance Technologies, Software Applications for Business and Healthcare, and Solar Photovoltaics), the Uni-

versity System of Ohio and the State of Ohio must jointly invest in the critical infrastructure necessary to support and promote the creation of new intellectual property (IP) in science and technology, and must support the subsequent commercialization of that IP.

Public Forum attendees frequently commented that the investment in incubators, innovation centers and research parks was an effective approach to creating platforms for promoting industry-higher education partnerships and incubators and innovation centers are essential to the goal of supporting statewide and regional economic development.

Task Force members also concluded that the development of statewide and regional ecosystems will enhance the state's regionally competitive position by enhancing the ability of universities to recruit and retain faculty and to support the emergence of faculty-initiated emerging technology companies by ensuring the sufficiency of human, infrastructure, capital and financial resources that will be necessary to help new businesses grow and prosper. Other national studies[9] have determined that linking innovation assets, such as people, institutions, capital and infrastructure, is essential to creating robust, localized ecosystems that can turbo-charge a state's or a region's economy. These studies have further found that successful industry-higher education collaborations are dependent upon the existence of these comprehensive ecosystems for the provision of the requisite financial, managerial and business development services and resources; essential to supporting start-up companies that are based on emerging technologies. Many Task Force members advocate for the statewide development of these ecosystems, so that Ohio can maximize the research engines it has created and supported throughout the University System of Ohio.

Innovation Ecosystem Structure

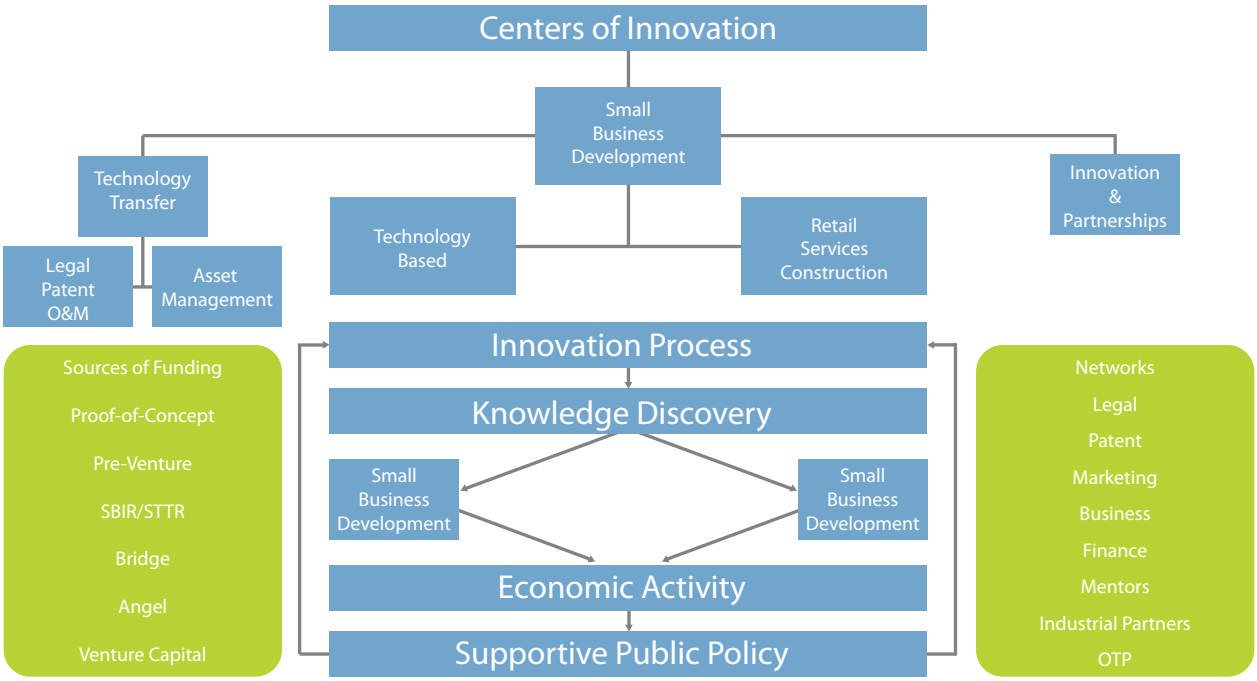


Figure 5

9 Impact: Innovation Model Program for Accelerating the Commercialization of Technology – A Proposal for Realizing the Economic Potential of University research; by Krisztina "Z" Holly, Vice Provost for Innovation University of Southern California 2010; Beyond the Rhetoric: Evaluating University-Industry Cooperation in Research and Technology Exchange, Volume 1 –The Case, A Report by the Business-Higher Education Forum 1988; Task Force on Diversifying the New York State Economy through Industry-Higher education Partnerships 2009; Living Studies in University-Industry Negotiations; by National Council of University Research Administrators and the Industry Research institute 2006.

As part of its work, the Task Force identified a number of themes which must be recognized and acknowledged within this Condition Report if their recommendations are to achieve the Regents and Chancellor's goal of increasing technology commercialization activity through industry-higher education collaboration. The threads of these critical themes can be found in each of the subcommittee reports found within this Condition Report and which provide the framework for the Task Force's summary recommendations. The critical themes are as follows:

1. Higher education and industry leadership in the 21st century must promote an environment that supports industry-higher education collaboration in order to expand the technology commercialization pipeline;

2. Ecosystems that support technology commercialization are essential and must be built collaboratively by industry, higher education, non-governmental organizations, and government leaders;

3. Accelerating technology commercialization requires a robust funding continuum from proof-of-concept to seed-stage to later-stage venture capital, and depends on both public and private support to ensure its availability;

4. Formal communication networks and databases are essential for sharing knowledge and identifying collaborative opportunities that otherwise may not be possible due to the complexity of accessing critical information;

5. The next generation of technology innovation will come from today's students who should be exposed to an entrepreneurial curriculum, coops and internships, provided with real life experiences and supported in promoting their intellectual property ideas;

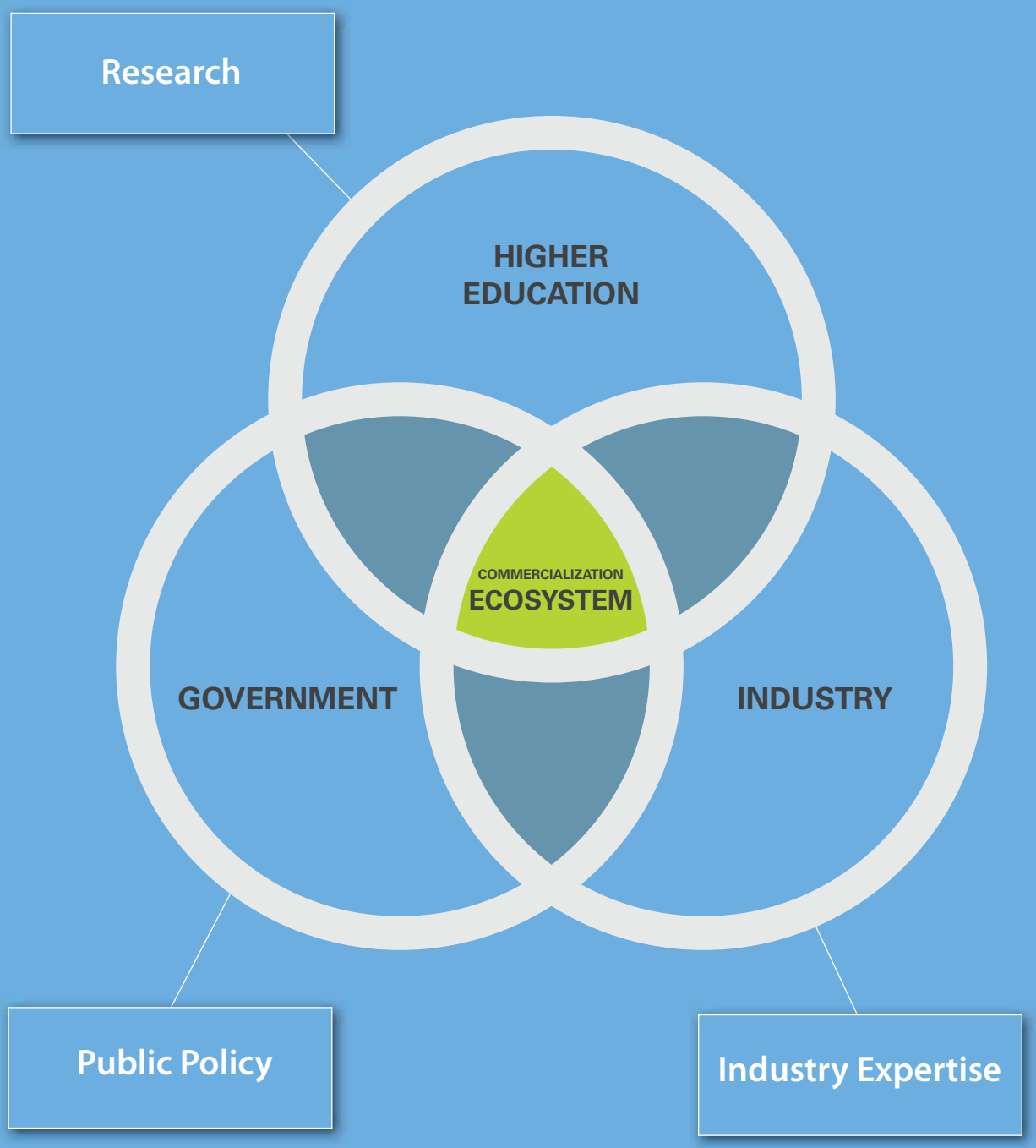
6. The innovation economy needs more than STEM expertise; the workforce continuum, which is essential to promoting technology commercialization, requires many different skill sets; and

7. To successfully achieve the goal of promoting technology commercialization, industry, higher education and governmental leadership must work together to identify and track measurable outcomes.

The Task Force's summary recommendations and proposed implementation steps are intended to help focus near-term resource allocation decisions and efforts. In the aggregate, these recommendations require joint collaboration between academia, industry, and government *(Figure 3)*. They are not intended to supplant the individual subcommittee recommendations identified in the body of the Condition Report, but rather to complement them. Collectively, the Task Force members deem that these recommendations represent a road map for how Ohio can strategically reposition itself to successfully compete in the innovation economy and to become a market leader statewide, regionally and globally.

Figure 3

Ecosystems that support technology commercialization must be built collaboratively by industry, higher education, and government leaders.



These Task Force summary recommendations are more explicitly articulated in the six subcommittee reports, but the essential findings and recommendations are summarized below. Task Force members stress that these recommendations, if implemented, will have a powerfully positive impact on Ohio's economy and the quality of life for all Ohioans. The specific subcommittee recommendations are as follows:

SUMMARY OF RECOMMENDATIONS: PROPOSED IMPLEMENTATION STEPS

ACTION TITLE	DESCRIPTION	IMPLEMENTATION STEPS
Capital Continuum	Ohio should support development of investment capital, from proof-of-concept, to pre-seed and seed-stage funds, to early-stage (Series "A" and "B") venture funds; employing capital from both public and private sources. Concurrently, Ohio should promote statewide and regionally based "first institutional funds" to focus on HEIs and industry technologies with commercial applications.	Maintain and expand Ohio Third Frontier seed-stage funding and the six Entrepreneurial Signature Programs; maintain and expand the Ohio Fund; develop incentives to attract "first institutional" and later-stage external funding to Ohio; expand opportunities for Ohio universities, colleges and private industry to invest in Ohio generated IP, and provide incentives for third-party angel and pre-seed investors.
University Incentive Systems	HEIs, in consultation with the Board of Regents should develop strategies that promote a "culture of entrepreneurship"—i.e., curricular and innovation—on university and college campuses by rewarding and incentivizing entrepreneurial activities by faculty, and developing user-friendly approaches to commercialization of HEI-based technologies.	HEIs' leadership must recognize and link applied research, the creation of intellectual property, and commercialization activities within the promotion and tenure review process; eliminate barriers to intra- and inter-HEI research collaboration and restructure HEI technology transfer and commercialization practices by creating user-friendly industry agreements, developing research information portals, and encouraging industry collaborations earlier in the technology development continuum.
University Entrepreneurship Programs	HEIs should allocate additional resources to expand entrepreneurial programming and curricular activities, including, but not limited to, providing rigorous STEM curricular options on campus and online and by providing more opportunities that can be accessed by students, staff and faculty who have an interest in entrepreneurship.	Ohio's 4-year universities and 2-year community colleges should expand their entrepreneurial curricula, collaborate with corporate partners to offer expanded student internships and cooperative experiences, promote meaningful business plan competitions, and develop experiential learning opportunities with start-up companies.
State Policy Support for Entrepreneurial Activities	In order to successfully leverage the broad-based diversity within Ohio's HEI research platforms, the state should encourage the development of statewide and regionally based strategies that are focused on the knowledge-based economy, and the state should support the adoption of policies and procedures that incentivize the recruitment and retention of high-tech businesses, and the talent to run them. The state should work with Ohio's Congressional delegation[10] to organize federal support of commercialization and identify key representatives from industry, higher education and government, including the Board of Regents, to lead and champion this critical initiative at both the state and regional level.	The Chancellor and Board of Regents should work with university and industry leaders, the Third Frontier and JobsOhio, to (a) promote the formation of public-private partnerships statewide; (b) work with universities, community colleges, industry and government to review state laws; (c) identify opportunities to incentivize private investments in technology commercialization activities; (d) promote statewide and regionally based economic development strategies that target and/or leverage existing statewide and regional resources; and (e) collect and disseminate data to measure the state's competitiveness in the global innovation economy.

10 See page 22 (footnote 5).

ACTION TITLE	DESCRIPTION	IMPLEMENTATION STEPS
Workforce Development: Linking Research Universities and Community Colleges in the Technology Commercialization Process	The State of Ohio must better align Ohio's HEIs and PreK-12 education with the emerging needs for both STEM and skilled workers with new competencies and attributes in order to support Ohio economic recovery and growth through increased commercialization in targeted technology and industrial sectors.	Ohio's HEIs should establish a statewide goal to increase the pipeline of STEM graduates over the next ten years, and should take responsibility for working directly with PreK-12 systems to increase the pipeline of graduating high school seniors who are qualified in the STEM disciplines. The Governor's Office of Workforce Transformation, in collaboration with OBR and the Task Force Subcommittee on Workforce, should develop a Workforce Commercialization Continuum that identifies current and future requisite jobs skills and proficiencies and, in partnership with Ohio's HEIs, should develop strategies to train and provide Ohio's current and future workforce at the PreK-12, community college, and university level. OBR and the Ohio Third Frontier should work collaboratively to develop internships and other experiential learning opportunities for students to develop the necessary skills to compete in the global innovation economy. This will require engagement of industry with a demand for new interns, particularly as part of OBR's pending Co-op and Internship fund.
Ecosystem Development	Working collaboratively, industry and higher education leadership – with the support of government – must develop a comprehensive profile of the resources required, including the financial, managerial, and technical resources that will be required to sustain a statewide and regionally-based ecosystem, essential to supporting university and industry activities throughout the State of Ohio.	The Ohio Third Frontier must promote a user-friendly industry/academia interface by examining how the Entrepreneurial Signature Programs might be improved or enhanced in order to create an environment of shared purpose; and to align the values and expectations both of industry and higher education. HEI leadership, in partnership with industry and government leaders, must work to integrate and/or develop the infrastructure and the systems essential for building and supporting entrepreneurial activity (early stage collaborations, master agreements, expert databases, Small Business Development Centers (SBDC) activities, etc.) within the Ohio Third Frontier, and to collaboratively devise incentives to encourage industry/HEI collaborations.
Incubator Capacity	HEIs should provide incubator capacity where faculty and industry collaboration can occur and where start-up companies can find a nurturing environment.	Ohio's HEIs should identify opportunities to partner with community colleges to create or expand incubator capacity and should take the lead in developing collaborative strategies to support early stage start-ups and joint ventures. Given the inherent flexibility in the community college business model, four-year universities should make it a priority to collaborate with community colleges to promote technology commercialization. Government should develop and offer incentives supporting universities and community colleges entering into such collaborations.

ACTION TITLE	DESCRIPTION	IMPLEMENTATION STEPS
Program Metrics	Annual data collection and publication of performance metrics should be central to the state agencies and to the universities that support and promote economic development and that make decisions regarding the application of critical resources, including human, facilities or capital resources.	Implementation of these recommendations should include the development of a data collection system—built in cooperation with the appropriate state agency(s)—with the appropriate benchmarks to measure the effectiveness of state and university policies and practices to build the innovation pipeline and support Ohio's technology commercialization strategies of recruiting and retaining high-paying jobs in key industrial sectors. Data sets should measure the state's capacity to support innovation, innovation development activity, and the impact (outputs) of those activities on the state, Ohio's HEIs and statewide and regional economic growth. Best practices should be shared among Ohio colleges and universities.
Updated Industry Agreements	Ohio's HEIs should seek long-term relationships with key corporate partners, governed by updated general umbrella agreements. These agreements should be sensitive to proprietary interests, emphasize strategic partnerships, goals, strategies, evaluation and timelines; not just licensing revenues and/or service agreements.	To promote industry and higher education collaboration and to achieve high-value and high-impact relationships, Ohio's HEIs should standardize industry material transfer agreements (MTAs) and licensing agreements to be more "user" friendly; university offices of Technology Transfer should seek to improve their overall efficiency, work to identify and encourage key industry strategic partnerships and promote the development of comprehensive relationship agreements that facilitate faculty-industry interactions.
Portals and Enhanced Communications Networks	Ohio should develop institutional portals and communication networks to advertise HEI faculty IP, research strengths and activities and to promote strategies to make it easier for industry to interact with faculty who have an interest in working with industrial partners. The state, in partnership with Ohio's HEIs, should implement a strategic communication plan for defining state policies, procedures and support systems intended to advance the commercialization of university technology.	The Ohio Board of Regents (OBR), in collaboration with Ohio's HEIs, should establish business engagement portals for each university and college, in order to market their patent portfolios and to share and promote their respective research capabilities. The OBR and HEIs must develop strategies for advertising and promoting faculty research interests and expertise, and work cooperatively with key industries to facilitate their introduction to and interaction with key faculty. The state should also consider a policy of providing a benefit for industries to invest cash resources in university research and development to further strengthen industry-higher education collaboration throughout the state.

The Task Force's findings and recommendations can be summarized as follows:

1. **REMOVE BARRIERS**: Remove barriers within and among Ohio universities and colleges that restrict entrepreneurial activities and technology commercialization

2. **BUILD STATEWIDE AND REGIONAL ECOSYSTEMS**: Build statewide and regional ecosystems that support Ohio's technology commercialization pipeline

3. **PROMOTE GREATER STATEWIDE AND REGIONAL COLLABORATION**: Promote higher education, industry, government and community collaboration in support of statewide and regional economic development

4. **CREATE AN ENTREPRENEURIAL ENVIRONMENT**: Nurture an environment and promote changes that support, promote and reward entrepreneurial activity within Ohio's HEIs

5. **RESEARCH COOPERATION**: Facilitate higher education and industry research collaborations to more efficiently and effectively utilize our HEI resources to support and attract industry to Ohio

6. **GENERATE CAPITAL RESOURCES**: Develop initiatives that provide the capital resources necessary to support the Innovation Continuum and promote the growth of new industry

7. **PLAN FOR FUTURE WORKFORCE EDUCATION AND JOB SKILL TRAINING**: Develop a Workforce Commercialization Continuum—in conjunction with the Governor's Office of Workforce Transformation—that identifies current and future requisite jobs skills and proficiency

8. **DEFINE METRICS**: Identify, apply and track key metrics to measure Ohio's progress related to technology commercialization and job creation.

The Task Force believes these recommendations are achievable given the resources that exist statewide and represent the capacity necessary for supporting a technology commercialization pipeline *(Figure 6 below)*.

As noted by the following chart, the resources are broken out by Ohio Third Frontier regions in order to demonstrate that the six state regions have significant capacity and expertise to support and grow their existing technology commercialization efforts. The chart is also informative as it shows that each region has its own unique strengths and underscores the need for statewide- and regional-based economic development strategies that leverage their unique resources.

	3rd Frontier Region		
	Central Ohio	Northeast Ohio	Northwest Ohio
University Centers of Excellence	**Ohio State** Biomedical/Healthcare Advanced Energy Advanced Materials Agriculture/Food Production Bioinformatics	**Akron** Polymers **Cleveland State** Biomedical/Healthcare **NEOMED** Biomedical/Healthcare **Kent State** Advanced Materials Biomedical/Healthcare	**Bowling Green** Biomedical/Healthcare Advanced Energy Business Organization **Toledo** Biomedical/Healthcare Advanced Energy Transportation
R & D Funding Concentration	Healthcare Pharmaceuticals Medical Devices Alternative Energy Advanced Materials Agriculture/Biomass Nanotechnology	Healthcare Diagnostics Pharmaceuticals Medical Devices Infectious Diseases Fuel Cells Alternative Energy Advanced Materials Polymers Agriculture/Biomass Aerospace Sensors Nanotechnology Transportation	Healthcare Diagnostics Medical Devices Photovoltaics Fuel Cells Alternative Energy Advanced Materials Alternative Energy Transportation

Figure 6

3rd Frontier Region

Southeast Ohio	Southwest Ohio	Western Ohio
Ohio University Biomedical/Healthcare Advanced Energy **Shawnee State** Biomedical/Healthcare Advanced Materials	**Cincinnati** Biomedical/Healthcare Transportation Advanced Materials **Miami** Biomedical/Healthcare Advanced Energy	**Central State** Advanced Energy **Dayton** Advanced Energy Advanced Materials Biomedical/Healthcare Sensors **Wright State** Transportation IT Biomedical/Healthcare
Healthcare Diagnostics Avionics Alternative Energy	Healthcare Diagnostics Pharmaceuticals Infectious Diseases Fuel Cells Alternative Energy Power and Propulsion Agriculture/Biomass Aerospace Propulsion Sensors Nanotechnology	Healthcare Diagnostics Photovoltaics Fuel Cells Coal to Liquified Fuel Alternative Energy Advanced Materials Aerospace Avionics Propulsion Data Management Sensors Transportation

	3rd Frontier Region		
	Central Ohio	Northeast Ohio	Northwest Ohio
Skilled Workforce Growth	Healthcare Pharmaceuticals Medical Devices Alternative Energy Advanced Materials Agriculture/Biomass Nanotechnology Diagnostics Fuel Cells Aerospace Data Management Sensor Transportation	Healthcare Diagnostics Pharmaceuticals Medical Devices Infectious Diseases Fuel Cells Alternative Energy Advanced Materials Polymers Agriculture/Biomass Aerospace Sensors Nanotechnology Transportation	Healthcare Diagnostics Medical Devices Photovoltaics Advanced Materials Alternative Energy Transportation Fuel Cells Coal to Liquefied Fuel
Edison Centers/ Incubators	**Centers** BioOhio Edison Welding Institute Polymer Ohio **Incubators** TechColumbus	**Centers** MAGNET **Incubators** Akron Global Business Accelerator BioEnterprise Braintree Center for Business Innovation GLIDE MAGNET Youngstown Business Incubator	**Centers** Center for Innovative Food Technology **Incubators** University of Toledo
OTF Pre-Seed Funds, Angel Networks, 3rd Frontier Funding, Venture Funds	Yes (4)	Yes (9)	Yes (1)
Small Business Development Center	Yes	Yes	Yes
Corporate Partnerships			

Figure 6 (cont.)

3rd Frontier Region		
Southeast Ohio	Southwest Ohio	Western Ohio
Healthcare Diagnostics Avionics Alternative Energy	Healthcare Diagnostics Pharmaceuticals Infectious Diseases Fuel Cells Alternative Energy Power and Propulsion Agriculture/Biomass Aerospace Propulsion Sensors Nanotechnology Photovoltaics Advanced Materials Transportation	Healthcare Diagnostics Photovoltaics Fuel Cells Coal to Liquified Fuel Alternative Energy Advanced Materials Aerospace Avionics Propulsion Data Management Sensors Transportation
Centers Edison Biotech **Incubators** TechGrowth Ohio	**Centers** TechSolve **Incubators** Hamilton County Business Center	**Centers** Edison Materials Technology Center **Incubators** The Entrepreneurs Center
Yes (1)	Yes (5)	Yes (2)
Yes	No	No

In order to promote and support these statewide and regionally based strategies, the Task Force recommends that the entities charged with implementing the recommendations contained in this report work with the statewide and regional partnerships that have been formed by the Ohio Third Frontier *(Figure 7 below)*. These partnerships represent an opportunity for industry, higher education and government to partner with statewide and regionally based agencies and organizations to build the infrastructure necessary to support the Task Force's recommendations and grow technology commercialization in their regions. The partnerships also afford an opportunity to more effectively target both public and private resources to ensure that they achieve maximum impact within the regions in terms of new business start-ups and high paying, quality jobs.

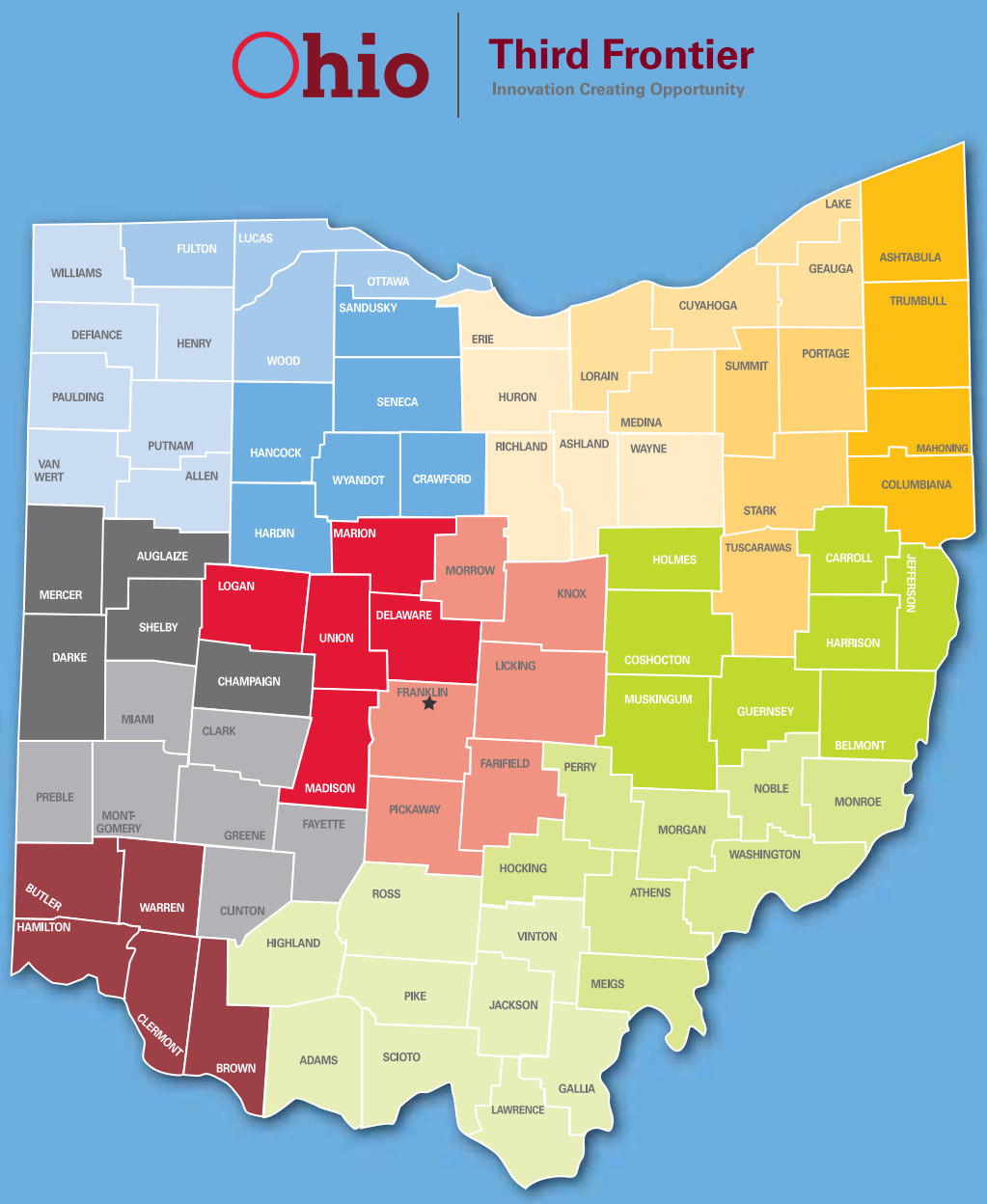


Figure 7

In order to ensure that Ohio is successful in growing its technology commercialization pipeline, the Task Force's final recommendation is that the entities charged with the implementation of this report develop feedback loops that measure the state's and regions' effectiveness in leveraging existing capacity to promote high value economic impact. The feedback loops should measure innovation capacity, activity, and impact *(Figure 8 below)*. The units of measure can be tailored to a region or summarized at a statewide level depending on their purpose or use.

