White Paper

A SMALL BUSINESS MODEL FOR FACILITATING PARTNERSHIPS IN THE INNOVATION ECOSYSTEM

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INTRODUCTION

Recent reports by the National Academy of Sciences[1] and the Office of Science and Technology Policy[2] as well as America COMPETES (Creating Opportunities To Meaningfully Promote Excellence In Technology, Education, And Science) legislation[3] identify and address the need for the U.S. government to promote and enhance technological innovation in order to maintain our national security and standard of living in a global economy. In our innovation-starved landscape where companies are supporting less research and development, the government plays a critical role in stimulating economic development via technological innovation with sponsored research and development.

Even though companies are conducting less internal research and development, the need for innovation has not subsided. Chesbrough[4] reports that companies are successfully looking outside their traditional internal R&D organization for new sources of innovation, so called "open innovation". As subsequently clarified by Chesbrough[5]

> *"Open innovation does not mean outsourcing R&D, nor does it mean closing down internal R&D. (Rather) It is a strategy of finding and bringing in new ideas that are complementary to existing R&D projects."*

A nation's ability to innovate is directly correlated to a nation's ability to create new knowledge through discovery research. Geoffrey Nicholson, champion of the 3M "Post-It-Note"[6], has simply and elegantly articulated the relationship between the processes of discovery research and innovation as,

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[1] Rising Above the Gathering Storm: Energizing and Employing America for a Brighter economic Future, National Academies Press (2005).
[2] American Competitiveness Initiative (ACI), Domestic Policy Council, Office of Science and Technology Policy, February 2006.
[3] America COMPETES Act (ACA), Public Law 110-69, http://science.house.gov 2007.
[4] Henry W. Chesbrough, Open Innovation: The New Imperative for Creating and Profiting from Technology, Harvard Business School Press (2003).
[5] Henry W. Chesbrough, Open Business Models: How to Thrive in the New Innovation Landscape, Harvard Business School Press (2006).
[6] www.zoominfo.com/people/Nicholson_Geoffrey_759064.aspx

"Research is the transformation of money into knowledge. Innovation is the transformation of knowledge into money."

To paraphrase,

1. Discovery research is the process whereby private or government investment in the form of dollars is used to generate knowledge.
2. Innovation is the process whereby knowledge is used to generate dollars in the commercial market.

Generally, as noted above, I think of innovation in terms of commercial markets. However, it is important to note that commercial markets have a component where the government is the primary customer. For this paper, I refer to this as a government market. Consequently, by extension to government markets, innovation is the process whereby knowledge is used to generate deployable technologies for government critical missions.

Whether for a commercial or government market, the key challenge within the discovery research-to-innovation paradigm is that the knowledge derived from the discovery research process is not in the form of the knowledge required as input to the innovation process. I refer the knowledge required for innovation as knowledge "ready for innovation" and I assess "readiness" in terms of:

1. Engineering Readiness,
2. Manufacturing Readiness, and
3. Intellectual Property Protection Readiness.

Some government agencies use a valuable rubric for assessing technology readiness level (TRL)[7] and manufacturing readiness level (MRL)[8] of emerging technologies. Although these tools were developed for government assessment, primarily DoD and NASA, I find them extremely valuable in developing technology trajectories for assessing technology for the both the commercial and government sectors.

Within this framework of market identification and readiness for innovation, I discuss the role of technology-based small businesses in facilitating partnerships between universities, small businesses, large companies and government, i.e. the innovation ecosystem. With universities, I generally include federal laboratories engaged in knowledge generation through discovery research and development activities. By company, I mean large corporations with commercial market channels or DoD prime contractors supplying to government markets. By small businesses I use the Small Business Administration size standard and include those small businesses engaged in research and development activities. Not only do I conclude that small businesses are uniquely positioned to contribute to the innovation ecosystem; I suggest they are a critical component to the innovation ecosystem. Finally, I present a paradigm for a university-

[7] Technology Readiness Level Definitions and Calculator, www.dtic.mil/ndia/2003systems/nolte.ppt
[8] MRL Assist Tool Website, www.mrlassist.bmpcoe.org/About_MRL/MRL_Assist_charts_DMC_2006.ppt

small business-large company innovation continuum aligning the strengths and goals for each organization resulting in a win-win for all.

THE CASE FOR SMALL BUSINESSES

Recently, the employment preferences of scientists and engineers seem to be shifting towards small businesses.[9] Small, technology oriented businesses employ more scientists/engineers (36%) than large companies (32%), universities (19%) or government facilities (13%).[10] Presumably correlated to the demand by small businesses for scientists and engineers, another study concluded that small business innovation is more closely linked to scientific research and more leading edge relative to large companies where the advancements are more incremental.[11] Furthermore, small technology orientated businesses produce 41% of U.S. patents and about fourteen times more patents per employee than large companies.[11] Small business patents are more highly cited than large company patents and are two times more likely to be in the top 1% of most cited patents than large company patents. An important source of funding for small technology oriented businesses is the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs.[12]

SBIR/STTR FUNDED SMALL BUSINESSES

SBIR/STTR legislation requires that Federal agencies with extramural R&D budgets spend approximately 3% of their R&D budget on SBIR/STTR projects with small businesses. The SBIR/STTR funding model consists of three phases. Phase I is a limited research effort in time and scope (nominally six months/$100K) to establish feasibility of innovative technical ideas. Phase II is a more extensive (nominally two years/$750,000K) research and development effort directed towards prototype and pre-production activities. Phase III is funded by non-SBIR/STTR monies and is directed towards product or process insertion into a commercial market or technology transition to the Federal sector. SBIR projects do not require university participation while STTR projects require at least 30% of the funds to go to a university or federally funded laboratory partner. (Recall from above, I generally consider federally funded laboratories as analogous to universities from the standpoint of knowledge generation.)

The award rate for Phase I awards is approximately one award for every ten proposals. The award rate for Phase II awards is approximately one award for every three proposals. Consequently, the “gated” design of the program reduces technical risk as a project proceeds from Phase I to Phase II and is ideally aligned with the need of large companies to mitigate or minimize risk associated with new product or process research and development.

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[9] Fred Block and Matthew Keller, “Where Do Innovations Come From? Transformations in the U.S. National Innovation System, 1970-2006” The Information Technology & Innovation Foundation, July 2008.

[10] NSF Science Indicators, 2005.

[11] Small Serial Innovators: The Small Firm Contribution to Technical Change, CHI Research, Inc. SBAHQ-01-C-0149 contract, February 27, 2003.

[12] U.S. Small Business Administration, Office of technology, http://www.sba.gov/SBIR

Since the program was established in 1980, there have been approximately 76,000 and 29,000 Phase I and Phase II awards, respectively, to approximately 17,000 small businesses.[13] Approximately 1,750 SBIR/STTR businesses have received venture capital funding, approximately 650 "went" public, approximately 1,100 were involved in M&A transactions, and approximately 85,000 patents were issued to SBIR/STTR businesses. As an indicator of innovative activities, small businesses with SBIR/STTR funds consistently account for about 25% of R&D 100 awards. The total value of Phase I and Phase II SBIR/STTR funding in FY2008 is approximately $2.3 billion and currently, there are approximately 6,500 small businesses with SBIR and/or STTR funding. Clearly, technology oriented small businesses are positioned to have a substantial impact on