Metrics

Figure 8

Acknowledgements

Each year the Board of Regents is required to produce a report on the condition of higher education in Ohio. For 2012, the Regents were intent on examining the state's capacity to transform significant aspects of higher education as well as highlight the unlimited potential of the University System of Ohio to be a major driver of economic prosperity in the state. To this avail, we chose to focus on *Advancing Ohio's Innovation Economy through Commercialization* for our fifth report.

Our goal in gathering information for the report was to develop a mechanism for receiving input from a wide variety of people involved in every aspect of commercialization in Ohio. To this end, the Regents convened a taskforce of 32 highly energetic, highly competent state leaders, representing industry, higher education, finance, government, and non-profit organizations to develop the recommendations contained in this report.

Each member of the taskforce committed an extraordinary amount of time to attend taskforce meetings, serve on subcommittees, host public forums throughout the state and develop subcommittee reports. I want to thank each member of the taskforce for their dedication, enthusiasm, and unique perspectives. Their passion for this issue was clear and their deep concern for the future prosperity of our state was inspirational.

I also want to thank The Ohio State University for hosting our Task Force meetings; the hundreds of individuals who participated in the 10 statewide public forums convened by the Task Force; and the following forum hosts: Case Western Reserve University, Columbus State Community College, The University of Toledo, Wright State University, Kent State University, Lorain County Community College, University of Cincinnati, Key Bank of Cleveland, The Ohio State University and The University of Akron.

The feedback received was candid, insightful and extremely constructive. Their input has served the task force and the Regents well in shaping our thinking and forming our recommendations. Many of the themes focused on in this report came from the public forum participants.

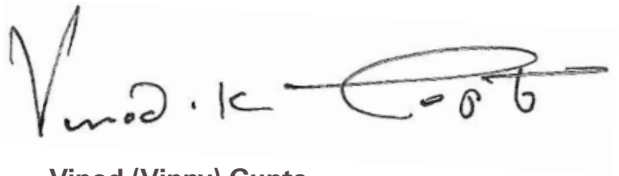
The task force's advisory committee played a significant role in assisting the task force and the Regents in honing and focusing the many concepts and ideas we heard through the process. I greatly appreciate the time and advice received from the advisory committee and look forward to their continued support through the critical implementation process.

One of the true highlights of producing this report was being able to work with the 14 interns from seven different USO institutions that assisted the Board of Regents and the task force. Their work reconfirmed my belief that Ohio has truly talented, highly motivated students who are ready and willing to take the challenge of moving our state forward if we provide them with the opportunity to do so. Their enthusiasm and commitment has inspired me to do all I can to assist Ohio in meeting its full commercialization and job-creation potential.

Very special thanks to Stephen Golding, the Chief Financial Officer at Ohio University. Stephen has contributed countless hours guiding the task force through the process of producing this report. His experience in developing similar reports in other states has been invaluable to the task force and the Board. I thank him for his tremendous contributions in drafting the Report and for his sage advice and counsel.

Finally, I want to express my appreciation for the members and staff of the Ohio Board of Regents and the consultants that assisted with the Report. None of the work of the task force could have taken place without their dedication, commitment and competence. I especially want to thank my colleagues on the Board who showed great confidence in allowing me to represent them on the task force. It has been my great privilege to work with so many consummate professionals.

Sincerely,



Vinod (Vinny) Gupta
Regent, Ohio Board of Regents
Chair of the Ohio Board of Regents' Innovation,
Technology Transfer and Commercialization Task Force

Leib Lurie

Appendices

FIFTH REPORT ON

The Condition of Higher Education in Ohio: **Advancing Ohio's Innovation Economy**

Appendix A

ACADEMIA DRAFT v6 – Final Draft
Last edited by: Daniel Gray, John Vennemeyer
April 30, 2012

Outline

1. *What are the most important factors and practices leading to the timely and successful commercialization of university-based technologies?*

   1.1 Functions of technology transfer and commercialization must be clearly defined and delineated.
   1.2 It must be recognized that the skills and experience required for technology transfer are different than those required for commercialization,
   1.3 Significant investment of capital, talent and infrastructure is required on behalf of the university.
   1.4 Universities must champion, promote, and take pride in their contributions to the economic development of their region and State.
   1.5 Strong University leadership providing a consistent message of the importance of entrepreneurial activity from the top down.
   1.6 Relational rather than transactional relationships with industry are key.
   1.7 It is important for universities to leverage regional strengths.
   1.8 The best universities to work with are the ones that welcome industry partners at all levels, from President to students.
   1.9 Universities have a strong asset base including supercomputers, high-end storage, high-end instruments, engineering software and test equipment. These assets, coupled with access policies to make sharing easier can be a catalyst to deeper, more meaningful relationships with Industry.

2. *What are the current limitations, practices, and barriers regarding university-industry collaboration in Ohio?*

   2.1 Too much focus on technology push rather than developing a deeper understanding of industry and market needs.
   2.2 Competition between universities hinders progress.
   2.3 Universities do not move at the speed of business.
   2.4 The conflict of interest policies may be too strict or interpreted too strictly at public universities.
   2.5 There is a lack of easily accessible 'prototyping' money.
   2.6 Entrepreneurial resources are lacking within the institutions and what talent exists is spread too thin.

2.7 There is a lack of university/industry integration in many departments at Ohio universities.
2.8 Faculty are generally not rewarded or recognized for the work necessary to patent/commercialize, though this is starting to change at select institutions.
2.9 There is a desire for a stronger entrepreneurial culture at many universities.
2.10 Undergraduate/Graduate students are generally not being taught the skills to perform this function or are not yet experienced enough to assume a leadership role in commercializing technologies.
2.11 There is a shortage of available entrepreneurs with the experience to successfully commercialize technologies after they have transferred from the universities.

3. *What is the current state of Ohio's productivity in terms of commercialization? See Chart*
4. *What are the strategies for increased success in the future and what are the best metrics for evaluating progress?*

4.1 Revamp tech transfer and commercialization practices
- 4.1.1 Revamp practices within tech transfer offices
- 4.1.2 Break down barriers to collaboration
- 4.1.3 Fill the funding gap

Priority Recommendations:
- Establish long term, relational corporate partnerships
- Recruit more commercialization talent on campuses

4.2 Incentivize entrepreneurship
- 4.2.1 Tangible incentives for researchers
- 4.2.2 Increase student involvement
- 4.2.3 Create a strong culture of entrepreneurship

Priority Recommendations:
- Allow tenure and promotion credit for commercialization/tech transfer
- Include commercialization in institution's strategic priorities

Abbreviations: BDMF – The Burton D. Morgan Foundation, BLP – Blackstone Launch Pad, BWC – Baldwin Wallace College, CWRU – Case Western Reserve University, EEC – Entrepreneurship Education Consortium, JSHECC – Jumpstart Higher Education Collaboration Council, Kent State University, LCCC – Lorain County Community College, NEOCEP – Northeast Ohio Collegiate Entrepreneurship Program, NEOMED – Northeast Ohio Medical University, NOCHE – Northeast Ohio Council on Higher Education, OU – Ohio University, OSU – The Ohio State University, UC – University of Cincinnati, UD – University of Dayton, USASBE - United States Association for Small Business and Entrepreneurship

In addition, the terms 'university' and 'academic institution' are often used interchangeably in this report, as many of the recommendations listed are intended to be applicable to both traditional 4-year universities and community colleges.

General Background

Ohio remains under the influence of one of the deepest economic recessions in modern times. To improve its current economic situation, Ohio must stimulate the development of a more competitive, high-growth economy that will generate the high-value, high-wage jobs of the future—this will require an ever-increasing supply of new products, services and ultimately new business ventures. To be successful in ramping up its external visibility within this increasingly competitive global economy, Ohio must not only establish a firm foundation of ongoing technology-intensive development, but it must also develop a workforce with the requisite skills to promote and support technology commercialization. To develop and maintain such a well-established foundation for economic growth – and create communities that support an entrepreneurial culture – requires sound public policy carried out within a broadly based political consensus—this observation underscores the importance of the roles played by federal, state, and local government entities in support of industry-higher education collaborations.

As is well understood, both the nation's and Ohio's economic prosperity are derived from our ability to introduce new, high value-added products and services into the marketplace. Technological innovation resulting from basic and applied research produces many of these value-added products. Success in this arena is increasingly dependent upon the ready availability of a vast infrastructure that includes a highly skilled workforce, state-of-the-art scientific expertise, manufacturing and fabricating capabilities, and the technological capabilities typically found on the campuses of our nation's great research universities. It is widely appreciated that one of this state's greatest assets is the University System of Ohio and its partnering private institutions of higher education. Because the scale of the needed infrastructure exceeds the resources of most single organizations, continued economic competitiveness is becoming more dependent upon successful collaborations and the development of strategic partnerships between industry, research universities, and government.

Accordingly, Chancellor Jim Petro and the Ohio Board of Regents created the Regents' Technology Transfer and Commercialization Task Force with a mandate to develop a statewide commercialization ecosystem that creates jobs in Ohio by effectively and efficiently moving university research to commercialized application in order to create, attract new businesses, as well as expand existing businesses.

Key Questions:

In collaboration with the Board of Regents, the Academia subgroup of the Commercialization Task Force sought to uncover current best practices regarding strategic academia/industry partnerships in the state of Ohio and nationally and to provide guidance for improving the quality and quantity of these interactions at the state level. Information on current and best practices was compiled between January 2012 and April 2012 from recent economic reports, interviews and two public forums held in Columbus, OH and Cleveland, OH. Details of reference materials can be found in Appendix A. This information was then used to answer the following questions:

1. What are the most important factors and practices leading to the timely and successful commercialization of university-based technologies?
2. What are the current limitations, practices, and barriers regarding academia-industry collaboration in Ohio?
3. What is the current state of Ohio's productivity in terms of commercialization? What are aspirational statewide goals?
4. What are the strategies for increased success in the future and what are the best metrics for evaluating progress?

Key Findings:

1. *What are the most important factors and practices leading to the timely and successful commercialization of university-based technologies?*

1.1 **Functions of technology transfer and commercialization must be clearly defined**. The functions of 'technology transfer' and 'commercialization' are different. 'Technology transfer' refers to the process of transferring a technology or product developed at a university to an outside entity, usually a company. 'Commercialization' refers to the process of taking a technology or product to market. At several universities, the function of technology transfer does not clearly differentiate between these two functions, which can lead to inefficiencies, confusion and less than optimal deployment and monetization of Ohio's technology assets. Further, there are limitations within the university infrastructure that prevent or discourage new company formation.

1.2 **Significant investment of capital, talent and infrastructure is required on behalf of the academic institution.** Successful technology transfer and commercialization activities do not occur by accident. In general, success in this endeavor requires significant and intentional investment by the institution. Examples of capital investment include technology accelerators, prototyping centers, entrepreneurial resources, bridge funding for very early stage companies, adequate and qualified personnel, a more commercial mindset and clear metrics on which performance can be managed in the technology transfer office.

1.3 **Academic institutions must champion, promote, and take pride in their contributions to the economic development of their region and State**. They are helping support their graduates' ability to remain and be productively employed in Ohio. Economies have grown out of those institutions and neighboring regions that have embraced tech transfer and commercialization fully. MIT and others have measured the direct and indirect economic impact

of their efforts. For example, the average salary at university startups is often 40-50% higher than the average in the state.

1.4 **Strong institutional leadership providing a consistent message of the importance of entrepreneurial activity from the top down.** The importance of top-down commitment was revealed as very important in university ecosystems with a strong track record of successful commercialization. Generally, successful commercialization programs require a significant investment of resources. This is only possible with support from university leadership. In addition, university leadership, with the support of policy changes, must provide incentives and vehicles to promote the accelerated commercialization of novel technologies. The Board of Trustees of each university must discuss this issue as a strategic plan is developed and this type of activity should be clearly located within the university's strategic plan.

1.5 **Relational rather than transactional relationships with industry are key.** The most productive technology transfer arrangements are founded on relational rather than transactional interaction, i.e. the goals of both the academic and industrial institutions are aligned and cultivated over time rather than operating as an independent series of research-for-pay transactions. There are several excellent regional examples of this that are explored in more detail in the response of Key Question 3.

1.6 **It is important for academic institutions to leverage regional strengths**. When individual campuses that have embraced entrepreneurship are able to connect regionally and thereby cross-pollinate through shared learning, resources and competitions, the results are amplified and help to build a regional attitude that encourages idea generation and start-up activity. The regional strengths also extend beyond university-to-university relationships; they must leverage the broader ecosystem of company formation vehicles, pre-seed/early stage capital, economic development groups such as the Third Frontier's Entrepreneurial Signature Program groups and the Edison incubators.

1.7 **The best academic institutions to work with are the ones that welcome industry partners at all levels, from president to students**. The technology transfer goals at each level of institutional leadership, from faculty to president, must be aligned. Misalignment at any level may compromise the relationship between an institution and a company. Good alignment fosters these relationships and results in increased productivity. A strong example of this is the University of Akron's relationship with the Timken Company, through the Timken Engineered Surfaces Laboratory in the College of Engineering.

1.8 **Sharing assets including supercomputers, high-end storage, high-end instruments, engineering software, prototyping equipment and test equipment can be dealmakers**. Universities often have access to resources that are out of reach for smaller companies. Ready access to expensive or high-end equipment is often a major incentive for companies to investigate academic partnerships. This creates a win-win situation for both companies and researchers while accelerating the pace of commercially viable research. Currently the process for early stage companies to discover and then access these assets is cumbersome and often cost prohibitive.

2. *What are the current limitations, practices, and barriers regarding university-industry collaboration in Ohio?*

2.1 **Too much focus on technology push rather than developing a deeper understanding of marketplace needs.** Faculty engaged in academic research are often disconnected from marketplace needs. The intellectual property generated from this research then often stagnates within the university since the motivation for research may not be founded on a clear market need. Including industry input in the early stages of research planning can have a significant and positive impact on the research plan and outcome. Early collaboration is often characterized by co-applications on grants. Currently the universities' ability to cost share in a meaningful way prevents some grant applications from being pursued.

2.2 **Competition between institutions hinders progress.** Competition between universities hinders progress. Collaborative efforts, as evidenced by the EEC and JSHECC, generally result in greater efficiency and effectiveness. Future funding made available by the Board of Regents should have collaboration conditions or incentives. JSHECC in particular has been in operation for 2.5 years and currently consists of over 20 member institutions openly sharing information, events and plans for student participation in entrepreneurial activity. The group meets bimonthly to discuss shared interests such as student involvement with incubators, internships, connecting with venture development services and competitions. The "Northeast Ohio Collegiate Entrepreneurial Ecosystem" shown in Appendix B summarizes the interaction among participants.

2.3 **Academic institutions do not move at the speed of business.** The timeframe for accomplishing projects in academia is often too slow for industry, especially with regard to research. Faculty with little or no industry

experience need to be cognizant of this fact and to be more timely and responsive to the needs of industry

2.4 **The conflict of interest policies may be too strict or interpreted too strictly at public universities**. Conflict of interest policies tend to discourage progress. Creating vehicles within or adjacent to the universities that can remove these conflicts or relaxing aspects of these policies, (for example by allowing the technology transfer office to take ownership in a company) will allow university and industry partners to align their goals and accelerate the commercialization process.

2.5 **There is a lack of easily accessible 'prototyping' money**. Technologies often need additional prototyping after initial proof of concept testing. The time it takes to raise additional funding can compromise industry interest. An easily accessible pool of money can accelerate the prototyping process, keeping industry engaged and increasing the probability of technology transfer. Several sites in Ohio such as the Lorain County Innovation Fund and the TechColumbus TechGenesis Fund have prototyping funds and early results indicate they are working.

2.6 **Entrepreneurial resources spread too thin.** Entrepreneurial resources are often underfunded, leading to a decreased capacity for timely and effective technology transfer. For example, an understaffed office must be very selective in the projects it chooses to advance. An underfunded office may not be able to afford necessary prototyping or legal assistance to all projects. {need to make sure we explain that it is both a shortage of resources and having the right resources (tech transfer talent versus company formation talent). More important is the need for connecting entrepreneurial talent to the technology pipeline and structuring standard agreements that allow for entrepreneurs to more immediately understand the commercial implications of a partnership with the institution, so that they can determine if they should be investing their time in the partnership.

2.7 **There is a lack of academia/industry integration in many departments at Ohio universities**. Both parties in many successful academia/industry partnerships make an effort to integrate the people on both sides into their everyday functions. Collaborations are much more successful when students, academic researchers and industry contacts make arrangements to integrate critical functions into a shared space e.g. working in the same facility.

2.8 **Faculty are not rewarded/compensated for the work necessary to patent/commercialize.** Research faculty who engage in entrepreneurial activity

are generally not rewarded for filing invention disclosures, forming a start-up or reaching out to industry. In fact, the opposite was true for many of the faculty we talked to. Department chairs often discourage this type of behavior because the opportunity cost results in less time for research. Also, the tenure structure of most departments in Ohio universities does not consider entrepreneurial success to be an important factor, leaving little motivation to engage in entrepreneurial activities besides personal satisfaction and potential long-term gain. Arizona State University recently became the first school in the United States to consider entrepreneurial activity in the tenure selection process and recently NEOMED implemented a similar policy. Schools across the nation will be paying close attention to the outcome.

2.9 **There is a desire for a stronger entrepreneurial culture at many universities.** For tech transfer to operate efficiently and effectively, it must grow out of a campus environment that celebrates and encourages an entrepreneurial culture. This culture can grow and thrive on campuses of all sizes and characters, but it is most fertile when it grows organically from the strengths and passions of the institution and its leaders. It is not antithetical to serious academic research, but rather enlivens the classroom and laboratory experiences in meaningful ways that can help students to build pathways to careers beyond graduation.

2.10 **Undergraduate/Graduate students are generally not being taught the skills to perform this function and are not yet experienced enough to assume a leadership role in commercializing technologies.** Exposure to entrepreneurship is minimal for most undergraduate and graduate students. Although programs are present on nearly all campuses, the required curriculum seldom includes entrepreneurial classes or experience for undergraduates. Graduate students working for an advisor who does not engage in entrepreneurial activity will also have very little exposure and tend to focus solely on academic research. Less than half of those graduating with an advanced degree will enter academia with the rest being hired in industry. This results in college graduates entering the workforce with little awareness of the entrepreneurial process or how to effectively work with academic institutions from the industry standpoint. In addition, there may also be issues of perception that entrepreneurship is only for business majors.

2.11 **There is an experience gap between successful tech transfer and successful commercialization at many universities**. One of the most difficult steps in the commercialization process is finding an individual with adequate market and industry experience to champion a product or idea. After the technology transfer office at a university has successfully protected an idea and

developed a prototype, there is often an experience gap in completing the necessary steps to achieve commercialization. For start-ups based on a university technology, the inventor is often not the best choice for growing the company. Hiring a qualified CEO is crucial to the early success of a new venture. The volume of qualified individuals who are willing to take on the risk of joining a start-up is smaller than the demand. This is a limiting factor in the number of successful start-ups coming out of universities.

3. *What is the current state of Ohio's productivity in terms of commercialization?*

2010 State New Economy Index - Ohio Rankings

Managerial / Professional / Technical Jobs	High-Wage Traded Services	IPO's 30	Online Agriculture 32	Patents 28
Workforce Education 38	Export Focus Manuf/Service 26	Entrepreneurial Activity 32	Broad Band Telecom 30	Industry R&D Investment
Immigration Knowledge Workers 9	Foreign Direct Investments 22	Inventor Patents 27	Health IT 26	Non-Industry R&D Investment
Migration U.S. Knowledge Workers 23	Job Churning 39	Online Population 32	High-Tech Jobs	Alternative Energy Use 34
Manufacturing Value-Added 19	Fastest Growing Firms	E-Gov't. 21	Scientists & Engineers 20	Venture Capital

This is where Ohio stands with regard to traditional economic metrics in comparison to other states. Future goals should focus on improving the metric outlined in Section 4, using these rankings as a benchmark to measure progress.

4. *What are the strategies for increased success in the future and what are the best metrics for evaluating progress?*

4.1 Revamp tech transfer and commercialization practices

When speaking with representatives from industry on how to improve commercialization out of academia, the subcommittee heard two related complaints over and over: it is far

too slow and too complicated to get technology out of institutions. Industry generally wants to work with our academic institutions, but when it takes too long or too much effort with uncertain outcomes, many projects lose their appeal. In order to begin to reduce these barriers, while recognizing that many of these policies were put in place to protect precious academic resources, the subcommittee recommends the following steps for our academic institutions: revamp the practices within tech transfer offices (4.1.1), break down existing barriers to collaboration (4.1.2), and focus resources to help fill the funding gap (4.1.3).

4.1.1 Revamp practices within tech transfer offices

The first step to making institutional policies and practices more friendly to the commercialization process is to begin with the offices already dedicated to these goals. The subcommittee recommends the following as concrete first steps:

1. **Focus on building long term strategic relationships with corporate partners. It is imperative that institutions build partnerships that are relational rather than transactional (See 1.5). (Priority Recommendation)**

2. **Attract more commercialization expertise to campuses to complement the strengths of the technology transfer officers (See 2.11) (Priority recommendation)**

3. Develop standardized, transparent process for inventors to work with the institution

4. Create clear standardized commercialization agreements for industry partners

5. Encourage early and aggressive involvement of campus officials to find the best ideas and move them into the process

6. Establish an affiliated organization that can monetize and/or commercialize the IP. For example, company formation that has an initial ownership structure of 20/20/20/20/20. 20% to the University, 20% to the Inventor(s), 20% to the CEO/Entrepreneur subject to actively leading the company AND securing external funding, 20% to the external funding source/investor and 20% set aside for the employee stock option pool.

Recommended Input Metrics:
- Number of institutions using standardized process
- Number of commercialization staff
- Number of strategic partnerships

Recommended Output Metrics:
- Invention disclosures/year
- Deals/year
- New capital investment dollars/year

- Researcher satisfaction

4.1.2 Break down barriers to collaboration

Big or small, all of our institutions, and all their academic departments within, have the ability to participate in commercialization activities. However, they often need to collaborate not just with industry, but also across departments or institutions to be successful. Additionally, there are many regional entrepreneurial support organizations, like JumpStart in Northeast Ohio and TechColumbus in Central Ohio, who are willing and able to partner with institutions to bridge gaps in the ecosystem. JSHECC does a good job connecting Northeast Ohio higher education institutions. There is room for improvement in other parts of the state. In order to make it easier for entrepreneurs to work in partnership with researchers, departments and institutions toward successful commercialization, the subcommittee recommends the following to begin breaking down existing barriers:

1. Increase opportunities for researchers to interact with industry, both formally and informally. For example, long-term university/industry relationships have been started at the University of Cincinnati by organizing events where industry comes to the university to discuss funding a general research need. Researchers and industry members then talk about which capabilities at the university could be leveraged to address part of that need, or something related to it. In parts of Ohio, incubators are deliberately reaching out to campuses. MAGNET has the Beta Space and TechColumbus has the BetaBox, both designed to attract students. Shaker LaunchHouse is connecting with students and recent grads drawing them into a growing entrepreneurial network in the region.

2. Revise interdepartmental policies that discourage cross-disciplinary research and IP development by incorporating institutional success metrics

3. Institutions with limited resources should develop regional partnerships with other institutions to enable full-scale entrepreneurial programs, similar to NEOCEP in Northeast Ohio which helps coordinate the entrepreneurial resources of some of the region's small liberal arts colleges.

Recommended Input Metrics:

Recommended Output Metrics:
- Number of interdepartmental projects started/year
- Number of inter-campus programs

<u>Case Study: Northeast Ohio Collegiate Entrepreneurship Program</u>

Tech transfer happens on college and university campuses of all sizes, although it is naturally a more deliberate and structured process on larger university campuses with dedicated tech transfer professionals and specialized graduate programs. However, a key piece of the success story in Northeast Ohio has been the creation of a vibrant collegiate

ecosystem with many strategic interactions among campuses of small liberal arts colleges, led by the Northeast Ohio Collegiate Entrepreneurship Program.

NEOCEP is a five-year experiment funded by the Ewing Marion Kauffman Foundation and The Burton D. Morgan Foundation (BDMF) to spread entrepreneurship across liberal arts college campuses. The five NEOCEP schools include College of Wooster, Hiram College, Baldwin-Wallace College, Oberlin College, and Lake Erie College. In a relatively short period of time, the landscape of collegiate entrepreneurship in the region – largely due to the NEOCEP initiative – has grown and changed dramatically. From a modest beginning of scattered entrepreneurship programs on a handful of Northeast Ohio campuses, the region has created a system of institutions and organizations that all work together to strengthen the whole.

By challenging these liberal arts colleges to work together collaboratively across and deliberately within their own individual campuses, the program has seen many successes across the board, including:

- Hiram College, which has now trained more than 90 percent of its faculty in the teaching of entrepreneurship, breaking down barriers and encouraging entrepreneurship to sprout and flourish in unusual places on campus.
- Oberlin College's Fifth Year Fellowship Program, through which students receive funding to start a business following graduation, with the support of the college community and its resources.
- Lake Erie College, renowned for its equestrian program, has introduced a unique equine entrepreneurship program that has generated businesses related to horse feed, waste products, horse trailers and tack.
- Baldwin-Wallace College has developed the Center for Innovation & Growth, housed in its own recently constructed building, heightening its presence and significance on the campus.
- The College of Wooster, known for its challenging senior Independent Study Program and its philosophy of Independent Minds, Working Together, has embraced entrepreneurship as a way of thinking, building its E-Center around informal brainstorming get-togethers (known as Popcorn Sessions), internships, competitions, and widely attended entrepreneurship events.
- These schools are leading the charge to form a national special interest group under USASBE to work more deliberately on how smaller colleges and universities across the country can be more effective in promoting entrepreneurship and commercialization on their campuses. The group should be fully operational by January of 2013 and will include many smaller NEO higher education institutions

4.1.3 Fill the funding gap:

Universities need to be very deliberate about planning for sustainability of their programs. Multiple streams of income are required. Baldwin-Wallace has done this very well with funds coming from endowment, earned revenue, donated funds and the operating budget. While securing funding will always be a central issue to commercialization, across the spectrum of interviewees there were some very specific

themes that began to emerge in regards to the role of the academic institution in funding. Specifically, there was a belief that academic resources could have an outsized impact on entrepreneurs within their campuses if targeted at filling the funding stages that were less attractive to industry. While recognizing that resources are tightening on campuses, the subcommittee recommends the following to help have the biggest impact on growing commercialization:

1. Increase funding in underserved stages, particularly prototyping.

2. Actively develop more and more robust seed and venture funds available to small businesses.

3. Develop proof of concept centers to give researchers the infrastructure needed to bridge the "valley of death". Thought should be given to how these resources could be maximized through specialization towards specific industries that are strong in each region.

4. Have the institutions provide real estate and access to equipment and talent free of charge in an effort to accelerate the commercialization as well as to reduce the amount of external funding required at the earliest stages.

Recommended Input Metrics:
- Number of proof of concept centers
- Number of proof of concept tests conducted

Recommended Output Metrics:
- New dollars invested in projects/year
- Dollars/project invested
- Number and % of disclosures that receive outside investment for ideas that have gone through proof of concept

<u>Case Study: Lorain County Community College's Innovation Fund</u>

At this time of scarce resources, it is still important for the academic community to find effective ways to make investments in supporting entrepreneurs, particularly in early stages when other sources can be hard to get. A great example of filling this gap, while leveraging resources to bring in more funding and opportunities for students is the Innovation Fund in Northeast Ohio. Led by the efforts of Lorain County Community College and with funding from the Ohio's Third Frontier, the Innovation Fund has invested $5.2 million in proof of concept studies and resulted in over $60 million of follow up capital.

The Innovation Fund fulfills its mission of promoting education and economic development by providing modest awards (up to $100,000) to promising technology-based start-ups located or willing to locate within the 21 counties of Northeast Ohio. Awards are made to help early-stage entrepreneurs progress through the business development continuum by providing resources to help validate the technology or prove the business model. In turn, recipients of Innovation Fund awards are required to provide

an entrepreneurial educational opportunity or internship for students, faculty or staff of Lorain County Community College and/or one of the Innovation Fund's partnering higher education institutions (University of Akron, Stark State University).

By helping current entrepreneurs succeed while nurturing a new generation of entrepreneurial talent, partners of the Innovation Fund hope to foster a robust environment in Northeast Ohio where innovation and entrepreneurship are encouraged and supported.

4.2 Incentivize entrepreneurship

The benefits of pursuing technology transfer are many, including (From MIT Technology Transfer Guide):

- Making a positive impact on society
- Feeling a sense of personal fulfillment
- Achieving recognition and financial reward
- Generating additional department/center funding
- Meeting the obligations of a research contract
- Attracting research sponsors
- Creating educational opportunities for students
- Linking students to future job opportunities

However, despite the many benefits that an academic institution and the communities they serve derive from entrepreneurial activities, the rewards, both tangible and intangible do not match up. This misalignment means many opportunities are missed as institutions fail to signal to members of their community, the importance of entrepreneurship. To begin to better align the benefits and rewards, the subcommittee recommends the following: offer tangible incentives to researchers (4.2.1), actively increase beneficial opportunities for student involvement (4.2.2), and foster a whole culture of entrepreneurship on campuses (4.2.3).

4.2.1 Tangible Incentives for Researchers

Despite the many benefits, entrepreneurial actions are not recognized in consideration of tenure at most universities. Many of the academic researchers the subcommittee spoke to were frustrated. They felt that not only were they not rewarded for pursuing transfer or commercialization of their research, but oftentimes de facto punished because they were falling behind in tenure track research or falling out of favor with their departmental leadership. Faculty had much less incentive to pursue commercialization than the strategic desire of their institutions. However, an institution's desire to pursue commercialization through the research of its professors needs to be balanced against the overall mission of the academic institution to discover and teach knowledge. In order to balance these two goals, the subcommittee recommends the following:

1. **Allow expanded credit toward tenure and/or promotion for research commercialization (See 2.8). (Priority Recommendation)**

2. Clarify and standardize the incentives policy for faculty who successfully license their IP and make sure the information is well understood.

3. Assist faculty members in developing the skills to start a business.

Recommended Input Metrics:

Recommended Output Metrics:

- Numbers of institutions offering tenure credit for commercialization
- Number of faculty trained in entrepreneurial skills/year
- Researcher satisfaction
- Percentage of faculty engaged in commercialization

<u>Case Study: NEOMED's Tenure and Promotion Standards</u>

There are few examples nationwide of academic institutions including commercialization activities in their tenure track and promotion standard, with Arizona State University widely recognized as the first large state institution to do so. However, we have a great example of leadership in Ohio in NEOMED, who have included commercialization and tech transfer in their standards for both tenure and non-tenure track faculty.

Adopted in late 2011, NEOMED's Procedures for Appointment, Promotion, and Tenure offer a great example of how to include commercialization in the standards, but also how to do so in a manner that expands, rather than limits an institution's ability to reward innovative faculty. The language from the tenure track standard is as follows:

Standards and documentation for promotion and tenure include, but are not limited to:

(i) Research and Scholarly Accomplishments

(a) The Standard

(i) Research is central to the mission of the College. Given the complexity of the College and the great diversity of talent within it, it is imperative that various kinds of academic work be recognized through a broad vision of scholarship. Scholarship includes, but is not limited to, the scholarship of discovery, integration, application and teaching. Scholarship is understood to include the traditional science of inquiry, investigation and experimentation known as research. <u>Scholarship and research may also include participation in clinical trials and commercialization, patent and technology transfer activities.</u> Such work may be primarily supportive for promotion decisions and weigh importantly in tenure decisions. While clinical care is insufficient alone to merit promotion or tenure, clinical innovation and improvement activities done in a scholarly manner and acknowledged to be

of regional, national or international importance are important indicators of distinction and merit consideration. Regardless of the type of scholarship, it should possess the quality of excellence, be peer-reviewed and be disseminated in the public domain.

4.1.2 Increase student involvement

As more and more students are becoming interested in doing entrepreneurial work, our academic institutions need to make sure we are supporting them by offering opportunities before and after graduation. The biggest issue the subcommittee heard from students and recent graduates is that entrepreneurial opportunities had very low visibility on campus unless they were very diligent in pursuing them. In order to make sure academic institutions are able to give all interested students the opportunity to get real world entrepreneurial experiences during school and keep them in Ohio after graduation, the subcommittee recommends the following:

1. Require corporate partners to offer students opportunities on joint projects.

2. Develop more experiential learning opportunities for students to work with start-ups before graduation, including co-ops and internships. Internships in entrepreneurial settings should be promoted including a model such as that offered by NOCHE. This summer they will place 50 students in entrepreneurship internships and train the companies to manage these positions effectively. BLP also has great potential to encourage commercialization. BLP is a co-curricular program that uses a model developed at the University of Miami in Florida and offers a prescribed method of engaging students through venture assessment, counseling and coaching. It will be implemented at KSU, CWRU, LCCC and BWC, giving access to over 72,000 students. It operates to enhance other entrepreneurship programs that may already be operating on campus. The BLP is scheduled to be fully operational in the fall of 2012. BDMF and Blackstone Charitable Foundation are co-funding the program over the next 3 years. Other regions of the United States will have BLP programs in the future, including one in Detroit, which is already in operation.

3. Develop more relationships with companies to actively place students in jobs/internships where they can gain experience and perhaps a job upon graduation. A good example of a program already in place is The Entrepreneurs EDGE Fellows model that places grad students in positions with companies where they take a technology that is sitting on the shelf and develop it into a viable product line or new business.

4. Embed foundational pieces of entrepreneurship education into the curriculum for all majors.

5. Promote business plan competitions with meaningful preparation, awards and follow-up benefits such as mentoring, space and access to capital, such as the

model with the Ohio State Business Plan competition, the TechColumbus incubator, and NCT Ventures.

6. Offer competitive full and partial tuition 'Entrepreneurship Scholarships' for promising students who plan to study and engage in entrepreneurship, akin to athletic scholarships.

Recommended Input Metrics:
- Competitions
- Entrants
- Internships
- BLP Participants
- Mentors engaged
- Number of entrepreneurship programs on campus

Recommended Output Metrics:
- Companies launched
- Dollars invested
- Jobs created
- Students working in entrepreneurial settings upon graduation

4.1.3 Actively foster a strong culture of entrepreneurship

A prerequisite for Ohio's institutions to become leaders in technology commercialization is the creation of a strong culture of entrepreneurship on and around campuses. Every person interviewed by the subcommittee and every speaker at our forums made this point. More specifically, this culture needs to be imbued throughout all the members of the community, from the president to the faculty to the students. That the buy-in starts at the top is an especially important point, as representatives of best practice institutions cited strong leadership from the top as a leading factor in their successes. While no single policy change or program can create a culture on it's own, the subcommittee believes the following steps represent a good start for our institutions:

1. **Inclusion of commercialization in institutions' strategic priorities (See 1.3, 1.4). (Priority Recommendation)**

2. Invest to make sure there is a full support network including capital, facilities and training.

3. Ensure there is a dedicated centralized infrastructure for commercialization on every campus. Center should be outside of the business college so that all programs have access.

4. Increase opportunities for researchers to interact with industry, both formally and informally.

5. Cultivate buy-in from faculty, even those not involved in commercialization, through intentional engagement and support from the administration.

6. Measure the leadership on their institution's performance against the key metrics identified. From there, the goals will cascade down to permeate the organization.

7. Reach out to alumni base. Alumni entrepreneurs are a source of financial support and can also serve as mentors, counselors, coaches, competition judges and internship sources. Dartmouth College was an early pioneer of this approach and has a well-established network of alumni entrepreneurs.

Recommended Input Metrics:

- Number of entrepreneurship-related classes
- Students in entrepreneurship minor
- Students to entrepreneurship major
- Entrepreneurship co-curricular activities and participation
- Faculty trained and engaged in entrepreneurship teaching and promotion
- Number of 'mentor hours' – time spent by entrepreneurs mentoring academic researchers

Recommended Output Metrics:

- Number of ventures started
- Jobs created
- Institutional funding
- Follow-on funding
- Competitions entered and competitions won
- Patents executed

<u>Case Study: Ohio University gets Faculty Buy-In</u>

From President McDavis down to the students, Ohio University has deliberately and successfully grown a culture of entrepreneurship over the past decade. Much of this success can be attributed to the fact that the University set out to deliberately put in place the resources and programs needed for success. However, one element in which OU has been particularly successful has been strong engagement from faculty in entrepreneurship, whether through starting businesses of their own or working with students on projects.

Getting faculty to commit to engagement on commercialization and entrepreneurship is generally not easy, as there can be a lot of skepticism at first. Ohio University recognized the crucial importance of winning over their faculty and did so by deliberately engaging them on the issue both informally and formally through the faculty Senate. However, while engaging the faculty is a good start, it needs to be matched the right message.

Joseph Shields, OU's Vice-President for Research and Creative Activity, explained how they approached the faculty, acknowledging their importance to the process and the positive potential for all members of the community from creating an entrepreneurial culture:

- Faculty already understand that a university should add value to the community in which it lives and this point provides a good context for the start of any discussion.
- The most important point of emphasis should be that there is educational value for all students to learn entrepreneurial and critical thinking skills. This point is critical for getting buy in from faculty who may not themselves be interested in entrepreneurial activities.
- Remember to point out that commercialization does not have to be in medical or engineering. This point is powerful at OU, where much of the commercialization energy is emerging from the digital media program.
- Even for faculty in departments without much commercialization, there is still potential for positive resource outcomes as money that comes back from commercialization can be invested in the university at large.

Summary

- To improve its current economic situation, Ohio must stimulate the development of a more competitive, high-growth economy that will generate the high-value, high-wage jobs of the future

- The success of technology transfer, commercialization and entrepreneurial activities within the Ohio university/higher education system will have a significant impact on the overall economic health of the state.

- Despite several regionally successful technology transfer, commercialization and entrepreneurial initiatives in Ohio, there exist institutional barriers to further success.

- **After careful research, we recommend the following for improved technology transfer, commercialization and entrepreneurship in Ohio universities and academic institutions:**

  1. Revamp technology transfer and commercialization practices within universities by
    - **Establishing long term, relational corporate partnerships**
    - **Recruiting more commercialization talent on campuses**

  2. Incentivize entrepreneurship among university researchers by
    - **Allowing tenure and promotion credit for commercialization/tech transfer**
    - **Including commercialization in institutional strategic priorities**

Appendix A – Reference Materials

Economic Reports

- AUTM Report Data – 2010
- AUTM's Proposal for the Institutional Economic Engagement Index
- The Economic Impact of Sponsored Research at the University of Utah
- Enterprising States Report - creating jobs, economic development, and prosperity in challenging times
- Milken Proposal – Value of the University System of Ohio to the State's Economy
- Task Force on Diversifying the New York State Economy through Industry-Higher Education Partnerships
- Ohio Third Frontier Report: Targeting Growth Opportunities for the next 3-5 years
- Promoting the University of Delaware's Office of Economic Innovation & Partnerships
- As an Industry Leader in the Technology Commercialization Process University of Akron - Emerging issues and recommendations for technology transfer and commercialization in a global manufacturing environment report

Public Forums – Summarized Transcripts

- Case Western Reserve University – February 14, 2012 (See 'Academia subgroup - Forum and Survey Summary spreadsheet' and 'Cleveland Forum Summary Transcript')
- Columbus State Community College – February 21, 2012 (See 'Academia subgroup - Forum and Survey Summary spreadsheet' and 'Columbus Forum Summary Transcript')

Interviews

- Aalap Dingh – PhD Student, Massachusetts Institute of Technology
- Portia Taylor – PhD Student, Carnegie Mellon University
- Cleveland Clinic Innovations:
    - Mark Low, Managing Director, Global Cardiovascular Innovation Center
    - Pete O'Neill, Director, Commercialization
    - Charles (Chip) Steiner, Director, Product Development
    - Sam Kiderman, Director, New Ventures
    - Tom Thornton, General Manager, Alliances

Internet

- BDMF website at www.bdmorganfdn.org.

Other

- Northeast Ohio Collegiate Entrepreneurial Ecosystem
- NEOMED Policy - Procedures for the Appointment, Promotion, Tenure, and Evaluation of Tenure-Track and Core Faculty
- An Inventor's Guide to Technology Transfer at the Massachusetts Institute of Technology
- An MIT Inventor's Guide to Startups: For Faculty and Students

Appendix B: Figures (See appendix for PDF version)

Northeast Ohio's Collegiate Entrepreneurial Ecosystem

More than 50% of people 18-34 indicate they are planning to or have started a business. And, even if they don't become entrepreneurs, they may go on to get a job with a young, venture-backed company or work for an established corporation taking cues from startups and acting entrepreneurially. The good news? There is a lot of support and many good reasons for students to start a business or work for an innovative company in Northeast Ohio.

Outreach & Programming

Blackstone LaunchPad

Entrepreneurship Education Consortium (EEC)

JumpStart

Manufacturing Advocacy and Growth Network (MAGNET)

Shaker LaunchHouse

Youngstown Business Accelerator (YBI)

Resources

BDMorganFdn.org
E-Spirit Newsletter

JumpStartInc.org

IdeaCrossing.org

Kauffman.org

Internships

BioEnterprise

NOCHE / NEOintern

Entrepreneurs EDGE

The Innovation Fund

Campus programs

Competitions

Entrepreneurship Immersion Week (EEC)

ideaLabs (EEC)

LaunchTown

TIEQuest (TIE Ohio)

Campus competitions

Networks

Blackstone LaunchPad

Entrepreneurship Education Consortium (EEC)

JumpStart Higher Education Collaboration Council

Northeast Ohio Collegiate Entrepreneurship Program

The Members of the JumpStart Higher Education Collaboration Council

Ashland University

Baldwin Wallace University

BGSU – Firelands

The Burton D. Morgan Foundation

Case Western Reserve University

Cleveland State University

College of Wooster

Entrepreneurial Engagement Ohio

Entrepreneurs EDGE

Hiram College

John Carroll University

JumpStart Inc.

Kent State University

Kent State, Stark

Kent State, Tuscarawas

Lake Erie College

Lakeland Community College

Lorain County Community College

Malone University

Northeast Ohio Medical University (NEOMED)

NorTech

Northeast Ohio Council on Higher Education (NOCHE)

Notre Dame College

Oberlin College

Ohio State University - OARDC

Stark State College

Walsh University

University of Akron

University of Mount Union

Youngstown State University

Appendix B

SUMMARY REPORT OF THE

CAPITAL SUBCOMMITTEE

PETER KLEINHENZ AND GEOFFREY CHATAS
5/20/2012

Summary

The Capital Sub-Committee of the Ohio Boards of Regents Task Force focused on the need for capital (including start-up, venture and later stage capital, including debt and equity in all forms) in State of Ohio.

The Sub-Committee engaged in numerous methods of 'fact finding', including the use of a 2010 report (and subsequent update) prepared by Michael Camp, head of the Entrepreneurship Center of the Fisher College of Business at the Ohio State University, titled "DEVELOPING A STRONG FOUNDATION FOR GROWTH "; numerous discussions with financial leaders both in Ohio and nationally, and finally holding two 'town-hall' format discussions in Columbus and Cleveland. These town halls attracted leaders from across Ohio to engage in day-long discussions about the current state of capital availability and the need for capital going forward.

By combining these various methods of information gathering, the subcommittee has been able to draw a number of high level observations and recommendations to the Task Force.

Summary of Observations:

- The members of the Sub-Committee have observed that while there is sufficient capital for pre seed and seed companies from numerous sources in the state of Ohio including the Third Frontier Program and numerous successful Angel capital programs across the state, there is a concern that these companies will not have sufficient access to sufficient "first institutional money" (particularly venture capital funding and private equity funding) of sufficient size to stimulate growth of new businesses in the state.

- Many participants noted that this need for incremental venture capital could be met through the formation of additional fund lead by professional investors. In addition, the Sub-Committee recommends that stake holders across the state provide support for such fund formation.

- The Ohio Capital Fund is an excellent start of creating more funds in Ohio but it needs to be renewed and expanded.

- Ohio needs careful economic analysis of these public private partnerships. Funding needs to be identified to continue and build on the annual Venture Capital Report by the Ohio State University Fisher School of business.

The Committee Chairs, Geoffrey Chatas and Peter Kleinhenz wish to thank the other committee members for their participation and invaluable assistance: David Pidwell, of Alloy Ventures, Radhika Reddy, of Ariel Ventures and the two interns Esra Cipa from Akron University, and Douglas Laundry from Kent State University.

Introduction

The Capital Committee of the Ohio Board of Regents' Commercialization Task Force conducted numerous individual interviews of public and private investment and economic development officials on the topic of the adequacy of seed and early stage capital in Ohio for technology- focused start-ups. The chairs also organized two town hall public forum meetings in Columbus, and Cleveland, Ohio, held respectively on March 27 and March 30, 2012 with entrepreneurs, angel investors, professional investors, educators, and other concerned parties on this topic.

In these meetings the committee solicited comments on the following three questions:

- Do we have sufficient capital to finance new technology-based start-ups in Ohio?
- Do we have enough capital at each stage of company development?
- What improvements need to be made to strengthen Ohio's capital infrastructure?

This report summarizes the information collected; thoughts and options gleaned from those discussions, and identifies the critical need to expand the available pool of capital in Ohio for professional investors to provide follow-on funding to our pre-seed and seed opportunities financed in part by the Third Frontier Program.

Findings

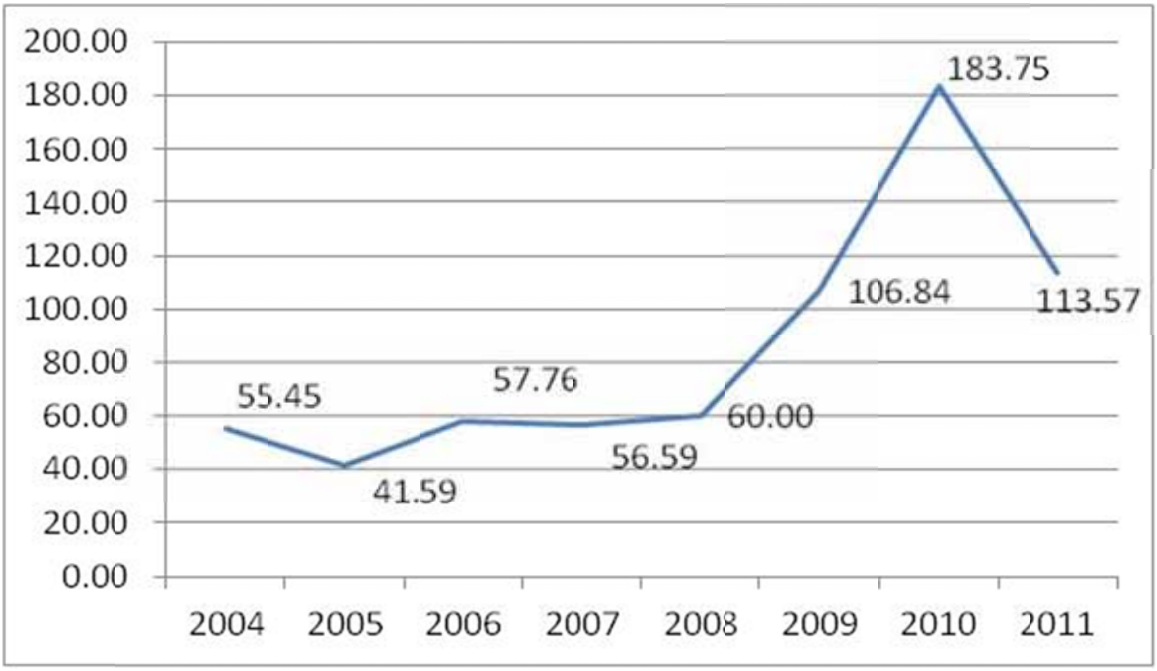
Universally, the participants were supportive and pleased with the efforts and progress the state of Ohio has made in assisting existing industries to develop more globally competitive products and fostering the formation and attraction of new technology based companies through the Department of Development and the Third Frontier Program. Many pointed to specific companies they worked with, or invested in, as a result of the Third Frontier Program. The participants were hopeful that the State would stay committed to these programs especially the Entrepreneurial Signature Program, (ESP) and the tax credit program that is used to support individual investors who have fostered the investments in many pre-seed and seed stage opportunities.

In general, participants shared the view expressed in a November 2011 study of Ohio's Third Frontier (OTF) Program prepared by Battelle Technology Partnership Practice: "OTF was created in 2002 to advance Ohio's economic competitiveness and the generation of high quality jobs. The results have been significant, generating 79,464 jobs, $6.6 billion in leveraged funding and creating, attracting, or capitalizing 701 companies between 2002 and June 2011. In addition,

qualitative changes have also resulted from Ohio Third Frontier investments, including the advancement of Ohio's entrepreneurial culture and the deepening collaborations between and among Ohio's industrial and research base."[1]

A more complete list of the performance statistics can be found at the Third Frontier web site: http://thirdfrontier.com/PerformanceMetrics.htm

In our discussions, there was a consistent expression that Pre-Seed and Seed Stage capital is readily available in Ohio through the Third Frontier Entrepreneurial Signature Program and from Angel Groups across 6 regions in Ohio. We shared the following chart in our meetings, which summarizes the amount of pre-seed and seed stage investment made annually in Ohio for the period 2004 through 2011.



(Ohio Pre-Seed/ Seed Stage Venture Investment by Year in $ Millions, from J Michael Camp Preliminary 2011 Venture Capital Report)

While there is variation in the amount of capital from year to year, the general trend illustrates a significant improvement in dollars invested in pre-seed and seed stage start-ups in Ohio over the period 2004-2011.

Throughout the State there is strong recognition that the Third Frontier programs are supporting new ideas developed in universities and nascent companies.

[1] Ohio Third Frontier: Targeting Growth Opportunities for the Next 3-5 Years, prepared by: Battelle Technology Partnership Practice, November 2011

Equally as strong however, was the wide spread concern that the companies created or assisted by various Third Frontier programs did not have access to sufficient capital down the road to build on the help they received from the Third Frontier programs. The specific capital necessary for growth is the, "first institutional money" or venture capital. The first institutional money is important as this group of investors brings a rigorous approach to understanding markets, access to other venture capitalists, and organized recruiting of other resources necessary to successfully build companies. These resources are typically within a specific domain and include for example: access to proven executive leadership talent, experienced consultants, and access to experienced product development and manufacturing skills, all of which increase the probability of success of a new commercial enterprise.

In both our meetings in Columbus and Cleveland there were a number of venture capitalist present in the audience. In an effort to understand the challenge faced by pre-seed and seed companies in gaining access to first institutional money we asked: is there sufficient professional capital in Ohio to match the efforts of the Third Frontier? One venture capitalist at the Columbus public forum advised that he had 42 pre-screened deals, which could not find financing. Similarly, in the Cleveland public forum, two participants indicated that each of their firms had 6-8 deals that were having difficulty finding venture financing. All of the professional investors noted that there is currently a shortage of firms in Ohio with available capital.

Several venture capitalists noted that the real reason for the shortage of capital is the dearth of limited partners who are willing to invest in an Ohio-based venture capital firm. Participant proffered that limited partners do not invest in Ohio-based firms for two reasons: one, limited partners are more comfortable investing in traditional costal firms; and two, Ohio- or Midwest-based venture firms are too small for limited partners to invest. Fund size is important to limited partners since investment guidelines typically limit their investment to no more that 5-10% of the total amount of a fund. Consequently, many Ohio-based venture capital firms who are less than $100 million of capital will not meet this requirement. Many Ohio pension funds only want to invest minimum amounts of money, such as $25 or $50 million per investment, given their large asset base. Their reasoning is based on simple economics: a smaller investment will not make a significant contribution to their overall investment return and the work involved in making a small investment requires the same rigor as a larger investment. Recognizing this practical concern, participants strongly encouraged the development of new sources of limited partners who can invest in smaller funds.

By way of example, participants in Columbus noted the Ohio Public Employees Retirement System (OPERS) has a program entitled, The Ohio-Midwest Fund that invests in smaller, high quality, venture capital and private-equity funds in the region which could be expanded and partially address this shortage of capital.

The first two Ohio-Midwest Funds, established in 2005 and 2007, were for $50 million each and were managed by Credit Suisse/ First Boston by their Columbus office. In 2011, OPERS approved a plan for an additional $100 million fund managed by Permal Capital Management of Boston.[2] Although $200 million aggregate investment sounds like a large investment, it is only 0.274% of OPERS' total investable assets (OPERS total investment assets at December 31, 2011 were approximately $73.2 billion[3]).

It is easy to see how expanding the OPERS program to the four other major public employees' pension funds: State Teachers Retirement System, State Employees Retirement System, Ohio Police and Fire, and Ohio Highway Patrol could make a significant amount of capital available for nurturing new start-ups in Ohio. In total, the investment assets of these five funds were approximately $163 billion in 2011. If all five public pension funds decided to create a similar funds based on 0.137% of total investable assets, (about 50% the percentage used by OPERS) then a fund of funds of approximately $220 million could be created.

The group also raised a broader issue of the critical need to challenge Ohio-based Limited Partners to rethink their lack of support for Ohio Venture Capital Funds. One consistent theme was that the retirement systems and many of Ohio's universities need to more broadly embrace the notion of the, "double bottom line " or "economically targeted investment". Briefly stated this means viewing investment in venture capital funds with the goal of securing both a competitive rate of return while achieving an important economic goal such as job creation or fostering the development of high technology companies within a region.

It is notable that OPERS has already recognized this concept and in their 2012 report stated: "This fund-of-funds initiative was created to provide returns for OPERS members, but also to encourage business growth within Ohio and the surrounding region. Since its inception, the Ohio-Midwest Fund has helped support more than 2,800 jobs and generated more than $160 million of investments in Ohio and Midwestern companies." [4]

Both the Columbus and Cleveland groups noted that Ohio's Board of Regents is in a unique position to develop and foster this notion of "double bottom line" investing among Ohio's leading universities to support the continuation of the

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[2] Ohio Public Employees Retirement Systems 2012 Investment Brochure: " OPERS Invests." www.opers.org/pensionresearchcenter/attachments/2012/2012-05-OPERS-Invests.pdf

[3] Ohio Public Employees Retirement Systems 2012 Investment Brochure: " OPERS Invests." www.opers.org/pensionresearchcenter/attachments/2012/2012-05-OPERS-Invests.pdf page1.

[4] Ohio Public Employees Retirement Systems 2012 Investment Brochure: "OPERS Invests." pg 2.

work of the Third Frontier. Ohio's academic intuitions and universities can help foster this expanded pool of investors by, for example:

- Investing themselves directly in venture capital funds or in funds-of-funds,
- Leading the effort to encourage the other four State pension programs to create similar funds-of-funds to the Ohio-Midwest Fund program,
- Using their clout to encourage Ohio-based private companies, family offices and for-profit entities to invest with the goal of the "double bottom line"

The committee was encouraged by the recently announced partnership between Ohio University and The Ohio State University to create a new commercialization funding model on the April 5, 2012. The universities intend to be the anchor investors in a $100M fund directed at early-stage funding of technology ventures.[5] However even with this development the committee feels there is overwhelming evidence for additional capital beyond this one fund.

Both the Columbus and Cleveland groups called for the continuation and expansion of the Ohio Capital Fund (http://www.ohiocapitalfund.com) which is a fund-of-funds established in 2006 by the State of Ohio to help increase private investment in Ohio companies in the seed or early stage of business development. As it currently stands, the Ohio Capital Fund has a commitment of $150 million from private resources to invest in qualified venture capital funds. As of early 2012, the Fund has been fully invested in 24 partnerships including: 8 Ohio based firms, 12 regional firms, and 4 national firms.

Thus far, venture capitalists backed by the Ohio Capital Fund have financed 64 Ohio-based companies. The majority of these companies have received some form of investment by the Third Frontier Program, although this not a requirement; most often the investment is from one of the six regional Entrepreneurial Signature Programs. Approximately 51% of the investments have been Series A investments and are typically the "first institutional money" in the company. The following chart illustrates the number of deals by round and by type of company.

	Seed	A	B	C	Growth	Total
Med/Bio	5	12	5	1	1	24
IT	12	14	3	2		31
Energy		3	1			4
Materials		4				4
Other	1					1
Total	18	33	9	3	1	64

[5] The Columbus Dispatch http://www.dispatch.com/content/stories/local/2012/04/06/turning-ideas-into-jobs.html

The effort by the Ohio Capital Fund is a good start, and statics credit the program with creating 2,176 jobs and utilizing their $82.3 million investment to attract a total $498 million for Ohio companies.

The program does need additional funding in order to continue. Ideally the Fund will become an evergreen fund as it receives distributions from the investments made by the venture capital companies. However, now six years into a 10 or 12-year cycle the fund is too new to have sufficient distributions to self-finance another round of investment in venture capital funds.

Another allocation of investment capital by the State of Ohio into The Ohio Capital Fund is necessary so that the Fund can renew investments in deserving exiting funds (funds with companies that are "exiting" by being purchased or going public, and thereby pay a return to the investors, including Ohio Capital Fund) and make new investments in attractive prospective funds. By looking at the vintages or timing of the 24 investments made by the Ohio Capital Fund, one can see (in the chart below) the majority of the funds are three to five years old which is typically the prime investment period for a venture fund. By the end of year five the venture fund has typically made most of their investments and is helping to add value to the investment with some follow-on capital.

Distribution	Vintage						
Type	2006	2007	2008	2009	2010	2011	Total
Life Science	3	1	3	1		1	9
Diversified Tech	3		2	3			8
IT	3		1			1	5
Energy/Materials						1	1
Growth		1					1
Total	9	2	6	4	0	3	24

The above chart shows that eleven of the twenty-four funds are vintage 2006 and 2007. Typically funds five or six years into the investment cycle would not be making new investments, but rather making follow-on investments to their current companies and looking to start fund raising for a new fund. And conversations with the Ohio Capital Fund confirm that 10 of the funds are in the mode of raising a new fund, underscoring the need for additional venture capital to support the pre-seed and seed programs already in place in Ohio.

The discussion among the various participants indicated strong support for the continuation and expansion of this program. Several participants suggested greater emphasis should be placed on supporting Ohio-based venture capital funds, but not to the exclusion of regional and national based firms. As of early May 2012, there has been legislation proposed in the Ohio House, Bill 511, to essentially increase the Ohio Capital Fund by $100 million. The proposed

legislation also includes some provision for requiring a venture capital fund manager to have a "significant presence" in Ohio and allowing the Ohio Capital Fund to define what "significant presence" means. [6]

One of the committee members was able to attend a public hearing on renewing the Ohio Capital Fund; one key issue of the State's policy makers considering the increase in the Fund is the potential cost of this program to the State of Ohio. In order to understand the potential cost to the State Of Ohio one needs to understand how the fund works. The Fund is currently financed by $150 million in bonds ($10 million must be kept in reserve, meaning there's $140 million to invest) issued on its behalf by the Columbus- Franklin County Finance Authority. Investors who buy these bonds are eligible for state tax credits, if and only if, they incur any losses in underlying bonds such as a default of principal or interest payment. So the State would only be required to issue those tax credits if the Fund encounters widespread losses in the portfolio of 24 venture capital companies. Encouragingly, as of January 2012 the Fund has invested $82.3 million and has already received distributions of $11.4 million, and the value of the portfolio among the 24 venture capital firms is about 1.03x's Ohio Capital's investment. The Fund's use of tax credits as a stopgap loss measure is somewhat unique and it is very likely that the State will never need to issue tax credits. So, the only cost to the State is the potential cost of a future tax credit, all other costs such as administrative expenses, interest expense, and principal repayments are borne by the Ohio Capital Fund.

There are some important questions that the Capital Committee wanted to explore to help give guidance to the Board of Regents and the public policy makers about the need for more capital in Ohio, but were unable to address. Some of the questions they were not able to answer include:

- How many deals that are viable and that have received either Third Frontier or Ohio Capital Fund investments are not getting further financing due to a lack of " first institutional money" in Ohio

- How much investment capital is needed by stage, Series A, B and C, of the opportunities currently in the pipeline?
- How much investment capital will be needed as our Universities' technology commercialization efforts continue to evolve and spin out companies?
- How much investment capital is necessary for the diverse and divergent financial requirements of information technology, life science, energy, and material science companies?

The committee had limited time to work on the quantitative answer to these questions, but feels that answering them would help policymakers' better plan to

[6] http://www.lsc.state.oh.us/analyses129/h0511-i-129.pdf pg.2

fill the gap that is occurring in venture capital investment for our Third Frontier companies. There is already an annual effort by The Ohio Department of Development, the six regional ESP centers and the Fisher College of Business of The Ohio State University to compile venture investment data. Their annual report can be a useful start to answering a number of these questions.[7] Unfortunately, due to lack of funding the 2011 report was not available for analysis by the committee, although the report's author J. Michael Camp from the Fisher School of Business and the directors and staff of the 6 regional ESP centers were very helpful in providing data to the committee.

The 2010 Venture Capital report clearly articulates the concern expressed by many of the participants in our forums; "The long term availability and accessibility of follow-on capital is a key piece of any thriving entrepreneurial ecosystem. As the number of Ohio pre-seed and seed-stage companies grow…the estimated demand for follow-on venture capital balloons."[8]

The authors of the Venture Capital report created a simple follow-on model that estimated Ohio will need $5.0 billion over the period 2010-2020 or about $500 million a year, on average annually. [9] Further, the model estimated that about $280 million per year is needed specifically for seed and early stage companies over the same time period. Giving credit to the already-approved Ohio Capital Fund and the Ohio-Midwest Fund, we reduce the additional annual need by $50M, but the annual need is still a significant $230M! Subtracting from the $280 million annual need, one-fifth of both the Ohio Capital Fund (1/5 x $150M = $30M) and the Ohio-Midwest Fund (1/5 x $100M = $20M), we arrive at an annual shortfall of $230 million, or $2.3 billion over ten years for seed and early stage companies in Ohio. (One fifth of both of the Funds dollar amounts are used because the investments of those Funds are assumed to be made over a 4 to 5 year time horizon.) There is a clear disparity in the amount of available capital in Ohio and estimated demand for capital by this simple model.

A more complex model would no doubt drive this number higher. The simple model is an excellent start but uses an average capital requirement without distinguishing the capital requirements for a specific type of startup. A more refined model would create an average capital requirement for each type of start-up: IT, medical device, biotech, energy, or materials start-up. Using very rough numbers to highlight the differences in capital required by type of company consider for example, an IT start might require $10 million in capital, compared to a medical device start-up which may need $30million, or a biotech company which requires $90M in capital

[7] See for example the 2010 report at http://fisher.osu.edu/mag/2011/VCreport2010/pageflip.html
[8] Ibid page 8
[9] ibid page 8 table 3

There was also considerable discussion at the public forums about the desirability of in-state sources of capital versus out-of-state capital. In was noted by the participants that in-state funds help develop Ohio's ecosystem as well as encourage the likelihood of companies staying in Ohio. These discussions broadened and highlighted the need for the formation of several Ohio-based funds of $100 million in asset size.

As noted above, the 2011 Venture Capital report was not available for analysis, although the report's author was very helpful in providing data to the committee. The committee and participants recognize the value of this report and note that Regents could be instrumental in making sure there is an annual study of the Venture Capital Industry in Ohio. The cost is not prohibitive and there is a clear benefit to public policy makers. Further, knowing this data is a key to marketing the State in an increasing competitive national and regional marketplace.

Conclusion:

There were many good ideas generated in the dialogue during the Capital Committee's discussion about the adequacy of funding within the State of Ohio for technology-based start -ups. The committee thinks there are several important points from our discussions to highlight:

- There is sufficient capital for pre-seed and seed companies within the Third Frontier Program, but there is a danger that these companies will not have access to sufficient "first institutional money" in Ohio to assure their growth.

- Ohio needs to expand the pool of capital available for professional investors in order to foster the development of Ohio-based venture capital firms. One existing program The Ohio Midwest Fund sponsored by OPERS should be considered by other public employee pension systems.

- The Ohio Capital Fund is an excellent program directed at creating more funds in Ohio, but it needs to be renewed at a minimum, and ideally increased by a larger amount than is currently under consideration.

- The Ohio Board of Regents can play a key leadership role in actively seeking potential investors in Ohio funds who see the "double bottom line " by investing in venture capital funds with the goal of securing both a competitive rate of return while achieving job growth in high technology companies.
- Ohio needs to do careful economic analysis on-going capital needs of our technology start-ups companies. At a minimum there is a need to know

the amounts by stage and deal type and build on the excellent work already underway by the Ohio State University Fisher School of business.

Recommendations

- The Capital Sub-Committee strongly supports the Ohio Third Frontier and the Ohio Capital Fund. These programs should be expanded and Ohio legislators should be encouraged to move forward with the expansion of Ohio Capital Fund
- The Sub-Committee believes that Ohio needs additional venture capital resources for first institutional stage investment and later stages to remain competitive. Accordingly, it strongly recommends that efforts be made to establish several Ohio-based venture funds to fund first institutional rounds of capital.
- The Sub-Committee believes that additional limited partner investors need to be found to invest in Ohio venture funds. The Board of Regents and Ohio colleges and universities are in a unique position encourage Ohio-based private companies, family offices and for-profit entities to invest with the goal of the "double bottom line".
- The Sub-Committee believes funding of the economic analysis of appropriate centralized annual report on Venture Capital in Ohio is essential. The Fisher Annual report is an excellent resource that should continue as the central focus of this effort.

Appendix C

Government Subcommittee Report
Draft v2.0: May 3, 2012
The Ohio Board of Regents
Technology Commercialization Task Force

Executive Summary

State government can play a pivotal and vitally important role as an advocate for and a partner with industry and higher education in catalyzing strong economic growth. While it would not necessarily be expected to take the lead in this regard, state government must maintain a balanced public-private partnership in order to provide incentives for risk-taking by the developers of innovative new technology commercialization initiatives including the developers of new business enterprises. Simultaneously, state government must continue to do what is expected of it within a dynamic, globally competitive innovation and commercialization ecosystem, that is, it must: a) ensure appropriate and reasonable regulations ; b) develop policies and support activities that led to an educated work force; c) build appropriate infrastructure to advance systems; and d) support commercially-directed scientific research that leverages the assets of the university system and public-private partnership programs like the Ohio Third Frontier.

To achieve this, we recommend that:

- The Chancellor and Board of Regents should work with university and industry leaders, the Third Frontier and JobsOhio, to (a) promote the formation of public-private partnerships statewide; (b) work with universities, community colleges, industry and government to review state laws; (c) identify opportunities to incentivize private investments in technology commercialization activities; (d) promote statewide and regionally based economic development strategies that target and/or leverage existing regional resources; and (e) collect and disseminate data to measure the state's competitiveness in the global innovation economy.

- The State of Ohio better align its higher education system with the emerging needs for skilled workers with new competencies and attributes in order to support Ohio economic recovery and growth through increased commercialization in targeted technology and industrial sectors. State government in collaboration with industry and higher education should develop a Workforce Continuum of Commercialization that identifies current as well as tomorrow's job-requisite skills and proficiencies. Accordingly, state government must work with the higher education system, including both the community colleges and the research universities, in order to develop strategies to train workers to meet Ohio's current and future workforce needs.

- The state government and the University System of Ohio work together to standardize industry material transfer agreements and licensing agreements to be more "user" friendly; university offices of technology transfer should work to identify and encourage key industry strategic partnerships and interactions. Ohio's universities need long-term relationships with key industry partners governed by updated general umbrella agreements emphasizing strategic partnerships and deal flow, and not just licensing revenues and/or service agreements.

- Ohio develop its six JobsOhio regions in a way that promotes a user-friendly industry-academia interface and develops a foundation of shared purpose, values, and expectations between industry and higher education that will leverage regional assets for high-value, high-impact collaborations. Working collaboratively and catalyzed by state government, industry and higher education leadership need to develop a comprehensive view of the resources required – financial, managerial, and technical – to sustain a region-based ecosystem essential to supporting university and industry start-up activities. University leadership, in partnership with industry and government, should work to integrate and/or develop the infrastructure and systems essential to building supporting entrepreneurial activity via partnerships with the Ohio Third Frontier ESP program, including master agreements, patent, license and start-ups, etc., within the six JobsOhio regions.

- The State of Ohio support the development of multiple sources of funding from proof-of-concept, to seed funds, to early-stage venture capital from both public and private sources. Ohio will need to incentivize the development of regionally-based "first institutional funds" to focus on university and industry technologies possessing relevant commercial applications. The General Assembly and the Governor will need to sustain Ohio Third Frontier funding to promote proof-of-concept and seed stage funding; promote venture capital formation by providing state incentives

for third-party angel and venture capital investors who are interested in university and industry based intellectual property; and develop new incentives for co-investments from universities and the private sector in Ohio-based emergent technologies.

- State and local governments take the lead in supporting programs that encourage universities to provide incubator space where faculty/industry collaboration can take place, and start-up companies can find a nurturing environment. Ohio's research universities should identify opportunities to partner with community colleges to expand incubator space and develop collaborative strategies to support early stage start-ups and joint ventures. Given the inherent flexibility in the community college business model, four-year universities should seek opportunities to collaborate with them in promoting their technology commercialization processes.

- State government take the lead in developing communication networks that centrally advertise university intellectual property as well as faculty research strengths and activities. State government should assist in the promotion of strategies that make it easier for industry to interact with faculty who have an interest in working with industrial partners. The State of Ohio in partnership with the higher education system should implement a strategic communication plan for defining state policies, procedures, and support systems intended to advance the commercialization of university technology. Ohio universities should continue to market their patent portfolios; develop strategies for advertising and promoting faculty research interests and expertise; work with key industries to facilitate their introduction and interaction with faculty; and collaborate with state government in developing technology based portals to facilitate industry-faculty collaborations.

- Enhancement of data collection and publication of commercialization performance. Such data and information can play a key role in assisting state agencies and universities that support and promote economic development and make decisions regarding the application of critical resources – human, facilities and/or capital. The State of Ohio should develop a data collection system with the appropriate benchmarks to measure the effectiveness of state and university policies and practices to build the innovation pipeline and support Ohio's "smart growth" strategies of recruiting and retaining high-paying jobs in key industrial sectors; data sets should measure the state's capacity to support innovation, innovation activity, and the impact, or outputs, of those activities on the state, the higher education system, and regional economic growth.

General Background

Ohio remains under the influence of one of the deepest economic recessions in modern times. To improve its current economic situation, Ohio must stimulate the development of a more competitive, high-growth economy that will generate the high-value, high-wage jobs of the future—this will require an ever-increasing supply of new products and services. To be successful in ramping up its external visibility within this increasingly competitive global economy, Ohio must not only establish a firm foundation of ongoing technology-intensive development but it must also develop a workforce with the requisite skills to promote and support technology commercialization. Developing and maintaining such a well-established foundation for economic growth – and creating communities that support an entrepreneurial culture – requires sound public policy carried out within a broadly based political consensus. This observation underscores the importance of the roles played by federal, state, and local government entities in support of industry-higher education collaborations.

As is well-understood, both the nation's and Ohio's economic prosperity is derived from our ability to introduce new, high value-added products and services into the marketplace. Technological innovation resulting from basic and applied research produces many of these value-added products. Success in this arena is increasingly dependent upon the ready availability of a vast infrastructure that includes a highly skilled workforce, state-of-the-art scientific expertise, manufacturing and fabricating capabilities, and the technological capabilities typically found on the campuses of our nation's great research universities. It is widely appreciated that one of this state's greatest assets is the University System of Ohio and its partnering private institutions of higher education. Because the scale of the needed infrastructure exceeds the resources of most single organizations, continued economic competitiveness is becoming more dependent upon successful collaborations and the development of strategic partnerships between industry, research universities, and government.

Accordingly, Chancellor Jim Petro and the Ohio Board of Regents created the Regents' Technology Transfer and Commercialization Task Force with a mandate to develop a statewide commercialization ecosystem that creates jobs in Ohio by effectively and efficiently moving university research to commercialized application in order to create and attract new businesses as well as expand existing businesses and make them more competitive on a global scale.

Key Questions

In collaboration with the Regents' Technology Transfer and Commercialization Task Force, the Government Subcommittee sought to uncover current best practices with regard to how state and local government entities might:

- Provide an environment supportive of technology start-up activity;
- Focus on economic development strategies for high-technology opportunities;
- Seek to leverage public resources to achieve economic development priorities;
- Identify lead agencies with responsibility for working with higher education and industry entrepreneurs;
- Provide economic incentive platforms; and
- Support portals for information sharing and connectivity.

The Subcommittee initially identified the following set of key questions and, then, proceeded to compile current information on best practices from recent economic reports; interviews conducted with Third Frontier program directors, incubator center directors, and university technology transfer officers; surveys of current stakeholders in government, industry, and higher education; as well as from the public forums organized by the other subcommittees of the Regents' Technology Transfer and Commercialization Task Force:

a. Does the state have the necessary strategic view of research strengths, industry needs and potential future commercial opportunities to inform actions that will create sustainable job growth and wealth creation for Ohio?

b. Are inter-institutional capabilities being appropriately exploited to make Ohio more competitive for the creation, retention and attraction of companies; the attraction of investment capital; and for securing funding from federal agencies?

c. In what manner might state government assist the universities in developing the right balance of transactional interactions and long-term relationships with Ohio business and industry in order to facilitate sustainable commercialization?

d. What can state government do to assist universities in leveraging additional federal agency and industry support for research activities directed toward commercialization?

e. Are there critical infrastructure components that state and local governments need to develop in order to facilitate the spinning off of more new business start-ups from university intellectual property?

f. Are there actions that state and local governments can take to encourage university faculty to become more actively involved in the commercialization process?

g. Has the state created the necessary portals and/or pathways for industry and the venture capital community to access the intellectual assets and technological capabilities of Ohio's universities?

h. What impediments do state and local governments need to eliminate in order to enhance the future development of Ohio's technological base?

i. How will state government know if its newly designed and newly implemented policies for the development of a vibrant, globally competitive commercialization ecosystem are actually working as planned?

Key Findings

1. *Does the state have the necessary strategic view of research strengths, industry needs and potential future commercial opportunities to inform actions that will create sustainable job growth and wealth creation for Ohio?*

    - **Ohio must develop a dynamic mechanism to provide ongoing state policy support for entrepreneurial activities.** The Chancellor and Board of Regents should work with university and industry leaders, the Third Frontier and JobsOhio, to (a) promote the formation of public-private partnerships statewide; (b) work with universities, community colleges, industry and government to review state laws; (c) identify opportunities to incentivize private investments in technology commercialization activities; (d) promote statewide and regionally based economic development strategies that target and/or leverage existing regional resources; and (e) collect and disseminate data to measure the state's competitiveness in the global innovation economy. These entities, working with the six JobsOhio regions, JobsOhio, the Ohio Department of Development, and other state and local agencies should review state laws and regulations to identify opportunities to incentivize private investments in technology commercialization activities and streamline commercialization processes, to promote regionally-based economic

development strategies that target and/or leverage existing regional resources, and collect and disseminate data to measure progress.

2. *Are inter-institutional capabilities being appropriately exploited to make Ohio more competitive for the creation, retention and attraction of companies; the attraction of investment capital; and for securing funding from federal agencies?*

    - **Ohio's research universities and community colleges must be an integral part of the technology commercialization process.** The State of Ohio needs to better align its higher education system with the emerging needs for skilled workers with new competencies and attributes in order to support Ohio economic recovery and growth through increased commercialization in targeted technology and industrial sectors. State government in collaboration with industry and higher education should develop a Workforce Continuum of Commercialization that identifies current as well as tomorrow's job-requisite skills and proficiencies. Accordingly, state government must work with the higher education system, including both the community colleges and the research universities, in order to develop strategies to train workers, to meet Ohio's current and future workforce needs.

3. *In what manner might state government assist the universities in developing the right balance of transactional interactions and long-term relationships with Ohio business and industry in order to facilitate sustainable commercialization?*

    - **Update and standardized industry agreements are needed.** Ohio's universities need long-term relationships with key industry partners governed by updated general umbrella agreements emphasizing strategic partnerships and deal flow and not just licensing revenues and/or service agreements. In order to promote industry-higher education collaboration to achieve high-value and high-impact outcomes, state government should assist the University System of Ohio by standardizing industry material transfer agreements and licensing agreements to be more "user" friendly; university offices of technology transfer and university research officers should work to identify and encourage key industry strategic partnerships and interactions. The state should also engage in a comprehensive review of its statutes rules and regulation that govern the commercialization process (specifically Intellectual Property and conflict of interest laws) to ensure maximum flexibility while protecting the interest of all parties involved.

4. *What can state government do to assist universities in leveraging additional federal agency and industry support for research activities directed toward commercialization?*

    - **Development of a dynamic statewide commercialization ecosystem is of paramount significance to the state.** Ohio needs to have its six JobsOhio and Ohio Third Frontier ESP regions promote a user-friendly industry/academia interface by developing a foundation of shared purpose, values, and expectations between industry and higher education that will leverage regional assets for high-value, high-impact collaborations. Working collaboratively and catalyzed by state government, industry and higher education leadership need to develop a comprehensive view of the resources required – financial, managerial, and technical - to sustain a region-based ecosystem essential to supporting university and industry start-up activities. University leadership, in partnership with industry and government, should work to integrate and/or develop the infrastructure and systems essential to building supporting entrepreneurial activity, including master agreements, patent, license and start-ups, etc., within the six JobsOhio regions.

5. *Are there critical infrastructure components that state and local governments need to develop in order to facilitate the spinning off of more new business start-ups from university intellectual property?*

    - **A well-defined capital continuum is critical for the development of university intellectual property.** The State of Ohio should support the development of multiple sources of funding from proof-of-concept, to seed funds, to early-stage venture capital from both public and private sources. Ohio will need to incentivize the development of regionally-based "first institutional funds" to focus on university and industry technologies possessing relevant commercial applications. The General Assembly and the Governor will need to sustain Ohio Third Frontier funding to promote proof-of-concept and seed stage funding; promote venture capital formation by providing state incentives for third-party angel and venture capital investors who are interested in university and industry based intellectual property; and develop new incentives for co-investments from universities and the private sector in Ohio-based emergent technologies.

6. *Are there actions that state and local governments can take to encourage university faculty to become more actively involved in the commercialization process?*

- **Incubator spaces for new start-up business enterprises need to be enhanced and located on or near campuses in order to facilitate active interactions of entrepreneurs with faculty and students.** State and local governments should support programs that encourage universities to provide incubator space where faculty/industry collaboration can take place, and start-up companies can find a nurturing environment. Ohio's research universities should identify opportunities to partner with community colleges to expand incubator space and develop collaborative strategies to support early stage start-ups and joint ventures. Given the inherent flexibility in the community college business model, four-year universities should seek opportunities to collaborate with them in promoting their technology commercialization processes.

7. *Has the state created the necessary portals and/or pathways for industry and the venture capital community to access the intellectual assets and technological capabilities of Ohio's universities?*

    - **Communication networks between universities and Ohio business and industry must be enhanced.** State government should take the lead in developing communication networks to centrally advertise University intellectual property as well as faculty research strengths and activities. State government will need to promote strategies that make it easier for industry to interact with faculty who have an interest in working with industrial partners. The State of Ohio in partnership with the higher education system should implement a strategic communication plan for defining state policies, procedures, and support systems intended to advance the commercialization of university technology. Ohio universities should continue to market their patent portfolios; develop strategies for advertising and promoting faculty research interests and expertise; work with key industries to facilitate their introduction and interaction with faculty; and collaborate with state government in developing technology based portals to facilitate industry-faculty collaborations.

8. *What impediments do state and local governments need to eliminate in order to enhance the future development of Ohio's technological base?*

    - **Ohio must reduce or eliminate burdens of collaboration.** Collaboration between Ohio's universities and colleges with Ohio business and industry would be significantly enhanced if state government were to consider the following sorts of incentives to reduce, or eliminate, barriers to collaboration:

i. Provide incentives for industry to sponsor university research and license university technology.
ii. Create specific policies and incentives for companies and academic institutions, faculty, staff, and students to encourage small, young companies to interact with universities.
iii. Ensure that there is sufficient risk capital available to support efforts by new and small firms to commercialize university technology.
iv. Develop policies to encourage the commercialization of academic research that ends up as industry-assigned rather than university-assigned patents.
v. Focus more resources on the evaluation of the commercial potential of the outputs of academic research rather than on efforts to increase the amount of basic research.
vi. Focus efforts to encourage academic entrepreneurship on fields in which academic research is of greater importance to technical advance in industry.
vii. Fund a best practices analysis and report to establish and maintain seed and other early stage venture capital assistance programs designed to help launch quality new ventures.
viii. Fund a best practices analysis and report of institutional technology transfer, commercialization, and academic entrepreneurship conflict of interest policies and practices to both assure that academics' personal financial interests in the outcome of research and commercialization pose neither real nor perceived conflicts of interests or commitment that may erode public trust and confidence in scientific integrity and objectivity.

9. *How will state government know if its newly designed and newly implemented policies for the development of a vibrant, globally competitive commercialization ecosystem are actually working as planned?*

- **The accurate and timely collection of program metrics is an essential element of properly maintaining the commercialization ecosystem.** Data collection and publication of commercialization performance should be central to the state agencies and universities that support and promote economic development and make decisions regarding the application of critical resources – human, facilities and/or capital. The State of Ohio should develop a data collection system with the appropriate benchmarks to measure the effectiveness of state and university policies and practices to build the innovation pipeline and

support Ohio's "smart growth" strategies of recruiting and retaining high-paying jobs in key industrial sectors; data sets should measure the state's capacity to support innovation, innovation activity, and the impact, or outputs, of those activities on the state, the higher education system, and regional economic growth.

Summary

The Government Subcommittee has worked diligently to provide a thorough set of answers to the key questions related to what state and local governments in Ohio can do to develop a statewide ecosystem supportive of high-technology start-up activity as well as making indigenous industrial firms more competitive in today's global marketplace. The Subcommittee has endeavored to define statewide strategies that would encourage entrepreneurial opportunities, leverage public resources to achieve economic development priorities, identify lead agencies with responsibility for working with higher education and industry entrepreneurs, provide economic incentive platforms, and develop logical portals for information-sharing and connectivity.

To develop a dynamic commercialization ecosystem, the State of Ohio needs clearly defined governmental policies and metrics as well as visible leadership, commitment of resources, and intelligent policies combined with measureable outcomes. Public policy leaders can promote innovation ecosystems by serving as champions to influence key decisions and other decision makers, by collaborating with state and local leadership to formulate new business creation and talent retention and recruitment strategies in conjunction with economic incentives to attract new investors. State leaders must provide the leadership in facilitating university, industry, and government partnerships to promote strategic technologies and collaborations.

The work of the Government Subcommittee to the Regents' Technology Transfer and Commercialization Task Force has very clearly underscored the importance of the roles to be played by state and local government entities in supporting strong industry-university collaborations in a vibrant commercialization ecosystem.

Appendix D

Industry Working Group Report
Technology Commercialization Task Force

Industry Working Group Members

John Hillenbrand Vice President & Chief Innovation Officer, Owens Corning
Industry Committee Co-Chair

Rebecca Bagley President & CEO, Nortech
Industry Advisory Committee Co-Chair

Lloyd Jacobs President, University of Toledo

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Jim Sattler President, NuVention Solutions

Industry Working Group Interns

Maria Baker Cleveland State University
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Introduction

In order to improve its economic situation for future generations, Ohio must stimulate the development of a more competitive, high-growth economy that will generate high-value, high-wage jobs. The new economy will require an ever-increasing supply of new products and services, and to be successful, the state must not only establish a firm foundation of ongoing technology-intensive development but it must also develop a workforce with the requisite skills to promote and support technology commercialization. To develop and maintain such a well-established foundation for economic growth – and create

communities that support an entrepreneurial culture – requires sound public policy carried out within a broadly based political consensus—this observation underscores the importance of the roles played by federal, state, and local government entities in support of industry-higher education collaborations.

The Ohio Board Regents believes that promoting more effective collaborations between Ohio companies and its public and private higher education institutions can be a key element to accelerate economic growth and competitiveness. In late 2011, the Technology Transfer and Commercialization Task Force was created with a mandate to develop a statewide commercialization ecosystem that creates jobs in Ohio by effectively and efficiently moving university research to commercialized application in order to create, attract new businesses, as well as expand existing businesses. The specific charge to the Task Force is to:

1. Identify the most important factors and practices leading to the timely and successful commercialization of university-based technologies;
2. Assess current limitations, practices, and barriers regarding university-industry collaboration in Ohio;
3. Define the current state of Ohio's productivity in terms of commercialization and establish aspirational state-wide goals;
4. Develop strategies that have the potential to increase the instances of university-industry collaboration and the execution of their commercialization activities; and
5. Define the resources and incentives that could accelerate university-industry technology commercialization in Ohio; and
6. Identify opportunities for infusing a culture of innovation within the University System of Ohio and conveying opportunities and university-based intellectual assets to the state's corporations.

Goals of the Industry Working Group

The objective of the Task Force's Industry Working Group was to gather information from companies based on their experiences in working with universities, both in Ohio and elsewhere. Information was sought on a broad range of industry-university interactions, including but not limited to:

- Licensing of university intellectual property by companies,
- Faculty and student entrepreneurship and creation of spin-off companies,
- Collaborative research partnerships involving scientists and engineers from both industry and academia,
- Industry participation in university-based research centers,

- Engagement of industry by academic institutions in research strategic planning, curriculum development, and other activities related to the academic core mission,
- Industry use of specialized equipment and other physical assets of higher education institutions, and
- Talent and workforce develop across all technology sectors.

The Working Group had an interest in understanding better the characteristics of successful and unsuccessful collaborations, as well as industry's view of where critical barriers to partnering lay. Finally, the Working Group attempted to focus on areas where incentives might be successful in promoting greater collaborations, and where policy changes and other interventions might enhance overall performance.

Data Collection

The Working Group recognized clearly the contributions of Ohio higher education institutions to regional economic growth, their efforts to sustain an innovation ecosystem, and their ability to help companies be more competitive in national and global markets.

In that context, companies collaborating with higher education institutions were viewed as important stakeholders in their work. The public forums organized by the Working Group framed the discussion with companies as an effort to understand "the voice of the customer." The Working Group was intentional in positioning Ohio private-sector firms as a customer of both primary outputs of the state's higher education system: knowledge (created though scientific or engineering research) and talent (embodied in graduating students entering the workforce).

The Working Group sought input from industries in sectors typically thought of as technology- or innovation-based—such as polymers and chemicals, advanced energy, pharmaceuticals, flexible electronics, and aerospace. It also reached out explicitly to companies from traditional sectors, such as automotive manufacturing, machine tools, building products and petroleum-based products. These sectors are increasingly technology-intensive, and they represent a significant share of employment in the state.

To obtain this full spectrum of input, three public forums were held in which senior executives from both large and small companies as well as start-up companies were invited to testify regarding their experience in collaborating with

universities. Meetings were held in March 2012 in Toledo (hosted by the University of Toledo), Northeast Ohio (Kent State University, and Cincinnati (University of Cincinnati).

The background information which was provided to public forum participants—which includes the key questions that the Working Group felt needed to be addressed—is included as Attachment 1. In total, representatives from over 50 Ohio companies participated in the forums. A list of participants for each of the events is included as Attachment 2.

Additional input to inform the thinking of the Working Group came from external sources, especially the work the national association of public research universities, the Association of Public and Land-grant Universities (APLU)[1].

Findings and Recommendations

Each of the public forums resulted a in a robust and substantive discussion. While the characteristics of the regional industry base in each part of the state are distinct, a common set of themes emerged.

1) Building a foundation of shared purposes, values and expectations is essential for successful industry-university collaborations

Participants reported of multiple situations where partnerships were initiated with good intent, only to encounter roadblocks as objectives of each party diverged. In some cases this resulted from conflicting cultural practices and methods of doing business, such as the difficulty encountered within academia of "doing business at the speed of business" when workload planning for both faculty members and—perhaps more importantly—their student researchers is organized around a semester or trimester calendar.

Success was often achieved in situations where the company and the academic institution had had the opportunity to become more familiar with one another. In such cases, information was effectively exchanged more easily, and partners had

[1] APLU's membership includes 217 institutions, consisting of state universities, land-grant universities, state-university systems and related organizations. Of the 14 member of the University System of Ohio which are not community colleges, ten are APLU members. Since 2007, APLU's Commission on Innovation, Competitiveness and Economic Prosperity (CICEP) has worked to assemble a set of tools, resources, and standards of practice that universities can use to make the most effective contributions to innovation and economic growth, and to communicate their value in these areas.

a better understanding of how to effectively work with one another. A shared desire to build long-term relationships beyond the limit of single project was also identified as a characteristic common to the most productive collaborations.

Findings:

1. It is critical for universities to clearly define and communicate the purpose of industry collaborations, including but not limited to technology commercialization.

2. It is important for all partners to:
    a. Emphasize long-term relationships and benefits from collaboration;
    b. Be thoughtful and transparent about milestones and the definition of success; and
    c. Be clear about the assets each partner brings.

Recommendations:

1. Build a university innovation ecosystem characterized by rich networks and multiple connection points with industry. Develop a range of mechanisms to engage partners and coordinate their use.

2. Promulgate policies on campus to facilitate and encourage industry collaborations (e.g., access to campus equipment and infrastructure, support for faculty consulting and industry sabbaticals, etc.) and reward resulting behavior.

3. Support alignment of curriculum with talent needs of industry.

2) Leveraging regional assets for high-value and high-impact collaborations should be a top priority to achieve the maximum impact from industry-university partnerships

Industry participants spoke repeatedly of their strong desire to have local collaborations, because they are viewed as a key part of an effective strategy leading to both business success for companies and economic growth for regional. Furthermore, companies see significant opportunities in terms of both the intellectual assets available at Ohio universities and the regional clusters which exist across the state and provide an organizing framework for building partnerships. That said, companies also stressed the need to remain competitive

nationally and globally, seeking out the best collaborators who would help them do so.

This challenge heightens the imperative for higher education institutions, regional organizations and the state's public policy community to seek out new opportunities for collaboration. Discussion among Working Group members and industry participants at the public forums focused extensively on having both industry and academic partners think more creatively about structuring individual projects and long-term relationships to enhance their impact within the state and the benefits which accrue to all parties.

This entails a closer examination on how all the assets of both partners—money, time, human capital, infrastructure, intellectual property and technology—are utilized and coordinated. One example which was raised was having a company bring its own "stranded technologies"— intellectual property or technologies owned by a company but which do not contribute to its core business functions and are not being commercialized—into a university partnership for development. Through collaborative efforts, such technologies could provide research and development opportunities for faculty and students and potentially provide the basis for a new business or be commercialized in the future by the company or another firm.

Findings:

1. Ohio companies find value in working with universities close to home (but also must engage the best partners and will find them where needed).
2. Regional clusters provide powerful organizing frameworks for collaborations.
3. Combination of state's industry base, emerging capabilities and university assets provides opportunities in a number of key technology areas.

Recommendations:

1. Be willing to explore creative/flexible approaches for collaborations.
2. Continue to take advantage of and leverage regional industry strengths and cluster networks as part of university strategic research planning.
3. Incorporate regional innovation-based economic development goals as a factor in technology commercialization strategy.

3) *Developing a user-friendly interface for companies seeking to create partnerships would help academic institutions significantly lower barrier to collaboration.*

Industry participants in the public forum noted that, in many cases, a significant effort is required even to begin to understand where high-value collaboration opportunities might exist with a specific academic institution. Institutions are, by their very nature, extremely accessible but extraordinarily fragmented. Looking at them from the outside, it is often difficult for a company to determine an appropriate or ideal point-of-contact: individual faculty member, department chair, dean, technology licensing office, VP for Research, Corporate Relations Office, etc. This challenge for a company is many times compounded by a lack of information about the real strengths of an institution and how its research and innovation resources could be put to use in the context of a collaboration.

Also discussed was the importance of reducing the administrative burden of initiating and executing collaborations. Public forum participants believed that much better use can be made of master agreements, standard templates and other tools which can expedite the processing and documentation necessary to create a partnership. Some noted that even negotiating standard terms may be appropriate in some situations.

Findings:

1. Companies identified significant challenges in building successful university partnerships.
2. Identifying research expertise and areas of excellence on campus.
3. Finding "guides" to help navigate through the system.
4. Coordinating across the range of activities they want to engage in (research, other kinds of faculty engagement, accessing students, using equipment, etc.).
5. Frustration also exists with frequently having to "start from Square One" with every new agreement or new partner.

Recommendations:

1. Develop strategies to enhance business acumen of faculty, staff and students engaged in industry collaborations.

2. Make universities more "customer-friendly" and easier to navigate for potential industry partners.
3. Create a central portal on the university web site and single point-of-contact for companies seeking to engage in technology partnerships.
4. Create a guide to areas of research expertise within university.
5. Standardize and simplify rules of engagement between university and industry.
6. Make use of master agreements, standard templates and other mechanisms to lower administrative burden of collaboration.

Implementation Strategies and Resource Requirements

Successful implementation requires work by both academic and industry partners, and can be facilitated and incentivized by a number of additional stakeholders, such as the Board of Regents, Ohio's executive and legislative branches and regional organizations.

The Working Group believes that the commitment shown by the academic participants on the Task Force demonstrates a strong interest in changing the culture of Ohio's higher education system and a willingness to meet the challenge of engaging more actively on regional and statewide economic growth. It is ultimately a change in culture which will drive revision in institutional policies and operations. A detailed assessment by each campus would be appropriate to determine changes at that level.

The Board of Regents has an opportunity to continue to be an advocate and champion for policies and programs which encourage more effective collaborations. The financial resources at its disposal should be leveraged not only to incentivize specific collaborative projects, but also help campus leadership bring about change and build a foundation on campuses which puts collaboration with industry closer to the center of the research and education mission.

Metrics

Measuring performance on an ongoing basis is a critical part of determining whether progress is being made toward the goal of creating more high-value and high-impact industry-university collaborations. In addition to drawing information from discussions with industry participants at the public forums, meetings of the

Task Force, the Working Group has taken advantage of an ongoing effort of APLU, as noted above.

The Working Group believes that while much of the effort needed to enhance the climate for productive collaborations is qualitative in nature, changes in culture and practice will be reflected in measurable outcomes. The table below identifies a set of metrics which capture the improvement in the innovation ecosystem.

Metric	Quantitative/Qualitative Measure(s)
Industry-sponsored research expenditures	Total expenditures and resulting from OH partnerships
Research agreements with industry	Total number (overall and OH companies) and total dollar value; resulting impacts
Campus equipment /infrastructure use by industry (inc. technical assistance, testing, work-for-hire, etc.)	Total projects (overall and OH companies); total dollar value; resulting impacts
Start-up creation from university technology	Total number; total follow-on financing to companies and employment growth
Start-up / small company support from university incubators, accelerators and other programs	Total companies assisted; dollar value of support; resulting impacts
Faculty/staff engagement in industry research collaborations	Total number of projects; number of participants; number of companies (overall and OH companies); total dollar value
Faculty /staff participation in industry support activities (consulting, board participation, etc.)	Total number of engagements (overall and OH companies); types of activities; hours spent
Industry engagement in non-research campus activities (visiting committees, advisory councils, mentoring programs, adjunct teaching, etc.)	Total number of activities; number of industry participants

Appendix 1
Industry Working Group Public Forum Background Document

Ohio Board of Regents Commercialization Task Force

Industry Working Group Public Forums

March 1, 2012 – University of Toledo
March 23, 2012 – Kent State University
March 28, 2012 – University of Cincinnati

Background and Context

The Ohio Board of Regents (OBR) is currently undertaking a study to explore opportunities for expanding collaborations between industry and the state's institutions of higher education, for the purpose accelerating innovation and supporting the growth of technology sectors. All higher education institutions, from community colleges to research universities, are included, as are both public and private institutions.

Focus areas of the Commercialization Task Force include enhancing the performance of university technology licensing offices, expanding programs to promote faculty and student entrepreneurship and the creation of spin-off companies, incentivizing more productive industry-university research partnerships, better leveraging the physical assets of higher education institutions and more effectively meeting the current and future talent needs of technology sectors. Overall, the Task Force seeks to develop a strategy for making higher education institutions more effective partners within their regional innovation ecosystems to accelerate economic growth and job creation in the State of Ohio.

Public Forums for Industry

The Industry Working Group of the Task Force is explicitly charged with soliciting input from technology companies across the state. Working Group members include:

- John Hillenbrand, Chief Innovation Officer, Owens Corning *(chair)*
- Rebecca O. Bagley, President & CEO, NorTech *(co-chair)*
- Dr. Lloyd Jacobs, President, University of Toledo
- W. Grant McGimpsey, Vice President for Research, Kent State University
- James Sattler, President, NuVention Solutions, Inc.

The Industry Working Group has scheduled forums at the University of Toledo, Kent State University and the University of Cincinnati. These events are designed to gather information about the experiences Ohio companies have had working with university partners. Senior executives from both large and small technology companies have been invited to participate in these roundtable discussions, which are structured to capture the "voice of the customer" and enhance our understanding of how higher education can better support individual companies and contribute to regional economic prosperity and national competiveness.

Discussion Questions for Forums

The agenda for the forums will be structured around a set of key questions. Participants are asked to be prepared to address a number of issues, highlighting the experiences of their companies and providing guidance and input to the Working Group.

1. Please identify and describe successful collaborations between your company and higher education institutions? These may include:

    - Licensing and commercializing faculty-invented technologies;
    - Sponsored research, joint research or faculty consulting which have helped bring products to market;
    - Product development, prototyping, or other technical assistance services;
    - Workforce training or other talent development initiatives;
    - Participation in centers, programs or other college/university initiatives;
    - Other types of collaborations.

    In your experience, what are the characteristics of successful collaborations? Where did you encounter obstacles and how were they addressed?

2. Please describe situations where your company was unsuccessful in developing a collaboration with a higher education institution, or where a partnership failed to achieve its goals? What were the most significant barriers to success? In general, where do you see the greatest challenges in fostering collaborations?

3. What would encourage your company to expand existing relationships with higher education institutions or initiate new activities? Examples might include:

    - Established networking programs to facilitate collaborations (offered by higher education institutions or a third party);
    - Financial incentives (such as research grant funds or seed/investment funds);
    - Greater knowledge of areas of strength within academic institutions (such as faculty research expertise, leading academic programs, centers of excellence);
    - Availability of dedicated space for collaborations, including incubators or accelerators;
    - Availability of technical resources for use by companies, including access to core facilities, testing equipment, design/prototyping services, etc.;
    - Other programs or changes in institutional or state policy to promote partnerships.

    Are there other specific changes in approach by academic institutions or by the State of Ohio which would encourage greater collaboration? What else can Ohio higher education institutions do be more "customer-friendly" in working with industry partners?

4. Over the long term, the Task Force wants Ohio higher education institutions to significantly increase their contributions to the growth of technology-based

businesses and industries. How can Ohio and its academic community be a larger part of your company's and industry's growth strategy?

Ohio Board of Regents Commercialization Task Force
Industry Working Group Public Forum
March 1, 2012 – University of Toledo

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Ohio Board of Regents Commercialization Task Force
Industry Working Group Public Forum
March 23, 2012 – Kent State University

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Ohio Board of Regents Commercialization Task Force
Industry Working Group Public Forum
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Appendix E

Ohio Board of Regents Technology Transfer and Commercialization Task Force
Report of the Technology Sub-group
May 3, 2012

Technology Sub-group Members

Norm Chagnon, Ohio Department of Development (co-chair)
Nagi Naganathan, The University of Toledo (co-chair)
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Problem Statement

The raw material of commercialization is represented by the research assets (including specialized infrastructure) of Ohio's higher education institutions individually and collectively. Even before consideration of what takes place around the activities that support the transfer and translation of research into commercial opportunities, there are a number of factors to be addressed that may influence the commercial value of those research assets. Are there specific policies and practices that can be applied at the level of the research enterprise itself to maximize the commercial value of the research assets and improve the likelihood that an increasing amount of the research and associated resources will contribute to commercial pursuits in Ohio?

Key Questions

<u>Culture Change:</u>

- How can higher education institutions better communicate institutional research priorities to assure faculty and industry that commercially relevant research pursuits are valued?

    - How can higher education institutions better educate and enable faculty and industry partners with policies and resources that will make them successful in these pursuits?
    - What reward systems and incentives do higher education institutions need to create to drive the interest of their faculty to engage industry, support start-ups and to pursue use-inspired research?
- What policies would encourage higher education institutions to successfully recruit new faculty that are predisposed to pursuing commercially relevant research and set expectations that such activity is part of the faculty's formal or informal contract with the institution?

Portfolio Management:

- How can higher education institutions be more effective in assessing the commercial potential/relevance of their research assets?
- What portals/pathways can higher education institutions create for industry and the VC community to gain working knowledge of their research assets and provide useful feedback on its commercial relevance?
- How might information technology and social media tools improve the transparency of assets and the engagement of the industry and VC communities in the process of evaluating and accessing higher education assets of potential commercial relevance?
- Would Ohio's competitive advantage improve with increased interactivity and marketing of the inter-institutional research portfolios and capabilities? How could institutions effectively work together in bundling assets across institutions to create potentially stronger commercial opportunities?

Industry Engagement:

- What new strategies/best practices can be widely adopted for creating forums that bring the higher education, industry and VC communities into regular contact to explore opportunities and facilitate an increase in the number, intensity and durability of relationships that influence research objectives and lower barriers to successful commercialization?
- How can industry be engaged as a primary participant in establishing intellectual property strategies while the research is ongoing so the resulting intellectual property portfolio is of maximum value?
- What novel organizational structures and approaches that exist outside the normal "comfort zone" of both higher education institutions and industry might help effectively catalyze commercialization activity when platforms of interesting and potentially valuable IP/know-how are identified?

- How do Ohio's higher education institutions best take advantage of "Open Innovation" and what does it take for institutions, individually and collectively, to become providers of choice for industry seekers?

Process

The findings and recommendations presented in this report are based on information collected through the following:

1) *State Science and Technology Institute (SSTI) Research (Appendix A):* SSTI, a nationwide network of practitioners and policymakers dedicated to improving the economy through science and technology, posed a number of questions above to members of its network members and provided a report of their responses.
2) *Open Innovation Conference Call (Appendix B):* Practitioners of Open Innovation in Ohio provided recommendations in a conference call with members of the technology sub-group on March 27, 2012. The participants included: Peter Rea (Baldwin-Wallace College); Camille Rechel (YourEncore); Nick Nikolaides (P&G); Tom Hughes (PolyOne), and Matthew Becker (University of Akron).
3) *Public Forum (Appendix C):* A public forum was held on April 26, 2012 hosted by the University of Akron with business, higher education and government participants.
4) Kauffman Foundation (Appendix D.): On March 19, 2012, a call was made to Lesa Mitchell, Vice President of Innovation, Kauffman Foundation, to discuss questions related to portfolio management and culture change.

Findings and Recommendations

There is general agreement that Ohio's higher education institutions have the breadth and depth of resources that are relevant to the commercial needs of companies within and outside the state. Those resources include: 1) the research portfolios of the institutions; 2) faculty and staff; 3) specialized facilities and equipment; and 4) campus ecosystems where the spirit of inquiry is continually refreshed by the new young minds of their students who are regularly introduced to the process of research, technology transfer, and commercialization. Collectively, these assets are viewed by industry as having the potential to make meaningful contributions to new product development, launch new companies, be responsible for day-to-day problems solving, and provide the much needed talent for commercialization and company growth.

The ultimate commercial relevance of higher education resources to industry involves a cost-benefit analysis that must be made by each firm attempting to access those resources. Critical to the decision are three elements:

1) *Awareness:* Can a company readily identify the resources that are of value?

2) *Access and engagement:* Is there a way to efficiently connect to those resources?
3) *Timeliness of action:* Will negotiation and deliverables occur in a timeframe that is responsive to the market-driven demands of the business partner?

Recommendations flowing from these findings address the key elements and fit into the inquiry categories of culture change, portfolio management and industry engagement. These recommendations are presented under two broad topics: (A) Business engagement portals and (B) Engagement Incentives.

A. Business Engagement Portals

The University System of Ohio (USO) must assure a comprehensive_infrastructure on USO campuses that facilitate business engagement between its universities and colleges, individually and collectively. Such infrastructure may either have to be created new on certain campuses or it may be a scale-up of the pilot efforts that are currently in place. In either case, USO must provide financial support at a critical level to assure a successful launch as well as its sustainability. Any such portals are already demonstrating their impact on certain USO campuses today, even in their infancy. Examples of such portals include the University of Toledo Innovation Enterprises, the University of Akron and Youngstown State University research foundations, and the Ohio State University Industry Liaison Office.

Outside of Ohio, the business engagement activities at MIT and the University of Michigan were viewed as models. The Michigan Corporate Relations Network was identified as an ambitious effort to develop a multi-institutional state-wide business engagement with many of the functionalities described below. Creating the appropriate "front door" for businesses and investors to access the research and associated resources of Ohio's higher education institutions is seen as a critical element by both universities and industries to increase the commercial relevance of the USO technology assets.

Portals should be separate and distinct from the Technology Transfer Office, focusing on communicating the institution's assets, building relationships between relevant faculty and industry scientists, and facilitating collaborative research and commercialization opportunities between the university and industry. The Technology Transfer Offices should focus on 'making the deal' and develop streamlined processes as well as additional approaches to facilitate rapid assessment and conclusion of IP negotiations and technology transfer.

While research foundations and industrial liaison offices are currently filling this function at some institutions, feedback from the business community suggests that the level of effort in this regard could be improved system-wide. In particular, the level of USO investment must recognize the desire and willingness of the USO institutions to participate in the technology commercialization processes via

liberal IP processes for industrial partners, who in turn are willing to make investments at certain thresholds for accelerated technology development. When developing the portal structure, it is important to recognize the difference and create policies and practices that distinguish commercialization practices in the two scenarios: (1) development of technology with active and current industry/business investments and (2) commercialization of pre-existing IP.

Near-term Goal: Establish a system wide basic level of functionality via USO funded business engagement portals at each of the colleges and universities of the University System of Ohio that have a track record of research expenditures and/or commercialization activities at certain established thresholds. Beginning at the institutional level increases the buy-in that is necessary to make such an activity effective and sustainable in the long term. Elements of the basic functionality should include:

a) a clearly defined and well-advertised structure that businesses, investors and economic development intermediaries that assist companies can easily identify;
b) the capability to describe and actively market key institutional resources, raising the general awareness and transparency of the opportunity;
c) an organizational structure that has sufficient autonomy to act in the best interest of the commercialization partnerships. Many successful models are based on independent non-profit entities to fill this role;
d) the capability to provide education and networking events that regularly engage businesses, investors, faculty, staff and students to discuss shared interests and improve the ability to form working collaborations; and
e) core staff with industry knowledge and experience that can understand business needs and effectively relate them to institutional capabilities.
    i. a majority of the core staff should be required to be housed in close-proximity of the active research centers and laboratories with an objective to instill a degree of ownership for the innovation and the passion in the staff to commercialize the technology. This will be a significant deviation from current practice where the staff is typically housed in a unit outside of the research enterprise such as the Technology Transfer Office.
    ii. the staff should be required to develop sustained, active relationships with major centers of research capability within the institutions and will have the authority to consummate agreements in a time-frame that is responsive to the market-driven needs of business customers. This may involve having standard or master agreements in place tailored to access specific resources.
    iii. all of the staff must have a strong understanding and connection with structures within the institution that have been specifically created to support applied research and commercialization in focused areas of technology. This would include various institutes,

Wright Centers, prototyping and applications centers led and sponsored by industry.

iv. the staff will be required to make it a priority to promote entrepreneurship and commercialization culture among the students and other young post-doctoral researchers by helping the young entrepreneurs successfully navigate the process of commercializing their ideas and innovations in a timely manner.

Intermediate-term Goal: Establish structured regional and state wide coordination among institutional business engagement portals. These structured partnerships will be established to facilitate the following.

a) provide a dedicated source of funding to support translational projects that bridge research and commercialization.
b) update core technology transfer policies and practices to lower the transaction cost of obtaining IP, especially focusing on reducing negotiation time.
c) establish state-wide networks that effectively use students to advance commercialization projects and build effective connections between companies and faculty; internships co-ops, practicums.
d) pursue open innovation methods that increase the frequency and sophistication of interactions between seekers and solvers to include advanced data base techniques, marketplaces and even IP auctions and support with educational efforts that promote intelligent risk-taking among collaborators.
e) strive to integrate the business engagement activities of institutions at least within regional clusters. Extend relationships to include appropriate economic development intermediaries that represent specific industry interest and have a vested interest in helping build industry/university relationships to advance commercial interests. In critical, highly competitive fields (e.g., diagnostics and therapeutics), consider statewide collaborations.
f) Focus on mutually-beneficial, long-term relationships, not short-term, one-off projects with a goal to engage multiple companies in a pre-competitive environment (safe zone) where problems and solutions are shared openly. The venues could be focused institutes, regional hubs, sand pit exercises and other mechanisms that facilitate a disciplined problem/solution dialog.

B. Engagement Incentives

While the systemic changes described above to improve the process by which commercialization partnerships are pursued will improve both the quantity and quality of these interactions, the formation of these collaborations may require additional incentives to occur more readily than they might otherwise. Incentives should be considered on both sides of the partnership.

Industries & businesses

Near-term Goal: Create a policy providing specific benefits for industries to invest cash resources in university research and development. The aerospace consortia efforts in Montreal (Canada) may be a good model to follow. Require that the engagement of technology stakeholders from both the USO campuses and the industries in executing accelerated project agreements instead of relegating execution of the agreements to third parties or offices/officers who are not involved in the technical projects.

Higher Education

Near-term Goal: Each USO institution should strongly and clearly communicate that institutional policy embodies the critical role of use-inspired research pursuits, collaboration with business and the formation of new enterprises both for the advancement of the institution and the contribution to regional and statewide economic development. That communication must convey that such activity is encouraged, supported and celebrated on an equal footing with the traditional education and research mission of the institution. Immediately reflect this emphasis in recruiting and hiring criteria for new faculty.
Near-term Goal: Significantly increase the emphasis and opportunities for students to be engaged in industry projects occurring at the institutions and at companies. Promote the importance of these opportunities as a critical gateway to employment.
Intermediate Goal: Faculty have a tried and true path to tenure, promotion or annual merit based pay based on peer reviewed publications, teaching, and professional service. Engaging in commercialization activity collaborating with industry or working to create start-up enterprises with tangible outcomes must not only be included in the list but have some equivalency to the other criteria associated with institutional reward systems that is recognized within and outside the institution.

Metrics

It is important that metrics are established at every layer that supports accelerated commercialization on USO institutional campuses. Such layers will include all transaction nodes starting from portals where the inquiries are received for preliminary follow-up, all the way up to specific outcomes measured by successful results normalized by investment and research expenditure. Candidates for such metrics are:

1. Number of documented business/industry inquiries with a minimal level of tangible follow-up (introductory meetings between campus researchers and industries, site visits, non-disclosure agreements for information exchange, etc.)

2. Number of inquiries translated to preliminary follow-up such as phase 1 pilot studies for scalability and alignment of business goals.
3. Number of non-faculty research and development personnel on campus who are engaged in active technology commercialization efforts.
4. Number of students who are employed via entrepreneurial internships and co-op experiences by the engaged industry partners.
5. IDFs/$1 MM Research: Invention disclosures received per $1 million research expenditure.
6. Deals/IDF: Percent of inventions that are subject of ultimate commercial transactions (e.g. license and option agreements)*
7. Gross Return: Gross commercialization revenue relative to the research expenditures.
8. Startups/$100 MM: Number of startup companies formed (or "spun-off") per $100 million of research expenditure.
9. Percentage of IDFs pursued: Percentage of inventions for which a patent application is filed.
10. FTEs/$100MM Research: Number of full-time licensing professionals employed per $100 million of research expenditure.

Appendix A
SSTI Research Findings

Are institutions competent and capable of bundling assets across institutions to create potentially stronger commercial opportunities? Are there ways to engage industry and the venture community to assist with this?

- Multiple people that were interviewed for this project indicated they could think of several individual instances of IP from multiple universities being bundled, but as one person described it this was "more project specific than systematic." Additionally, some people interviewed mentioned multi-university research centers or consortia that resulted in cooperative IP arrangements between the universities. Specific examples of bundling assets across institutions on a regular basis were harder to find.

- From 2008 to 2011, NSF's Partnerships of Innovation funded the Inter-University Technology Bundling Project, which brought together technology transfer offices from 18 universities and research institutions and was facilitated by the Larta Institute. Under the project, the group worked to bundle IP across institutions. The results of the project are not available, but we have requested information from Larta Institute about their experience.
  http://nsf.gov/awardsearch/showAward.do?AwardNumber=0650347

- The University of Utah is working on the development of a regional network of schools. The Western Innovation Network, funded by a National Science Foundation grant, will allow affiliated schools to collaborate by sharing limited resources. http://www.westerninnovation.com (website was unable to be accessed on March 30, 2012)

- Based in Pennsylvania, the mission of the Nanotechnology Institute is to focus on the transfer of nanotechnology discoveries and intellectual knowledge from universities to industry partners, and on the rapid application and commercialization of nanotechnology to stimulate economic growth. Companies interested in securing or licensing a particular piece of nanotechnology or a bundle of complementary technologies, can work with the Institute's Nanotechnology Commercialization Group (NCG), which can help negotiate the licensing agreements. http://nanotechinstitute.org/ip-and-licensing

- In February 2012, the Michigan Economic Development Corporation provided $2.4 million to create the Tech Transfer Talent Network, made up

of seven Michigan universities. The primary purpose is to increase the supply of seasoned entrepreneurs and innovators who can lend their expertise to university tech transfer offices. The state hopes that these connections will serve as important bridges to launch technology-based startups or license university inventions to established companies. While not the explicit purpose of the Network, it is conceivable that multi-institution IP bundling could result. Press release: http://ns.umich.edu/new/releases/20234-u-m-to-lead-statewide-tech-transfer-talent-network-to-bring-more-inventions-to-market

- In March 2012, the University of Maryland System announced the creation of University of Maryland Ventures a tech transfer program that will help researchers at University of Maryland College Park and University of Maryland Baltimore commercialize their inventions. http://mpowermaryland.com/initiatives/institute-for-technology-transfer-and-commercialization-ittc/

- Maryland Governor O'Malley has requested $5 million for the Maryland Innovation Initiative that brings together five of the state's research universities, which would each put in $250,000. The money would be used to help specialists seek out innovations that suit the market's demands, and then provide the funding to bring these technologies to commercialization. http://mlis.state.md.us/2012rs/bills/sb/sb0239f.pdf

- One state interviewed mentioned that they had hired a staff member to look across the universities to see if there is IP that could be bundled. They are still at the fact-finding stage, but the universities have expressed strong support for the concept. In the author's opinion that is likely due to the credibility of the organization and the length of its relationship with the universities in its state.

Are institutions creating necessary portals/pathways for industry and the VC community to gain working knowledge of their research assets and provide feedback on its commercial relevance?

Databases of faculty members and available IP are a common approach used by institutions to make industry and the venture capital community aware of research assets available at the higher education institution.

- In March 2012, the University of Texas system launched the Research and Technology Search Engine to allow users to search online for research and technology experts, news, centers, and facilities. The portal provides access to information at all 15 institutions. It should be noted that this database is

like others that when a search term is entered, the results that are presented are references to papers, reports and websites rather than a list of faculty. Website: http://www.utsystem.edu/initiatives/innovations/search/

- Ball State, Indiana University, Purdue, and University of Notre Dame participate together in the Indiana Database of University Research Expertise (INDURE), which permits searches for faculty at the four institutions. INDURE represents a different approach from the University of Texas system on what results are presented. INDURE returns just a list of researchers. https://www.indure.org/

- While the databases/websites are common, those interviewed offered a number of observations on creating and maintaining one:
    - As one person put it, they "couldn't just bribe the universities to do it—they had to let them do it themselves" or there wouldn't have been buy-in at the universities.
    - Keeping the database current is difficult.
    - The cost of creating and maintaining the database can be expensive with reports of one state's database costing more than $1 million.
    - Having one database that crosses universities may be difficult because universities frequently have their own reasons for creating a searchable database and prefer specific vendors that better meet their needs.
    - Finding a researcher through the database should be viewed as just the first step rather than the end result. Multiple people interviewed recommended that there always be a human component to the database (i.e., users could search the database, but they would be directed to a specific person who would make the connection with the appropriate researcher).
    - One person interviewed reported that open source approaches to the databases are being developed which has the potential of further changing things.

Another common approach is the creation of an office or unit within the university to serve as the front door or gateway to the university. Examples include:

- University of Michigan's Business Engagement Center (BEC) provides companies with a gateway to the University of Michigan. Through the BEC, companies can identify and access the university's resources, including research discoveries, new technology, high-tech facilities, student and alumni talent, continuing education programs, and strategic giving opportunities. http://bec.umich.edu/index/

- In November 2011, the Michigan Corporate Relations Network was launched as a statewide university network involving six Michigan research universities. The initiative includes establishment or enhancement of business engagement offices. The existing business engagement offices at MSU (Business-CONNECT), UM (Business Engagement Center) and WSU (Front Door) are resources for businesses in navigating university offices. Both businesses and economic development agencies across Michigan leverage these "one-stop shops" to gain access to university research expertise and student talent. By supporting the formation of similar business interface offices at Michigan Tech, WMU and UM Dearborn, this six-school network is designed to magnify the value and impact for businesses across the state. http://urcmich.org/news/111109business.php

- In 2006, the University of Minnesota launched the Academic and Corporate Relations Center (ACRC) website, which offers access to the university's resources of interest to business and industry. The Office for Technology Commercialization helps advance business goals by licensing U of M technology using research facilities for product development, or sponsoring research projects. A listing of licensable technologies is available through the Technology Marketing Site. An online portfolio provides a searchable listing of available technologies categorized by one or more technology types. Each technology listing includes a detailed description and contact information for a Technology Marketing Manager. http://www.research.umn.edu/business,

- Established in 2003, the University of Wisconsin-Madison's Office of Corporate Relations serves as the front door to university resources for business and industry and focuses on providing service to companies in the following areas:
    - Recruiting UW-Madison graduates and interns
    - Providing executive education and professional development
    - Accessing faculty and staff expertise
    - Advancing technology transfer
    - Enhancing global competency
    - Fostering entrepreneurship

  http://www.ocr.wisc.edu/

Other examples relevant to this question include:

- The recently-announced University of Maryland Ventures will develop a common website to serve as a portal for outreach to the venture capital community. (See above for more info on University of Maryland Ventures)

http://mpowermaryland.com/initiatives/institute-for-technology-transfer-and-commercialization-ittc/

- AUTM launched the Global Technology Portal (GTP) in February 2012 to as a one-stop shop for corporations to find university technologies available for licensing, as well as for all its members (universities, corporations, and government labs) to find each other for collaborative research projects. The portal is designed to help quicken the pace of product development by making it much easier for corporations to identify potential university partners equipped with needed research capabilities. AUTM members can list available technologies on the website. www.gtp.autm.net

- In Utah, the Kickstart Seed Fund was created in 2009 with University of Utah, Utah State University, and Brigham Young University all putting some money into the fund as did private sources of funding. The investment committee meets monthly with representatives from the universities and private sector. While Kickstart does not focus exclusively on university technologies, the model does represent a means by which relationships are being developed between universities and private investors. http://kickstartseedfund.com/

- The Georgia Research Alliance's VentureLab evaluates the commercial potential of university-developed technology and helps fund the technology research necessary to further develop the invention or discovery. In GRA's experience, VentureLab has become an entry point for venture capitalists, not only because they and angel investors help review projects, but also because they pay attention to the projects that are funded; this interest then can translate to a broader relationship with GRA and the universities.

- Some of those interviewed for this project referenced IP review committees with private sector representatives to provide advice on the commercial viability of technology. Mixed views were expressed on the committees with the concept being praised but doubts about the practicality. Doubts arose because of questions about how timely reviews could be done and the availability of high quality reviewers.

Appendix B
Kauffman Foundation Call

Traditionally R&D monies flow from the government (NIH) to universities where various basic and applied research projects are carried out. Basic research has gotten the lion's share of funding dollars due to their capacity for innovation. In the technology commercialization and transfer process the prevailing thought is that these researchers must be trained on how to bring their research to the market. It is believed that this will speed up the transfer process. New research suggests that these might be outdated beliefs.

Lesa Mitchell is Vice President of Innovation at the Kauffman Foundation. I had a chance to speak with her and talk about some of the key areas for reform in the technology transfer process. I have listed them below with a brief summary of each.

<u>Key Points/Recommendations</u>

- There is no difference between basic research and applied research. Both lead to innovation and thus no distinction should be made.
- Universities should not try to train their scientists/researchers how to commercialize their research rather they should provide uninhibited support for it. Mrs. Mitchell suggested a "ebay for technology" where researchers "shopped their research" ,as authors do their books that are awaiting publication.
    - *Recommendation: This can be accomplished through deregulating university licensing.*
    - University leadership would retain ownership of the research but the researcher would be allowed to choose whom to work with.
- This idea has been implemented at the University of North Carolina, University of Hawaii and Carnegie Mellon through the IBridge Network: http://grantsinfo.unc.edu/expertise/iBridge
- This website is not specific to one university. Rather it is a centralized site for researchers at various universities. Mrs. Mitchell described it as "a Craigslist or Ebay for university science"
    - This site is beneficial because industry partner will visit this site. Research has shown that they will NOT visit individual university websites.
    - This site uses express licensing to reduce transaction costs and speed up the process. Complete online process.

- To date it has been used for 18 pieces of innovation. These 18 pieces of innovation have been licensed over 100 times and have brought in over $100 K.
- Licenses are written to favor the startup company not the university. (Not true for U of Hawaii) This is a point of contention as the general council for many universities question the legality of this. Given that it is occurring at UNC and other places Mrs. Mitchell believes this to be false.

➢ *Recommendation: Reduce transaction costs*

➢ *Recommendation: Process should not exceed 90 days. (Current industry average is 9 months.)*

➢ *Recommendation: More educational programs that help undergrad and grad students understand the commercialization process and what to do to commercialize their research.*

- This should be a pull process not a push. Making things faster and easier will improve things across the board. This is a certain amount of disappointment or frustration that can set in given the current process. This cannot be ignored as it affects many researchers. As barriers are brought down and the process is simplified the support and participation should increase.

Appendix C
Open Innovation Conference Call: Summary

Establish effective business engagement centers

- separate and distinct role from technology transfer office
- institutional welcome mat for industry; facilitate organized/easy access to faculty, research, facilities/equipment and students; especially critical for large/complex research universities
- first step in ongoing and active engagement of broad base of potential industry partners
- MIT a model

Make co-creation/invention a primary goal of industry/university relationships

- upstream from technology licensing
- develop trust
- strive for mutually-beneficial long-term relationships, not short-term, one-off projects
- share problems and solutions openly
- engage multiple companies in pre-competitive environment (safe zone)
    - focused institutes, regional hubs, sand pit exercises and other mechanisms that facilitate disciplined problem/solution dialog
    - interdisciplinary players
    - integrate students as well as faculty and staff
- define commercialization objectives and roles of each party
- with clear scope of work, vested parties in this process take deal to the technology transfer/ licensing office; up front work to reduce tensions inherent in IP negotiation

Broadly institute talent/culture education and events to teach potential higher education and industry partners how to engage in "intelligent risk-taking"

- skill foundational to developing trust, pursuing productive problem/solution dialog and negotiating mutually-beneficial IP relationships

Extend beyond traditional technology transfer metrics to track real economic outcomes

- not just # of companies formed but # of companies capitalized and their survival rate
- not just number of patents/licenses but number of patents actually used in a commercial product or process

Other

- Web portals, data bases and other IT solutions might help industry/university partnerships but only as a tool to augment people-to-people relationships and knowledge sharing.
- Presentation and packaging of inter-institutional research capabilities and IP seen as potentially powerful but not a great deal of evidence that this happens regularly and systemically. Kansas State University/Ag Sciences suggested as a potential model.
- P&G master agreement with USO positive in increasing number of faculty contacts but still challenges with regard to IP negotiation and funding
- UK and other countries more strategic at national/regional level in their support of industry/university collaboration and commercialization; co-funding opportunities available that don't exist in US (federal level).

Appendix D
Technology Subgroup Public Forum
Meeting Minutes 4.26.2012

Culture Change

- We need people who are both skilled (have previous experience) and are interested in commercializing their research
- University missions are not oriented towards industry or companies. They are not a priority or important for most universities. Universities are geared towards students
- Leadership buy-in is important, commonly there are a lot of doubters
- Incentivize researchers to work with industry and vice versa. Be sure that incentive is appropriate. Universities might want one thing while businesses want another. Ex: business might want tax break, this might not be as appealing to universities
- Increase the number of university professors on national scientific committees
- Don't make technologist businessmen and don't make businessmen technologists; have them use their respective skills to work together
- Time and effort required for approval make it economically unfavorable, it is too hard for small start ups

Portfolio Management

- University resources are both people and equipment
- Where does this collaboration take place? Location – campus or virtual? Many universities don't want to give up resources (space) to accommodate industry offices
- Researchers need to know how to start the commercialization process and what all it entails. A specific contact is needed at university for university employees and for industry
- "Office of Research" might be a viable option (research foundation is another option)
- Community based networks vs. university centralized – community based is favored as it does not limit the involvement or make it a specific university event. It leads to more collaboration, more expansive networks and longer term relationships
- Researchers need increased autonomy

- Need to train people (not researchers) to be tech transfer reps that can assist in commercialization process
- Youngstown Research Foundation is used as point of contact when industry players want to use university resources. It was started 1.5 yrs ago as a non-profit entity. While it is associated with the university it is not controlled by university Master agreements held by research institute. To date is has increased the speed of the process but it is still hard to get people to understand its benefits.
    - Ready Zone - for-profit (LLC) sector of the research foundation that is for products
- Universities have lots of resources but there's no business plan. There needs to be a system or plan for what to do with underutilized assets
- Commercialization process needs more commonality
- Idea: Fund 501c3s that are specific to certain key technologies
- Some private sector opportunities can be taken by university but must be careful but there is room to move. If it is already being done for profit then back off

<u>Industry Engagement</u>

- Two ways "spin in" from university or "spin out" to university
- Companies must understand what is being done at the universities and how it can be used to benefit them
- Large/medium international businesses do not pay close attention to what is going on locally (in Ohio)
- Do small businesses want university partner? Short term yes, long term no - a control issue. So once the relationship is established how does it develop and continue? What is the relationship with the University post-contract?
- Long term relationships lead to more new technology. It is not only about the current IP offerings it is also about what possibilities the collaboration might produce
- Open innovations is best for technologies that do not have a home (Can't figure out best way to use them). For academia must set value 1st then look for home.
- Which Universities to work with? For industry it depends on the university. Traditionally research universities have collaborated more. How does the process fit for teaching universities?
- Industry scientists can be used to connect with university scientists to increase collaboration. Both sides should be incentivized for this interaction
- How to build research community connections - company could pay for research of students. This would help establish short term and long term

bonds, help student find employment after college (many times the students are hired before graduation) in this way could be viewed as recruiting.

Other

- Transfer failures happen when university over-values their contribution
- Failure happens because researchers can't explain/understand market
- Case Western University's MBA program links senior MBA students to businesses. Their final project is how technology can benefit the business of choice. This has been very successful thus far
- Better to work with masters students because they are on a shorter time schedule (must complete degree in 2-3 years) so it gets done in time. Undergrads are viable if used for honors senior thesis - must be selective

Final Comments/Recommendations (Closing Roundtable Comments)

Update tech transfer policies to make them more user friendly
Faulty incentives that promote commercialization, innovation as a part of tenure
Centralized database of technologies not controlled by tech transfer office
Solutions are university specific because barriers are different for each university
Collaboration should be required as part of tenure track
Improve speed and access
Develop people internally that can say where tech may be useful
Train right people in technology
Evaluate success using multiple criterion
Incentivize industry to bring problems to universities to solve
Create new practicum for science MBA
Share info between groups via directed marketing
Focus on top three strengths of individual university and market these to industry
Make interface free and easy
New streamlined operating procedures for industry.

Appendix F

Aligning Ohio's College and University Graduates with Industry Talent Needs to Support Increased Commercialization

A Report from the
Sub-Committee on Workforce Development
Ohio Commercialization Task Force

Chaired by
Roy A Church, President
Lorain County Community College
&
David Hopkins, President
Wright State University

May 2012

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Ohio Technology Transfer and Commercialization Task Force: Report of the Sub-Committee on Workforce Development

I. Problem Statement

Goal of Sub-Committee:

To better align Ohio's higher education system with the emerging needs of workers in key roles and levels, and the new competencies and attributes that will be needed…to support Ohio economic recovery and growth through increased commercialization, specifically within the eight areas of technology application in related industry sectors.

The Ohio Commercialization Task Force was organized to explore how Ohio colleges and universities can effectively work with industry to accelerate the pace and impact of tech transfer and commercialization by leveraging growth opportunities identified by Battelle within eight technology areas with significant commercial opportunities for Ohio industry, most prominently for the six sectors that are dominated by manufacturing.

The Sub Committee agreed early on: 1) to determine the current ability of Ohio's higher education system to meet industry demand for workers in the six industry sectors (recommended in the Battelle report) that is crucial to successful commercialization, and 2) to explore with employers which emerging competencies they seek from new hires; how the workforce and competencies needed might vary across the various stages of the commercialization continuum; and how industry and higher education can more effectively collaborate to meet future workforce needs in a timely manner. We explore the importance of STEM and other professional and skilled workers throughout the processes of commercialization, proposing a linear model of commercialization to facilitate discussion between Ohio industry and higher education leaders.

In the report, *Ohio Third Frontier: Targeting Growth Opportunities for the Next 2 – 5 Years,* Battelle identified nearly 200 industries that align with the six industry sectors with from manufacturing (123). Others are energy (6), IT (11), R & D (5) and wholesale trade (1). Without making the linkages entirely clear, these industries are aligned with eight areas of technology opportunities: *Advanced Materials; Aero-propulsion Power Management; Fuel Cells and Energy Storage; Medical Technology; Sensing and Automation Systems; Situational Awareness*

and Surveillance Systems; Software Application for Business and Health Care; and Solar Photovoltaics.

What Is Meant by the Commercialization Process and Why Are STEM Workers Important to Its Success?

A review of academic literature as well as the rationale given for new national and state strategies reveals two fundamental points: 1) Innovation creates opportunities for commercialization which, in turn, is key to strong economic growth; and 2) the supply of STEM workers is a necessary but not sufficient to drive innovation and application of existing technology in new ways that produce new market growth. From the White House to the National Governor's Association, and states such as Maryland, all stress the importance of increased STEM education at the secondary and postsecondary level to meet current gaps in supply for STEM workers (and others) needed to support and stimulate innovation and commercialization processes[1]. "A rich pipeline of innovation plays a pivotal role in the region's industrial development, commercialization, and ability to sustain long-term growth"[2]. Further, STEM workers are argued to be an important component of the innovation pipeline. According to the U.S. Department of Commerce[3], *"STEM workers drive our nation's innovation and competiveness by generating new ideas, new companies and new industries."*

The Battelle study does NOT discuss the *occupational profile* of the six industry sectors. Also, it is not evident which occupations within these industries are critical to supporting innovation and commercialization of new applications of technology and the different stages of the commercialization process. We chose to begin with STEM occupations given the strong research and policy arguments that support the hypothesis that a strong STEM-educated workforce is critical to innovation and commercialization.

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[1] John Thomasian, *Building a Science, Technology, Engineering, and Math Education Agenda*, NGA Center for Best Practices, December 2011, p 19;
[2] Milken Institute, *Best Performing Cities, 2010: Where America's Jobs Are Created and Sustained*, http://www.milkeninstitute.org/pdf/bpc2010.pdf
[3] Langdon, et. al; *STEM: Good Jobs Now and in the Future*, ESA Issue Brief, July 2011, U. S. Department of Commerce, p. 1

Commercialization Continuum

Traditionally, the process or continuum of commercialization is thought to be linear, beginning with idea generation to market launch of the new product or technology-based opportunity. As part of our investigation, existing literature on commercialization models was reviewed in a search for a model that focuses on the nature of work to be performed. It followed then that this model would facilitate a discussion about workforce skills, competencies, personal attributes, and leadership skills required within each phase of the commercialization continuum.

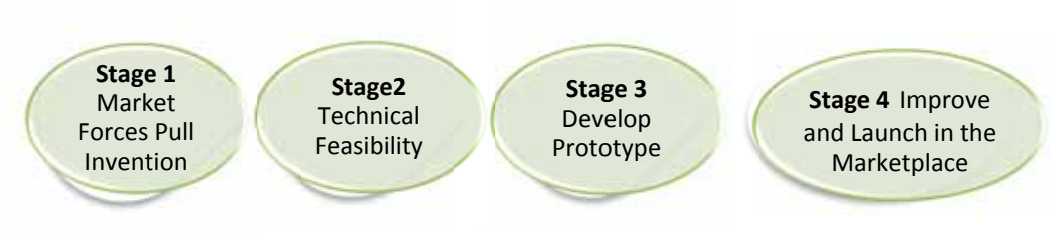
The search included university commercialization to industry-specific commercialization; and state government commercialization strategies to various federal government department commercialization strategies.[4] We chose a linear model developed by H. Randall Goldsmith (1995) because this model combines the technical elements of innovation leading to commercialization with market and business elements.[5] By probing more deeply into commercialization we more clearly understand workforce development needs.

The Goldsmith commercialization continuum combines research, product development, marketing and business development, including manufacturing. His is a six stage process, the first four lead up to and include introduction of a new product or process into the market. The initial four stages encompassed a Concept Phase, (Stage 1) Investigation and a Development Phase, (Stage 2) Feasibility, (Stage 3), Production Development and Introduction to Market (Stage 4). The last two are: Growth (Stage 5) and Maturity (Stage 6). The key point to make is that *a project needs more than experienced and creative researchers; successful commercial projects need "a good business plan and a good business team"* (Ferguson, p. 3).

[4] The literature spans more than four decades and approaches commercialization from two general typologies: linear and functional models (Ferguson, 2008, p. 3 and 4).

[5] Gregor Ferguson, "Commercialization Models", *Rumor Control*, September 30, 2008, p. 3

Goldsmith (1995) Commercialization Process Model



Stage 1: **Market Forces Pull Invention:** This is a research phase across technical market and investment areas. Research is both basic and applied and shaped by market demand. This phase may survey existing technology and assess market possibilities and professional and capital needs.

Stage 2: **Technical Feasibility:** A working model is developed, preliminary production is worked out and safety and environment features are assessed. In other areas, market characteristics are identified (customers and volume) and seed capital is raised.

Stage 3: **Develop Prototype:** Materials and processes are identified, the technology is tested and production methods are developed.

Stage 4: **Improve and Launch:** Production system is built and field support developed. Introduction into the market and response analyzed and customer relationships developed. Establish business functions, hire, train, and execute contracts. [6]

This model was used in our industry forums and participants were asked to discuss what occupations, competencies and skills might be unique at each stage.

[6]The Goldsmith model has the advantage of being flexible but structured. For example, the second stage is Feasibility. In this stage technical experts develop working models, test the technical features, assess how the technology could be manufactured, assess safety and environmental factors and finalize the design. Yet, the process does NOT advance without completing a market study and determining economic feasibility. Flexibility comes from the model's capacity to accommodate setbacks (simply return to an early stage) and incremental change (e.g. technology is enhanced, upgraded or adapted to new customer needs) which requires only that a stage be ignored or that element be modified that relate to new business start-ups. See the model below for the model and brief descriptions of each phase.

Implications for identifying workforce needs. Other commercialization studies provides insights about workforce development strategies needed to accelerate commercialization projects. In the early 1970s, extensive studies of successful commercialization found that five factors explained commercialization success. The factors include the following in descending order of importance. Commercialization success comes from—

- Understanding customer needs;
- Paying attention to marketing and publicity;
- Performing development thoroughly;
- Taking advantage of external scientific experts; and
- Extending greater authority to senior level innovators.[7]

The workforce needed to accelerate commercialization:

- Thinks critically and in terms of both technical and human systems;
- Listens and develops relationships with customers;
- Works with individuals from many different disciplines;
- Utilizes translational skills;
- Communicates effectively in many different environments[8]

Importance of STEM Workforce

Scientists, engineers and supporting technicians have long been accepted as critical to the dynamic flow of new ideas emerging from structured R&D activities within corporations and higher education, and are heavily supported by federal policy and funding. Carnevale argues that STEM students completing certifications, 2 and 4-year degrees and beyond, are now in demand to support the wide array of ways in which commercialization now occurs. "STEM workers are no longer the only ones responsible for introducing new and innovative technology and products….that function is leaving the confines of the lab and moving into the realm of design, customization, marketing, and distribution." Nonetheless, STEM competencies based in science and math are growing as they expand into other occupational areas and levels. "STEM workers now include engineering technicians, systems administrators, and others who require skills that can be obtained with less than a bachelors' degree."[9] He estimates that

[7] R. Rothwell, C. Freeman, A. Horsley, V.T.P. Jervis, A.B. Robertson, and J. Townsend, "SAPPHO Updated Project, Phase II" *Research Policy*, Vol. 3 (1974): p. 259-260.
[8] Ibid, p. 250-260.
[9] Carnevale, *STEM*, p74.

nationally, 27% of all STEM jobs require less than a bachelors' degree; some even less than an associates' degree. [10]

Evidence of Manufacturing Becoming More Focused on STEM and Skilled Jobs

Manufacturing workforce needs dominate the six sectors identified in the Battelle study. What are emerging workforce needs in successful commercialization of new products and processes that embed new technologies into existing products? A recent national study of job postings by manufacturers reveals that job openings directly related to the manufacturing process—traditional production activities—are far outnumbered by other occupations that support the production process.[11] The changing importance of commercialization within manufacturing may account for the shifts that are occurring in this occupational mix for jobs in which manufacturers are hiring (Figure 1).

Jobs With Largest Numbers of Postings

Occupation	Openings	% of Total Openi
Sales Representatives, Wholesale & Manufacturing, Except Technical & Scientific Products	50,811	7.6%
Mechanical Engineers	44,453	6.6%
General & Operations Managers	20,057	3.0%
Computer Software Engineers, Applications	19,217	2.9%
Retail Salespersons	17,034	2.5%
Maintenance & Repair Workers, General	12,597	1.9%
Computer Systems Analysts	10,788	1.6%
Industrial Production Managers	10,718	1.6%
Manufacturing Engineers	10,432	1.6%
Computer Software Engineers, Systems Software	10,372	1.6%

Jobs With Least Numbers of Postings

Occupation	Openings	% of Total Openi
First-Line Supervisors/Managers of Production & Operating Workers	8,864	16.2%
Inspectors, Testers, Sorters, Samplers, & Weighers	7,035	12.8%
Production Workers, All Other	6,946	12.7%
Computer-Controlled Machine Tool Operators, Metal & Plastic	6,057	11.0%
Assemblers & Fabricators, All Other	3,853	7.0%
Machinists	3,179	5.8%
Welders, Cutters, & Welder Fitters	1,078	2.0%
Cutting, Punching, & Press Machine Setters, Operators, & Tenders, Metal & Plastic	970	1.8%
Separating, Filtering, Clarifying, Precipitating, & Still Machine Setters, Operators, & Tenders	904	1.6%

Center for Regional Economic Competitiveness, *US Manufacturing Jobs: Where Companies Are Hiring*

Figure 1

Many of these jobs in demand are STEM jobs or are jobs requiring strong STEM education as well as business and managerial skills and competencies.

[10] In a detailed recent report by Anthony Carnevale, simply titled *STEM*, the current debate around post-industrial commercialization, is addressed head-on: "while the linear models of commercialization still prevail in which R&D prime the pump of new technology, innovation is no longer a one-way street from labs and corporate campuses to markets". Major examples of Google, Federal Express, and even Apple, are huge commercial successes based on "using existing science and technology in ever more complicated networks." He argues that "American STEM workers are becoming part of an increasingly global innovation system and workforce."

[11] Center for Regional Economic Competitiveness; ***U S Manufacturing Jobs: Where Companies Are Hiring,*** November 2011.

Defining STEM Occupations: Several national studies define STEM occupations similarly but with important distinctions. Beginning with this 2007 U.S. Bureau of Labor Statistics publication, Standard Occupational Classifications, or SOCs, are aligned with each of the four elements of STEM[12]:

1. **Science** is comprised of Natural Scientists which include: Life Scientists, Physical Scientists, and natural science technicians.
2. **Technology** usually refers to information technology or computer-related occupations. Essentially these are Information Technology, or IT, occupations—*about half of all STEM employment*.
3. **Engineering** is the use of science to solve practical problems. These occupations include engineers, drafters and technicians as well as engineering technicians. These workers are not far behind IT workers in accounting for all STEM employment across all industry.
4. **Mathematics** is equated with mathematical science and is narrowly defined as jobs that focus exclusively on mathematics. Actuaries, Mathematicians, Operations research analysts, and Statisticians are examples. As a result of this narrow definition, they comprise a small percentage of all STEM workers.

U.S. STEM Employment 2011		
	Jobs	Percent of Total
Scientists (less social scientists)	963,043	13.4%
Computer (IT)	3,736,253	52.0%
Engineering	1,598,139	22.2%
Engineering Technicians	771,601	10.7%
Math	118,374	1.6%
Total	**7,187,410**	100.0%

Nationally and *by a large margin, IT and engineering and engineering technician occupations are the primary job opportunities in STEM careers*.[13] A 2011 U.S. Department of Commerce report demonstrates the following differences for STEM and non-STEM employment.[14,15]

[12] Nicholas Terrell, *STEM Occupations, Occupational Outlook Quarterly*, Spring 2007, U.S Bureau of Labor Statistics.
[13] IBID, pp 26-29.
[14] Langdon, et. al; *STEM: Good Jobs Now and in the Future*, ESA Issue Brief, July 2011, U. S. Department of Commerce
[15] Note that STEM occupations are essentially the same set of occupations defined earlier by Hecker as 'high tech' occupations when attempting to define 'high tech industry some years back. Occupational data was used as a surrogate for other data more difficult to collect which more directly measures an industry's effort to innovate and

- In 2010, there were 7.6 million STEM workers in the United States, representing about 1 in 18 workers.
- STEM Occupations are projected to grow by 17.0 percent from 2008 to 2018, compared to 9.8 percent growth for non-STEM occupations.
- STEM workers command higher wages, earning 26 percent more that their non-STEM counterparts.
- More than two-thirds of STEM workers have at least a college degree, compared to less than one-third of non-STEM workers.
- STEM degree holders enjoy higher earnings, regardless of whether they work in STEM or non-STEM occupations.

Research Questions

The research conducted was organized into two phases:

1. What are the gaps in demand and supply of STEM and other occupations that are important to industry in support of its growth strategy built around increased commercialization, and how well Ohio's higher education system meets that demand?

2. What are the competencies, job requirements and occupational mix needed by industry during the various stages of commercialization, through the proposed 4-stage continuum?

The Center for Urban and Public Affairs at Wright State and the Joint Center for Policy Research at Lorain County Community College collaborated to assist the Sub-Committee in the design of a research investigation. This included collection of federal and state economic data on industry and occupations linked to the eight technology-focused areas and conducting two industry forums to solicit the input of industry leaders from the six industry sectors.

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apply advanced technology—R & D expenditures as percent of all expenditures; R&D employees as percent of all employees; patent activity, etc.

II. Findings

1. Gap Analysis

Demand for STEM Workers in **Ohio**: Projected Growth in **Ohio** and **Jobs Ohio** Regions

Occupations considered critical to developing technology and for supporting technology-enabled innovation

STEM Employment in Ohio is estimated to be 252,633 in 2011, growing 1% annually, and is dominated by IT professionals. This is due to IT being used throughout business organization to support IT-enabled infrastructure.

U.S.& Ohio STEM Employment 2011				
	U.S.		Ohio	
	Jobs	Percent of Total	Jobs	Percent of Total
Scientists (less social scientists)	963,043	13.4%	26,978	10.7%
Computer (IT)	3,736,253	52.0%	137,881	54.6%
Engineering	1,598,139	22.2%	58,388	23.1%
Engineering Technicians	771,601	10.7%	26,343	10.4%
Math	118,374	1.6%	3,043	1.2%
Total	**7,187,410**	100.0%	252,633	100.0%

Figure 2

Ohio's economy mirrors the nation in terms of the composition of STEM disciplines. However, Ohio ranks 23rd among the states (plus D.C.) in the concentration of STEM jobs—only 3.9% of all jobs in Ohio vs 4.1% for the nation. Michigan—the exception among our neighboring states—ranks 8th with 4.8% of all jobs in STEM occupations.

- Ohio would have to add 44,516 more STEM jobs (or 17%) to its economy in order to rank among the top 25% of states.
- Ohio is expected to lag the nation in STEM job growth, potentially widening the gap. Ohio is projected to grow STEM jobs by 3.8% over the next four years while the nation's growth rate is 5.6%. Ohio needs to grow an additional 15,276 STEM jobs just to keep pace.

Northeast Ohio and Dayton

Scientists are a small part of the region's STEM employment; Biomedical Engineers & Biochemists & Biophysicists are expected to grow 24% and 17% respectively, in next 5 years. The highlighted occupations below comprise a

relatively greater share of all jobs when compared to state or nation. Chemists, while a strong base historically, are expected to decline in number.

SOC Code	Description	2012 Jobs	% Change	2017 State LQ	2017 National LQ	Openings	% Openings	Annual Openings	2011 Median Hourly Wage	Education Level
17-2031	Biomedical engineers	254	24%	1.67	1.03	86	34%	17	$33.76	Bachelor's degree
19-1011	Animal scientists	50	4%	0.92	0.94	11	22%	2	$18.20	Doctoral degree
19-1012	Food scientists and technologists	219	5%	0.78	0.94	49	22%	10	$21.91	Bachelor's degree
19-1013	Soil and plant Scientists	123	7%	0.80	0.56	30	24%	6	$18.87	Bachelor's degree
19-1021	Biochemists and biophysicists	404	17%	1.29	1.16	130	32%	26	$26.54	Doctoral degree
19-1022	Microbiologists	73	4%	0.55	0.30	15	21%	3	$22.40	Doctoral degree
19-1023	Zoologists and wildlife biologists	55	4%	0.66	0.21	11	20%	2	$19.17	Bachelor's degree
19-1029	Biological scientists, all other	207	6%	0.96	0.46	45	22%	9	$22.15	Doctoral degree
19-1031	Conservation scientists	104	2%	0.71	0.40	8	8%	2	$28.67	Bachelor's degree
19-1032	Foresters	51	6%	0.69	0.34	5	10%	1	$19.74	Bachelor's degree
19-1099	Life scientists, all other	176	5%	0.93	1.01	26	15%	5	$31.06	Bachelor's degree
19-2011	Astronomers	30	7%	1.03	1.29	5	17%	1	$35.56	Doctoral degree
19-2012	Physicists	97	5%	0.61	0.46	18	19%	4	$42.89	Doctoral degree
19-2031	Chemists	1,540	(2%)	1.20	1.41	283	18%	57	$29.29	Bachelor's degree
19-2099	Physical scientists, all other	191	5%	0.65	0.40	33	17%	7	$27.97	Bachelor's degree
19-4011	Agricultural and food science technicians	182	2%	0.52	0.63	37	20%	7	$16.45	Associate's degree
19-4093	Forest and conservation technicians	107	4%	0.88	0.24	26	24%	5	$14.86	Associate's degree
45-4011	Forest and conservation workers	64	0%	0.61	0.58	10	16%	2	$11.81	Moderate-term on-t
	Total	3929	0.04			828	0.21	166	26.77	

Figure 3

Again, the largest number of STEM jobs are in IT—which will grow 5% by 2017 and pay an average of $26 an hour. These jobs are available for graduates of both 2- and 4-year institutions. When compared to Cleveland region, the

STEM	IT in Cleveland & Dayton Regions								
Description	2012 Jobs	% Change	Openings	% Openings	Annual Openings	2011 Median Hourly Wage	Education Level	2017 National Location Quotient	2017 National Location Quotient2
Computer and information scientists, research	330	8%	63	19%	13	$43.01	Doctoral degree	0.79	1.44
Computer programmers	5,029	(3%)	489	10%	98	$26.27	Bachelor's Degree	0.86	0.93
Computer support specialists	6,508	4%	1,134	17%	227	$19.09	Associate's Degree	0.84	1.23
Computer systems analysts	6,141	6%	1,023	17%	205	$30.25	Bachelor's Degree	0.73	0.84
Database administrators	1,295	7%	193	15%	39	$29.01	Bachelor's Degree	0.82	0.87
Network and computer systems administrators	5,281	8%	836	16%	167	$27.25	Bachelor's Degree	1.06	1.18
Network systems and data communications analysts	4,845	13%	1,064	22%	213	$25.28	Bachelor's Degree	0.85	0.97
Computer specialists, all other	3,049	4%	457	15%	91	$29.45	Associate's Degree	1.00	1.53
Computer operators	1,427	(10%)	82	6%	16	$15.94	Moderate-term on-the-job training	1.01	0.74
Numerical tool and process control programmers	337	(12%)	37	11%	7	$21.26	Work experience in a related	1.62	3.09

Figure 4

Dayton Region's IT jobs are a greater percent of all jobs—reflecting its greater importance to their economy. It is important though, to not confuse *industries* with *occupations*. Work done between 1999 and 2008 by the Northeast Ohio Software Association (NEOSA) indicates that two out of three IT occupations and jobs in northeast Ohio were not in the traditional IT industry sector.

Engineering Occupations

In northeast Ohio and Dayton regions, only chemical engineers comprise a larger proportion of all jobs than they do for the nation; some engineering occupations, as a percent of all jobs are significantly smaller than for the nation as a whole.

STEM	Engineering in Cleveland & Dayton Region									Dayton Region	
Description	2012 Jobs	% Change	Openings	% Openings	Annual Openings	2011 Median Hourly Wage	Education Level	2017 State LQ	2017 National LQ	2017 State LQ	2017 National LQ
Chemical engineers	594	(5%)	78	13%	16	$38.44	Bachelor's degree	0.88	1.45	1.20	1.92
Civil engineers	2,553	6%	389	15%	78	$29.92	Bachelor's degree	0.93	0.65	1.15	0.84
Computer hardware engineers	260	3%	50	19%	10	$39.73	Bachelor's degree	0.98	0.29	1.97	0.60
Electrical engineers	1,654	(2%)	218	13%	44	$33.88	Bachelor's degree	0.97	0.78	1.07	0.89
Electronics engineers, except computer	811	(1%)	105	13%	21	$32.28	Bachelor's degree	0.64	0.43	2.87	1.92
Total	5872	0.02	841	0.14	168	32.69					

Figure 5

- Civil and Electrical engineers are the largest number of workers in the Cleveland Region.
- No growth is expected in demand for Engineers overall.

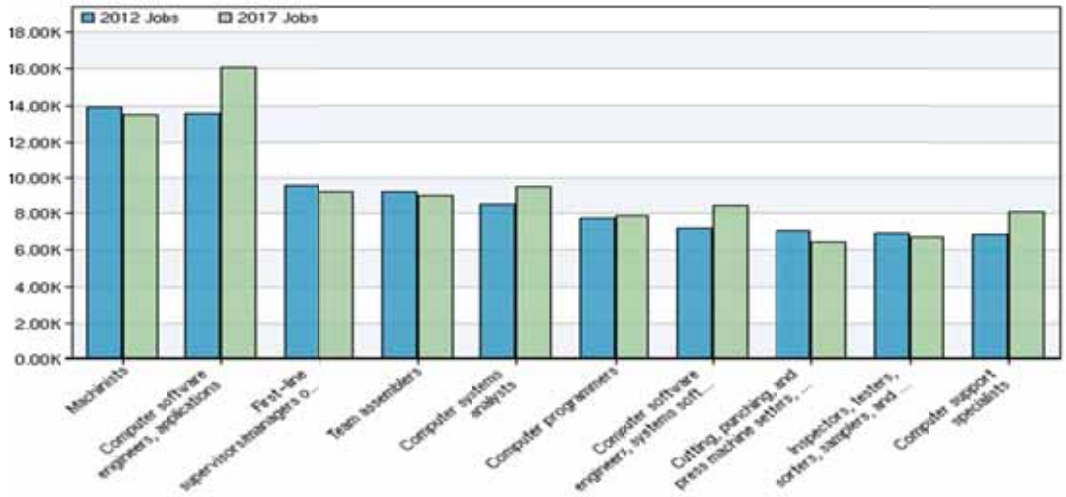
Dayton's economy demands relatively greater numbers of engineers. The need for Chemical and Electronic engineers, as a percent of all Dayton jobs, is twice what it is for the nation. The relatively low employment in Scientists and Engineering occupations is the result of an Ohio mix of industries that is less focused on innovation and commercialization to drive its growth.

Ohio's Occupational Focus of Six Industry Sectors

In this section, the focus is directly on the occupational mix and sources of greatest growth of jobs in the six industry sections combined. Manufacturers dominate these six sectors. The chart in Figure 6 identifies the occupations with

the largest number of jobs in 2012 and projected change by 2017, with STEM occupations highlighted.

Ohio Job Growth in Occupations for the Six Industry Sectors Combined 2012 to 2017



This chart includes the 10 occupations with the largest number of jobs in 2012 in the Six Industry Sectors Combined. While Machinists have the most jobs in 2012, by 2017, Computer Software Engineers and Applications will dominate employment in these, largely manufacturing, industry sectors. By 2017, Ohio's STEM employment in these six sectors will contribute 11% of all jobs, compared with 3.9% for all Ohio industry.

Of the top 25 occupations by size of employment in the six industry sectors shown in the table (Figure 7), six are STEM and five are IT. While many of the traditional jobs in manufacturing are declining over the next few years, all STEM occupations are growing. The growing importance of IT to advanced manufacturing and distribution systems is a focus of workforce need that merits further inquiry. One of the best practices in industry/higher education partnership is the Regional Information Technology Engagement Board (RITE) in northeast Ohio. While IT top leadership from all industry comprises the Board, the region's headquartered Fortune manufacturers dominate the composition and reflects the growing importance of IT to its business model.

Description	2012 Jobs	2017 Jobs	Change	% Change	% of Industry	2011 Median Hourly Earnings	Education Level
Machinists	13,938	13,514	(424)	(3%)	4%	$17.43	Long-term on-the-job training
Computer software engineers,	13,578	16,065	2,487	18%	4%	$36.98	Bachelor's degree
First-line supervisors/manage	9,575	9,224	(351)	(4%)	3%	$24.28	Work experience in a related field
Team assemblers	9,206	9,027	(179)	(2%)	3%	$14.16	Moderate-term on-the-job training
Computer systems analysts	8,531	9,471	940	11%	2%	$33.67	Bachelor's degree
Computer programmers	7,772	7,918	146	2%	2%	$29.66	Bachelor's degree
Computer software engineers,	7,209	8,477	1,268	18%	2%	$36.15	Bachelor's degree
Cutting, punching, and press	7,055	6,422	(633)	(9%)	2%	$14.08	Moderate-term on-the-job training
Inspectors, testers, sorters, s	6,893	6,684	(209)	(3%)	2%	$15.83	Moderate-term on-the-job training
Computer support specialists	6,872	8,095	1,223	18%	2%	$18.73	Associate's degree
Network systems and data co	6,716	7,852	1,136	17%	2%	$26.88	Bachelor's degree
Computer-controlled machine	5,505	5,686	181	3%	2%	$17.18	Moderate-term on-the-job training
Helpers--Production workers	5,454	5,204	(250)	(5%)	2%	$11.41	Short-term on-the-job training
Customer service representat	5,348	5,845	497	9%	1%	$14.35	Moderate-term on-the-job training
Maintenance and repair worke	5,242	5,080	(162)	(3%)	1%	$16.31	Moderate-term on-the-job training
Welders, cutters, solderers, a	5,040	4,869	(171)	(3%)	1%	$16.28	Postsecondary vocational award
Sales representatives, wholes	4,783	4,813	30	1%	1%	$23.88	Work experience in a related field
Managers, all other	4,745	5,067	322	7%	1%	$16.39	Work experience in a related field
Laborers and freight, stock, a	4,698	4,315	(383)	(8%)	1%	$10.96	Short-term on-the-job training
Network and computer syster	4,348	5,249	901	21%	1%	$28.42	Bachelor's degree
Industrial engineers	4,313	4,576	263	6%	1%	$33.75	Bachelor's degree
Sales representatives, wholes	4,236	4,602	366	9%	1%	$31.70	Work experience in a related field

Figure 7

Ability of Ohio's Colleges and Universities to Supply Annual Industry Needs For STEM Workers

Do Ohio colleges and universities graduate enough STEM majors to meet the demand for annual job openings? Is there a numerical gap in Ohio's ability to graduate the numbers needed to fill industry demand just reviewed?

Figure 8 shows for Ohio shows the difference between the projected number of annual job openings (net addition plus need to replace worker turnover) and the number of students completing a 2- or 4- year degree in the matching STEM discipline; student

Occupational Grouping	Gap
COMPUTER SYSTEMS	-2471
ALL OTHER ENGINEERING TECHNOLOGY	-3
ELECTRICAL/ELECTRONIC ENGINEERING	59
MATHEMATICS	59
ALL OTHER ENGINEERING	67
PHYSICS/ASTRONOMY	99
CHEMICAL ENGINEERING	122
FORESTRY AND CONSERVATION	172
AGRICULTURAL/FOOD SCIENCES	184

Figure 8

numbers have netted out international students graduating from Ohio institutions, leaving only U.S. citizens that are mostly from Ohio.
Computer Systems is the aggregate of all IT jobs. Each year, there is an overwhelming shortage of graduates to fill available jobs. Minimally there are 2500 too few IT completers to satisfy annual demand. The shortage gets worse were we to determine the mis-match between specific IT jobs and qualifications (certifications, degree, skills and competencies and work experience) employers are seeking and the array of IT majors among our graduates.

In the other STEM occupational categories there appears to be a slight surplus of graduates. However, again, this assumes a perfect match of skills with job requirements, which employers verify is not the case.

One More Evidence of Too Few STEM Completers: The limitation of this analysis is that it assumes that all graduates will seek employment in STEM occupations. This is far from accurate.

Only About Half of STEM Graduates Choose Or Remain in STEM Occupations. A recent national study of college students that originally enrolled in 1993 found that only 19% completed a STEM degree; 81% completed some other major. Of the STEM graduates, only half were employed in STEM jobs upon graduation, and by 2003—10 years from beginning college, 1 in 5 were now working in related professional or managerial occupations. "The market for STEM competencies is broader than the search to fill STEM openings."[16] This tendency is just as strong in all areas of STEM disciplines and occupations.

Conclusions

Ohio's economy lacks the technology-intensity needed to significantly drive growth in Scientists, Engineering and Mathematical occupations. Even within the Six Industry Sectors identified by Battelle, and despite that these sectors employ greater relative numbers of STEM workers than the rest of Ohio industry, many STEM occupations are under-represented in Ohio's occupational mix, as judged by the Location Quotients even though these sectors employ greater relative numbers of STEM workers than Ohio industry generally. This accounts for the state's poor standing on STEM employment as a percent of all jobs.

[16] Anthony Carnevale; et. al., *STEM*, Center on Education and the Workforce, Georgetown University, December, 2011; p 42.

Further, IT predominates among STEM occupations in companies; however companies use rather than produce IT products. This fact suggests that Ohio does not have a niche in producing IT products and services.

With the exception of IT, Ohio industry, compared to the same industries nationally, employ relatively fewer STEM workers. This presents a challenge for the Task Force overall: Ohio industry likely lags behind the nation in having the talent base required to drive a rapid increase in new commercialization of technology and products. It will be important that other Sub Committees recognize Ohio's limitation of incumbent STEM workforce strength as part of the workforce development challenge for markedly increase the pace of commercialization.

2. Industry Forums

The commercialization forums were designed to ask industry leaders to join the State of Ohio to work toward the goal stated at the beginning of this report: to better align Ohio's higher education system with the emerging needs for workers, and the new competencies and attributes they likely will require, in support of Ohio economic recovery and growth.

Leaders invited were from the six industry sectors and were asked to attend one of the two meetings.

- March 12, 2012 at Wright State University. President Hopkins assisted by Drs. Dustin and Dockery, and Intern Charles Campbell

- March 13, 2012 at Lorain County Community College. President Church, assisted by Dr. Shanahan and Intern Austin Dean

<u>Critical Questions for Industry Leaders Panel:</u>

- How can Ohio's universities and colleges become better partners with industry to drive increased commercialization? Our lens is the "workforce."
- We need your help to understand what occupations—STEM and others—drive innovation and commercialization within your industry.
- We also need your ideas for how higher education can dramatically increase the supply of entrepreneurial talent needed to grow Ohio's share of industries with promising futures.

Specifically, they were asked to:

- Provide insight into the Gap between a growing demand for STEM (and other) workers and the current supply of Ohio graduates from our 2- and 4-year institutions.
- Review the proposed continuum of commercialization and identify critical occupations and competencies needed at each of the stages along the continuum.
- Provide short-term and longer-term recommendations to the Sub-Committee.

Both forums were conducted using the same discussion but slightly different facilitation techniques. Participants were seated at round tables with the majority at each tables being industry leaders. Discussions were led by table facilitators using computers to assist in the documentation of discussion at each table. There were three rounds of two questions each.

Key Findings from Industry Forums:

Understanding the Gap & How Well Ohio Higher Ed Meets Industry Demand

1. STEM Employment in Ohio is estimated at 252,633 and growing around 1% annually. It is dominantly by IT, Engineering and Engineering Technician employment.
2. STEM workers require much more than technical expertise acquired in college courses; employers look for students and job seekers who have business and leadership skills, and can demonstrate relevant work experience, especially in their industry, and possess problem-solving skills and work well in a team-based environment
    - E.g. In Dayton, it is important to understand how government works in terms of contracts, timelines and security clearance.
3. Lack of connections between industry and higher education contributes to gap—addressing the gaps noted can begin with better data at state level on the nature of the gap, and creation of work experiences during college that employers help design and support

Understanding the Skill Needs Throughout the Commercialization Continuum

4. Invention Pulled by Market Forces—STEM workers are important (engineering, physics, modeling and simulation, and chemistry): Technical Feasibility—Engineers and Scientists are important; Develop Prototype—

workers need to understand production and product life cycles. Also need business and marketing skills; and Improve and Launch—Non-STEM skills become more important but they must understand the technology and how to work with customers.

5. The Possible 5th Stage of Commercialization (or Taking Production to Maximum Scale) By 2015, , based on a 2011 study by the Boston Consulting Group[17], U.S. companies producing for U.S. consumption are projected to reach a point of indifference between producing their products off-shore vs. on shore. This creates the future opportunity for Ohio early-stage commercial successes to continue producing for U.S. markets if industry and higher education can create the right mix of smart people working with smart machines to be price-competitive with off-shore sources.

Overall Strategic Suggestions from Industry Participants

- Call for Action for Higher Education—aggressively improve its role and responsibility to prepare students for gainful employment in Ohio; a college credential is not an end but means to career, employment, entrepreneurship, etc.
- Start ongoing collaboration of industry and higher education to work on closing the gaps and growing jobs that require STEM (and other) graduates prepared and motivated to work within the Continuum of Commercialization. One aspect of closing the gap is to have higher education become "demand facing," that is for all levels of higher education to recognize and respond to market needs for skills, education and training, and as demanded by employers.
- Begin now to greatly expand the pool of STEM workers and related career pathways. Promotion and awareness of STEM Careers, Commercialization and Entrepreneurship directed at youth and adult learners in order to grow the pool of interested students and job seekers

Collaboration is First Step

- Higher Education entities need to work together and not in competition with each other … make better use of valuable resources
- Start Now to Build Enduring Partnerships
  - Takes too long for higher education respond… this needs to change
  - There needs to be more conversation between industry and education to drive change more quickly

[17] The press release may be found at http://www.bcg.com/media/PressReleaseDetails.aspx?id=tcm:12-75973.

- Grow internship programs that connect colleges and industry and create more and better experiences

Promotion and Awareness on Careers linked to Commercialization

- Market to students the idea of careers in industry … put a greater focus on engaging young women in these career pathways
- Internships and Co-ops … need to sell younger students on 'the coolness' of such opportunities
- Get to the middle school students to help them understand education and that work can be fun. Also to communicate needs for classes in high school that are prerequisite for STEM training in college
- Students need to be shown it is cool and financially rewarding to be involved in manufacturing … a great way to make a living … need to get to students at younger ages
- Increase student exposure to business and industry leaders in the classrooms … more than just once a year …career nights … multiple visits throughout the year
- Students need opportunities to apply what they have learned … need to incorporate capstone projects and co-op opportunities for this to happen

Student-Centered Ideas

- Students need opportunities to apply what they have learned … need to incorporate capstone projects and co-op opportunities for this to happen
- More group projects for students that are laced with technology applications
- More hands-on learning for our students
- Industry to provide more internships and co-op opportunities for both students and professors

Faculty-Centered Ideas

- Incentivise faculty to re-vamp the delivery and content of instruction
- Encourage professors to take a sabbatical to become involved in business and industry
- Allow industry to shape and drive Adult Certification

More thorough summaries are available upon request.

III. Key Recommendations of Sub-Committee: Putting It All Together

Overall Conclusions on Which Recommendations are Based

Our research and industry forums confirm the importance of STEM and other occupations to Ohio's economic recovery generally and to advancing the pace of commercialization especially within the manufacturing and IT industries in the Six Sectors identified by the Battelle study.

Beyond this immediate strategy, Ohio's economy as a whole currently employs a mix of occupations in which knowledge of science, engineering and mathematics is not required. This helps explain why STEM jobs in Ohio lags the nation and many other states in percent of all jobs and future growth rates. The relatively lower demand for these technology workers, even in the Six Sectors for many STEM occupations, suggests that Ohio's standing as an industry technology center is based on metrics other than the strength of STEM and other technology workers.

The lack of demand for STEM workers, at least in part, accounts for the appearance that Ohio is producing a sufficient number of graduates annually based on expected job openings. However, national data reveals that only half of STEM graduates actual enter STEM jobs upon completion of college or university programs.

From the supply perspective, it is our view that Ohio faces a tremendous challenge in: 1) expanding the enrollment in STEM majors or minors over current levels of enrollment and completion; and 2) aligning the curriculum and experiential learning components of STEM education to better reflect the preparation that industry deems necessary to future commercialization and industry vitality.

If national data is correct, then Ohio industry demand for job growth from year to year far exceeds supply from higher education. The inference is that Ohio's colleges and universities need to <u>double</u> the number of 2 and 4-year degree holders, as well as those completing a credential, but not a degree. This does not include additional supply that will be needed if Ohio is successful in accelerating commercialization, which is the premise of this Task Force.

<u>Statewide analysis does not inform us about how these gaps exist on a regional basis, for example across Jobs Ohio regions</u>. At the regional level, these gaps

might be more or less pronounced, and might emphasize varying mixes of specific STEM occupations. Further research is required to determine unique regional differences.

That said, the industry forums identified important factors that form the basis for on-gong and deep discussions among industry and higher education about how to bring into closer alignment the outcomes envisioned for students entering STEM education and training to prepare them for what employers seek.

It is the Sub-Committee's view that improved alignment of demand and supply of STEM workers and other identified occupations or competencies, requires: 1) Increased collaboration between industry and higher education; 2) Enhanced ability of higher education to be more flexible and adaptive; 3) Assume greater responsibility for student success and career placement; and, finally, 4) Committed industry leadership to determine what more they need to do in order for higher education to be helpful to industry around meeting workforce needs.

Essentially, the following elements can yield significant results for Ohio—stronger partnerships between industry and higher education system that can: 1. Increase the in-flux of students and transitioning adults into STEM and other critical career paths, 2. Improve the responsiveness of career education to industry needs, and 3. Place more students into jobs that increases the relative numbers of STEM educated students and STEM jobs in Ohio's industry. Underlying the specific recommendations is a holistic approach to achieving the goal of greater alignment.

1. More and enhanced partnership between industry and higher education to address alignment of demand and supply of workforce needed to drive innovation, entrepreneurship and commercialization, especially the eight areas of technological opportunities in which the six industry sectors are prominent economic drivers of the Ohio economy.

2. Enhanced abilities of higher education to work with industry, public workforce system and others to

    - Build the pool of STEM and other career-focused youth and transitioning adults for college entry;
    - Prepare STEM and related programs that respond to industry needs and competencies used in hiring; and

- Connect industry internship and other work experiences and job opportunities with students in Ohio's higher education system.

3. Greatly enhanced student enrollment in STEM career education; improved retention and completion numbers and rates; and increased numbers and placement rates of students into gainful employment, especially within the six industry sectors and STEM or other occupations viewed by industry as vital to increasing the pace of commercialization in Ohio.

Specific Recommendations and Metrics[18]

Recommendations are organized under the headings: 1. Closing the Gap; 2. Aligning Skills and Competencies across the Commercialization Continuum; and 3. Ongoing Research and Data Needs

1. Closing the Numbers Gap—Increase Pipeline of STEM workers from Ohio colleges and universities by 10% per year for the next 10 years

Maryland has set a goal to increase the number of STEM graduates by 40% in five years. Their strategies includes aligning curriculum with industry needs; increasing numbers of internships, coops, STEM apprenticeships, research lab experiences, etc.

In Ohio, higher education needs to increase STEM graduates by 10% per year, just to catch up to the US average of STEM job growth. This may be a stretch goal but is a must if the goal of the Task Force is to be realized.

Metric: To reach the goal of 10% per year, we must

A. Ensure that OBOR and each institution has a strategic goal and plan focused on increased enrollment in STEM careers, retention and completion of higher educational credential, and connecting students with industry opportunities for internships and employment. The Board of Regents should require that all universities and colleges in Ohio establish their own metrics to meet this state goal, and to increase enrollment,

[18] Recommendations are based on the premise that time was limited and that the Sub-Committee likely will recommend that OBR and other state leaders continue to address research questions, address data needs and implement ongoing industry and higher education collaboration around aligning industry evolving needs with post-secondary career education programs.

prevent attrition, increase numbers of college graduates employed in STEM careers; and provide financial incentives to support both colleges and students that results in greater numbers of STEM enrollment and graduates.

- One way to incentivise students in career choice is to model a version of Ohio College Access Grants such that students with STEM majors and career interests receive larger grants.
- Colleges are actively committed to *transformational change directed at aligning their programs with in-demand occupations* and that they engage employers to address emerging, and changing needs, and that they need financial assistance to accomplish major changes. State competitive grants are a way to support workforce development priorities within the higher education system; funding workforce development is extremely hard due to budget constraints within the institution's academic operational budgeting processes. *Maryland estimates that the cost to meet their graduation goal is from $1 to $3 million annually.*
- Higher Education Certifications and Industry-endorsed Certifications for Un- and Under-Employed workers can be an effective way to quickly increase the supply of workers for STEM Employment; these programs can be completed 12 to 18 months or maybe less. No matter the educational attainment these workers already have, Ohio's 2- and 4-year colleges and universities have the ability to offer credit-bearing credentials that are tailored to prepare workers for start or re-start their career that lead to STEM employment. Working in collaboration with industry employers, Ohio's Adult Workforce Education Centers, and Ohio's public workforce system, they can create innovative stackable credentials that can meet employer qualifications. These workers can be recruited, assessed and advised on STEM career opportunities they can pursue with minimal time to completion of a postsecondary credential that has labor market value. For Ohio's 2-year system, **Certificates of Completion and Proficiency** are available for students who can complete a technical credential with 32 to 36 credit hours, often done in compressed time periods in which adults are together as cohorts and can access supplemental resources. This enables low to middle skill workers to move quickly into skilled and technician level employment, and continue to advance their education and career thereafter. At the university level, there is the **Certificate of Advanced Study** which can be used in a similar way to provide degreed workers (and about 1 in 4

dislocated worker has a college degree) Stackable Certificates that can lead to advancement or change of STEM job. These short-term, credit career education programs are more often, but not nearly enough, in the 2-year system. Given that the existing workforce in Ohio lags many states and the nation in educational attainment. OBR should work with its higher education institutions to pursue grants to support these workforce development-focused strategies. In a recent report, *Technology Generators in the Dayton Region*, prepared by the Dayton Development Council, the following recommendation is made: "Ohio's four-year universities have….connect with regional industry drivers…..policy should require them to also have workforce development strategies and hold them accountable to meet outcome measures.."[19] The Sub-Committee recommends that OBOR and the Office of Workforce Transformations do a thorough investigation of how to increase the pipeline of STEM credentials and employment in the next four years through strategies that use these stackable credentials available Ohio institutions.

B. Dramatically increase the number of work and research opportunities—experiential learning—for STEM students in conjunction with industry. This implies that industry needs to cooperate by creating a great deal more internships or provide Ohio students with improved access to ones they have; and STEM programs must increase capacity and ability to prepare and incent students to extend their time to completion to include these experiences; make room for academic credit within the already rigid curriculum requirements around structured learning.

It is important that students gain work experience through experiential learning at every level and at more than one juncture in their continued acquisition of higher education credentials, from completion of a credit credential, but no degree, to attainment of an associate degree, bachelor's degree and post-graduate training. It is important to note that length of work base learning experience has no effect on the successful transition into employment, and subsequent success on the job. Rather, it is the quality of the experience. A review of evaluation literature reveals: Quality short-term experiences such as service learning show career progress, satisfaction and gains in student learning. The outcomes associated with

[19] Frazier and Dockery, p 20.

experiential education are more closely tied to the overall quality of the experience verses the length of the experience. "Standards of Practice" include: intention, preparedness and planning, relevance and authenticity, reflection, orientation and training, feedback and continuous improvement, assessment and evaluation, and acknowledgement (celebration). Student experiences that adhere to these standards are shown to lead to increased gains in student learning, career progress and satisfaction.

In a 2000 study by National Association of Colleges and Employers examined the impact of internship/co-ops, or other form of work experience while a student to career progress and satisfaction among graduates of two and four year public and private institutions of higher education. The major determinate of impact is a work experience that is directly related to their field of study. This was true even for those students who had a work experience through a means other than a forma internship or coop[20].

- At the same time, length of these experiences did not impact: length of time to find a job; job satisfaction on the job; level of responsibility on the job; or speed to advancement. Conversely, it stands to reason that students with multiple quality experiential learning opportunities will fair equally if not better than their peers with one longer term work-based learning experience. It would also stand to reason that students with multiple experiences broaden their network base by exposure to numerous employer and professional associations.
- Introducing short quality internships early in student's program of student, followed by longer, perhaps even full time experiences later on is an approach used by some employers, such as Sherwin-Williams with IT students, as they prefer to hire from within the alumni pool of students with which they have good experiences.
- The key is to develop quality work base learning programs, no matter the length, and this takes adding capacity and professional on staff and faculty as well as employers that are new to offering internships, coops, or apprenticeship-type work experiences.
- The Sub-Committee recommends that OBR structure its new program funded by the casino licensing fees to support both the development of capacity and demonstrated, dramatic increased in STEM work base learning

[20] Kysor and Pierce, *Does Intern/Co-op Experience Translate into Career Progress and Satisfaction?*, Journal of Cooperative Education, Winter, 2000 pp 25 – 30.

opportunities that help student prepare for and connect with employer opportunities and requirements.

Metrics: Increase the number of Ohio's college and university STEM majors who do an internship or coop by 10% each year; and ensure that 75% of all STEM students have access to one of these opportunities.

C. OBR forms and supports Industry/higher education consortium that continue the work started with the skill panel design begun by the Sub-Committee. Industry is a critical partner to higher education if we are to meet this goal.

Rather than forming partnerships as statewide collaborations, we recommend organizing these boards within each of the Jobs Ohio Economic Regions and include all interested OBR institutions to participate with industry. The purpose is to form an action agenda that assists industry to define the emerging skills requirements along the most relevant STEM career pathways, and to assist the region's institutions to:

- ✓ Build a Greater Pipeline of interested students; to
- ✓ Design and Deliver Innovative Approaches to learning which includes increased use of experiential learning (especially internships and coops); and
- ✓ Develop connections that bring the student together with the employers around employment opportunities.

Each of these industry/higher education partnerships needs to have a major focus on the six sectors and eight areas of technology opportunities in order to help drive the overall recommendations of the Task Force.

The northeast Ohio RITE Board serves as one model of authentic and enduring engagement designed to address the needs for IT workers now and in the future. The INTER Alliance of Greater Cincinnati and others around the state are demonstrating the ability to measure progress on the three objectives above.

Metrics: Number of collaborations created and staffed by college or university with support of the Regents; Evidence of joint activities to increase high school grads and transitioning adults that elect to pursue

career opportunities in STEM; Track increased enrollment or percentage of enrollment with STEM majors; Evidence that industry partners impact design and revision of STEM programs including curriculum; Improved numbers of students placed with partner employers for internships and other learning experiences; Increase employment rates of Ohio completers into STEM career employment with partnering companies.

Establish metrics to monitor placement into gainful employment into industry workforce needs that were articulated to higher education. This area includes employment or entrepreneurship; sustaining and advancing with industry along a career pathway; increased earnings over time; returning to higher education (at request or support of current employer) for additional learning in the same or compatible area of career advancement; etc.

For employers, we need measures of improved satisfaction with the 'product of higher education' and reduced difficulty to fill key positions that are crucial to industry commercialization plans.

D. State of Ohio develops a STEM Career Resource Center that is online and provides resources to career advisors, faculty, students and job seekers and that focuses specifically on the priority needs of industry and most promising career opportunities for students.

- Create an online forum where professors and students can more easily interact with industry on research problems

An important aspect of increasing commercialization activities in Ohio universities is to encourage the development of connections partners. A way to accomplish this is to create a website where industry and academe can connect to discuss the research they are conducting and how each might be of assistance to one another. This website can be a place where industry and academe establish initial connections that lead to deeper and long-term relationships.

Metric: Online forum in place and advertised by December 2013.

E. OBR develops policy, provides administration and resources, and sets strategic priorities that enable Ohio colleges and universities to make

change and learn from proven approaches used within Ohio. The Bill and Melinda Gates Foundation is investing in Ohio currently by funding the cadre of three community colleges to create real institutional change that achieves a shift in focus for our students from access to completion. The Foundation's plan is to fund the state to scale up the promising results by engaging other colleges. This major investment in Ohio's higher education system promises significant returns and certainly can be connected with state priorities to increase the numbers and pace to completion of STEM majors throughout Ohio.

Metric: OBR and OACC convene annual forum to provide all 2 year institutions to learn from the Ohio Cadre and MDRC, as evaluator, of promising practices and approaches, as well as what hasn't worked, create a clearinghouse to promote sharing, and establish Ohio priorities for how to use these strategies to increase STEM pipeline of students that meet employer expectations. Deadline for set of policies and recommendations is June 2014.

2. Aligning Skills and Competencies Across the Commercialization Continuum

A. Align Education and Workforce Development Priorities of OBR with Other State Economic Development Programs, including 3rd Frontier

- <u>OBOR should encourage and assist colleges and universities to create or borrow curriculum on Entrepreneurship for students in STEM disciplines</u>**.** Participants in the Workforce Subcommittee public forums believed that students needed a broad range of skills throughout the Commercialization Continuum. Many responses stressed that students needed to "cross-pollinate" between the disciplines. In order to accomplish this goal, students in STEM disciplines should be encouraged and allowed to take courses designed through the cooperation of business schools, technology transfer offices and STEM departments on entrepreneurship in the university setting. Establishing a course to illuminate early in their educational program that helps students gain knowledge and skills beyond the lab bench.

  <u>Metric:</u> Internet portal for sharing curriculum is operative and an outreach / marketing campaign is underway by Dec 2013

- Create partnership between OBR and 3rd Frontier to create internships and coops within 3rd Frontier companies receiving grant assistance with STEM, entrepreneurship and business students to create strong, first-hand work experience while they are students that will be valued by future employers. ODOD should require recipient companies to supply experiential learning opportunities for students in exchange for financial assistance; this is a proven component of the highly successful Innovation Fund housed at Lorain County Community College Foundation which is supported by the 3rd Frontier program.

  Metric: Programs in place at over 90% of Third Frontier companies by December 2014

- Financially subsidize start-up companies in their use of Ohio's college and university students as interns and coops, or part time employees.

  Although many larger companies have vast funds to pay interns, smaller companies who might offer students more mentorship and learning experiences find that it makes little economic sense to host interns. This problem is especially acute with start-up companies, ventures not yet flourishing and other small companies who use graduate students as interns. One respondent at the public forums who has started several biotechnology companies noted that it makes little economic sense for him to host graduate students because they will take the training the receive at his companies and upon graduation migrate to larger companies in the sector.

  Initial goal: Proposal for this program presented to OBOR & ODOD by December 2012.

B. Work with industry to create short-term exchanges for interested professors**.** Much of the conversation in the public forums centered on the need to make STEM courses more attuned to practical problems and less theoretical. For professors who have stayed in academe and have little, or dated experience in industry, crafting classes geared to more "real-world" problems is challenging. In order to address this disconnect, the Board of Regents' should encourage colleges and universities to establish programs to allow faculty to visit companies for several weeks, most likely while

school is not in session; in addition, a formal sabbatical in which faculty can work on temporary assignment with participating companies could be given preference in awarding sabbaticals. Attendees at the public forums also noted that this type of program should not be limited to STEM disciplines as more professors should be able to explain how the subject and skills they teach in a certain course mirror the knowledge and abilities students will need in the workplace.

Initial goal: Proposal for this program presented to OBOR & Industry Partners by December 2012.

C. Include a 5th Stage of Commercialization designed to keep production to meet market growth within Ohio whenever possible. This would allow a number of critical outcomes to Commercialization in Ohio.

- First would be to provide employment opportunities to a wider array of Ohio's workforce, including production workers. Markusen[21] looked at product and profit cycles and her stages. "Superprofit" (stage II) and "Normal Profit" (III) both are contained within Stage 5. As the product moves from stage II to stage III, engineering/technical employment moves from a high share to a moderate share, while skilled production workers move from moderate to high. It may be argued that since this work was produced in 1985, that production workers have necessarily taken on higher levels of technology to remain globally competitive. Once example of this is two Ohio cities winning the global competition to produce Ford's most advanced engine, the EcoBoost.[22]. This creates an opportunity for those either not qualified or not interested in being direct STEM workers, but rather can use and apply technology within the production process—smart workers and smart machines equal higher productivity and global competitiveness.
- With production comes backward linkages and supply chains. This creates not only additional employment opportunities, but also creates opportunities for innovation and anchoring the firm(s) in a new industry to the region. In Markusen's work on profit cycles, as competition increases and profits move to the more normal range, firms will tend to seek low cost production locations. By being early in the innovation

[21] Ann Roell Markusen. *Profit Cycles, Oligopoly and Regional Development*. The MIT Press, Cambridge MA, 1985.
[22] http://media.ford.com/article_display.cfm?article_id=30386

cycle, access to a flexible workforce anchors, along with suppliers, the firms and the industries to the region.

- Using the cluster approach from Michael Porter and the notion of competition among firms in an industry, a region with comparative advantage will benefit from localized agglomeration economies with both specialized labor and backward or forward linkages. But having the industry product produced in Ohio, there will be the "chemistry" for additional product innovation and reinvention. Individuals in firms will see both process and product improvements and innovations that will help the industry remain competitive.
- Finally, production will attract investment in buildings and other capital from domestic and international sources. A press release[23] in 2011 from the City of Akron outlines the growth of a biomedical innovation company, FMI. FMI's product is a diagnostic imaging device, with FMI's headquarters and production facilities located in Akron. The 150,000 square foot facility will house 50,000 sq ft of research and development and 100,000 ft sq of manufacturing space. The development of the facility was made possible with financing made available from the Chinese in a relationship forged between the City of Akron and China.

3. Ongoing Research Needs

A. Expand the data analysis started by this investigation to more thoroughly document the STEM gap within Ohio by building comparative analysis for all Jobs Ohio regions. This should include the industry demand and the supply of matching STEM completers from the 2 and 4 year institutions within each region.

Metric: OBR sets date of June 30, 2012 for this work to be complete; updated annually using statistical estimation; plus analysis of hiring needs based on Ohio Means Jobs real-time job posting system

B. Inform STEM workforce policy and practice using the new Data Quality Elements database that links education and workforce data.

As documented in Carnevale's seminal work, nationally only about half of all STEM education completers at every level directly enter STEM

[23] http://ci.akron.oh.us/news_releases/Display.asp?RecNum=459

occupations, even given the higher pay scales that STEM jobs typically pay. These students have options and many are following their immediate career goal in other occupation areas of professional and technical work. Ohio needs to have better data on career and job placement choices being made by Ohio completers, STEM and non-STEM. This is needed if we are to work closely with industry to prepare students who at the end of their education will be interested in the jobs our industry partners have. The ability to track our students into employment choice and gain insight into those choices will help career and academic advisors work with incoming students to work on career and educational choices. A new Data Quality initiative may be just the tool needed.

Ohio has made great progress in linking education data to workforce data. Ohio now has the capacity to empower stakeholders to use data to inform decisions to improve student achievement.

For example, a student's experience can be followed into the workforce, where analysis of industry worked in and quarterly pay can be examined. By linking education and workforce data, the State increases its ability to answer new questions, and in this case, Ohio can answer questions about students in STEM fields.

- How does participation in advanced curricular options, e.g., honors, dual credit, and Advanced Placement (AP), in high school affect postsecondary student success and retention in the STEM fields?
- How do course-taking patterns differ for students who successfully complete STEM degrees from those who change their majors to non-STEM fields?
- What is the common education pathway for students who graduate from STEM disciplines--analyzing a student from a two-year to a four year institution, and from an associate's degree, to bachelor's, to master's, and to PhD's?
- How are employment patterns, earnings and employment stability different for different types of STEM graduates and for STEM graduates at different levels of graduation credentials?
- Which institutions' STEM graduates are having the greatest success in the market place? What can we determine through additional analysis that will enlighten us about the role of the institution in contributing to that success?

These linked data systems can help policymakers and educators determine how to promote STEM student attraction, retention, and graduation. They can also help determine which industries and companies STEM students are being hired into and the size of those companies. The size and types of companies can give insight into the type of student preparation that is most efficacious.

Metrics: OBR and the Office of Workforce Transformation collaborate on designing a research program designed to begin to provide answers to questions that will be posed by the continued work recommended throughout this section; Increase percent of STEM graduates that are employed in STEM occupations within Ohio.

IV. Implementation Strategies & Resource Requirements

To better align Ohio's higher education system with the emerging needs for workers, and the new competencies and attributes that will be needed…to support Ohio economic recovery and growth through increased commercialization, specifically within the eight areas of technology opportunity in related industry sectors.

While OBR should be the lead state agency responsible for developing an implementation plan for these recommendations, it is equally important for the Governor to continue to use his personal leadership to bear on forging the industry/ higher education partnerships needed to close the gaps that exist and to further anticipate changing workforce needs in an Ohio economy in which commercialization is increasingly important source of economic growth. It is equally important to share these recommendations with the new Ohio Office of Workforce Transformations. Major changes are being discussed for Ohio's public workforce system which is the other major source of state and federal investments crucial to successful implementation of many of the recommendations contained in this white paper.

The Governor and Chancellor need to be vocal about what all partners, higher education, industry and pubic workforce systems alike, need to do if the goal of alignment is to be achieved, and if Ohio is regain its economic prominence.

V. Metrics

Long term progress in building relationships and action plans are a necessary condition for sustained and scalable outcomes for students and employers that can be seen in measurable reductions in the skills gap.

Specific Recommendations:
These are contained at the end of each recommendation in section III.

VI. Post Script

The timeline for the work of Sub Committees was compressed and the recommendations on workforce are not as well-developed as members would prefer. More work needs to be done and the members of the Workforce Sub-Committee make one closing recommendation: that OBR schedule a short series of working sessions in which our group engage with leadership of OBR and others at the state level to further refine these recommendations contained in this document to agree on specific metrics—deliverables and outcome measures—and an action agenda that begins later this spring.

Technology Transfer in Ohio

A White Paper by the Technology Transfer Officer's Council

Technology Transfer often finds itself in a difficult position inside the universities and research hospitals of Ohio ("Ohio Schools"). The commercialization aspect of Technology Transfer often runs counter to the main mission of the University, which is educating students and knowledge dissemination. Additionally, while faculty members at many Ohio Schools participate in Technology Transfer activities, such participation is not part of the criteria on which their performance is graded. Finally, there is a perception that given the vast amount of dollars poured into research that university Technology Transfer is deficient in transferring technology to industry. Although Technology Transfer at Ohio Schools is not deficient, it could be improved greatly with some changes in the business model and inputs from State and Local Government and the universities themselves.

Defining Commercialization

First, it is critically important to define what the commercialization process is. The most common and reasonable definition would include the following six steps

1. Creation of intellectual property ("Creation")
2. Protection of the intellectual property ("Protection")
3. Marketing of the intellectual property ("Marketing")
4. Licensing of the intellectual property ("Licensing")
5. Manufacturing a product based on the license ("Manufacturing")
6. Sale of the technology covered by the license ("Sales")

It is very important for the public, including the State and Local Governments, to realize that Technology Transfer Offices often only have direct control of Protection, Marketing and Licensing. And even though a Technology Transfer Office may have direct control of these factors, there are a number of constraints on an office such as politics, budget, and resources. While commercialization is usually the ultimate goal, too often the focus is on only Creation, Protection, Marketing and Licensing. Not only are the Manufacturing and Sales steps just as important, but they are far harder to achieve. Those two steps can often embody a significant part of what is commonly referred to as the "valley of death." The "valley of death" is the arduous terrain between proof of concept and the beginning of mass production and significant sales. This is where many promising ideas fail. As mentioned before, most Ohio Schools do not

have staff or mechanisms available to help with these two steps. Moreover, most Technology Transfer Offices in Ohio are not responsible for those steps per their institution. Often, the public looks upon university Technology Transfer to grow commercialization, when really the focus should be primarily on Protection, Marketing and Licensing.

Steps State and Local Government Can Take To Encourage Ohio Schools To Grow the Commercialization Process.

Universities and research hospitals in Ohio have a wealth of intellectual property. What they usually lack are business partners. These business partners are usually either licensees or start-up companies, that take the university generated intellectual property and flesh out Manufacturing and Sales. State and Local Government could provide incentives to attract start-up companies and entrepreneurs to engage universities in licenses and start-up companies. These groups would inevitably drive deal-flow, which in turn would drive the Manufacturing and Sales that Technology Transfer Offices cannot directly control. Incentives to manufacture technology and intellectual property developed at Ohio Schools would drive those critically important factors and help ultimately with the commercialization process. Such incentives could be in the form of tax breaks, support of incubator and accelerator programs, and increasing the availability of direct funding for these business partners.

There are also steps that State and Local governments can take that would directly help the Ohio Schools with the commercialization process. Most importantly would be providing incentives and funding to help universities develop the seeds of intellectual property with commercial potential. Large federal grants are excellent at providing the funding resources to develop commercially viable intellectual property. Unfortunately, too often faculty members in our universities find themselves early in their careers without the resources to do the work required for the data to apply for the large Federal grants. A program similar to the old Research Incentive Fund would allow universities to issue small awards to faculty members early in their career. These awards would allow these faculty members to acquire data and expand basic concepts enough to make winning a Federal grant possible. These large Federal grants are absolutely essential to Ohio Technology Transfer. The former Research Incentive Fund, now called the Technology Validation and Start-up Fund, is now for nearer-term intellectual property. And this leaves some Ohio Schools with a large void for basic intellectual property creation. Funding nearer-term intellectual property is an excellent and needed idea, but without funding for basic intellectual property creation, there will soon be a problem of schools not having a vibrant intellectual property portfolio. Furthermore, the large Federal Grants have many implications to Ohio Schools beyond just intellectual property creation. They are a large source of funding for Ohio Schools, jobs for Ohioans, prestige of our Ohio Schools,

attraction and retention of faculty, and education of our Ohio students. Even though near-term intellectual property funding is important, basic intellectual property funding is even more critical.

Most university research is supported by basic research grants and is conducted at the other end of the commercialization spectrum. Basic research does not often result in a direct commercial application; rather it provides a foundation for the development of technology with potential application to a genuine commercial market. Faculty members working on projects are often unaware of the commercial potential of discoveries from their laboratories. Although most universities take aggressive steps to identify commercializable technology from university research, there is limited public funding to cover the expenses associated with commercializing basic research, especially when commercialization is the primary aim of the research. This leaves promising technology unfunded in the gap between funds for basic research and funds for commercially viable technology. A proof-of-principle/prototype/technology maturation fund would serve the technological entrepreneur whose basic research produces a promising new concept but whose funding does not support efforts to commercialize the technology. The availability of funds for commercializing basic research will create an incentive for researchers to develop these commercially applicable concepts, resulting in an increase in invention disclosures from university researchers, which should translate into additional license agreements and start-up opportunities. While the recent, TVSF program through the Ohio Department of Development is a move in the right direction, most technology transfer offices would benefit significantly by having resources to immediately deploy.

Steps the Ohio Schools Can Take To Grow Technology Commercialization

While help from our State and Local Governments would be essential in growing the commercialization of intellectual property developed in Ohio, there are many things the individual universities can do to grow the process as well. First, would be a commitment by the Technology Transfer Offices to engage business the way they want to be engaged. That is not to say that many offices do not already do a great job in this endeavor, but there is the perception by business that Technology Transfer Offices in general behave like academics with respect to business. Remembering that perception is reality, Technology Transfer Offices have to engage business on their terms. At its heart, a licensing function is essentially sales. Keeping that in mind, our potential licensees are customers and have to be treated as such. In any negotiation, the side that is paying has the leverage, unless there is monopoly situation. And technology transfer in most cases is the opposite of a monopoly situation. Most businesses have a myriad of opportunities for their dollars. So we as Technology Transfer offices have to be aware that we are competing for the time resources of the business, not the other way

around. We must lower their transaction costs, and we can do this by meeting their timetables. The business world moves a bit faster than the academic one, so we must always be cognizant that the amount of time we take in responding to requests is very carefully scrutinized. Even response times that would be considered normal in other contexts may be seen as too long because of the association with academia. We must err on the side of expediency to change the perception that we are hard to work with.

Second would be formal realization that we are primarily a business function. What this means is that the other activities of Technology Transfer Office, such as evaluating technology and agreement support, while necessary, should take a backseat to deal development. That coupled with ensuring deal development has to be done on the terms of the party bringing the money to the table, should drive deal flow and ultimately, commercialization. Oftentimes it is easy to get bogged down in the safety of complex agreements and traditional deal structures. It is important to drive deal flow in any way possible, and that includes making the contracts, as well as the contracting process as easy as possible for a prospective licensee.

Because there is a perception that Tech Transfer Offices in Ohio are not already committed to these ideals; we as Technology Transfer officers are committed to work harder in these areas to ensure the perception changes. What we are currently doing may be adequate, but it is not yet enough to change the public perception. In our view there is unfair criticism levied on Technology Transfer. However we as technology Transfer Officers are committed to careful reflection and ensuring that we are ultimately driving commercialization on business terms. In doing so, we will do everything in our power to make the public perception of our Offices a positive one.

Many universities in Ohio have done an excellent job in implementing some of these concepts. For example those Ohio Schools which are represented by Research Foundations and Institutes are able to interact with the business community on terms that are a little more business friendly, and a little removed from academia. Through the Technology Transfer Officer's Council we are able to share best practices among the Ohio Schools.

Support the Ohio Schools Need From Senior Management to Grow Commercialization

There seems to be a disconnect with what the State and Local Governments want from Ohio Technology Transfer and what the administration of the Ohio Schools set as performance metrics for Technology Transfer Offices. Many Technology Transfer Offices are only given the support and resources to do the basics of technology transfer (i.e. Protection, Marketing and Licensing). It is unrealistic given the support that these offices receive to expect them to take on the full commercialization chain of Creation, Protection, Marketing, Licensing,

Manufacturing and Sales. In these times of very constrained resources, some offices find it difficult to meet the basic requirements of university policy and federal law. That leaves precious little time to do the necessary things that would successfully grow a business unit. Licensing is built around personal relationships and networks, universities should make it a priority to supply Technology Transfer Offices with the resources to grow and foster these networks. Too often "mission creep" takes us away from our central purpose – licensing technologies and growing the commercialization chain.

It is therefore requested of administration to fund and staff these offices at a level that allows them time to grow their function. Furthermore, it is requested that the Technology Transfer Offices' metrics reflect the realities of commercialization and the State's goals. Often the metrics chosen are those that are easy to measure, but not necessarily what needs to be measured. For example, too often the emphasis is revenue. While critically important, revenue sometimes reflects luck, and not effort. It is suggested that along with revenue and deal-flow, metrics are developed that measure the use of an IP portfolio, IP portfolio management, and business contacts.

Summary

In summary, the most important things the State and Local Governments can do to help grow technology commercialization in Ohio is give incentives for business to license university technology, while providing incentives to venture capitalists and start-up companies to locate and grow in Ohio. Of equal importance are highly qualified and well-funded researchers with excellent support infrastructure, as well as funding mechanisms for these researchers to generate basic intellectual property and prove concepts of new ideas.

The Ohio Schools would be well-served to make sure they are operating at the speed of business, and not at the speed of academia. Additionally, Ohio Schools must continue to improve relationships with the business community and do what is necessary to change the negative perception around working with Ohio Technology Transfer Offices.

Sincerely,

Matt Willenbrink

President, Technology Transfer Officer's Council

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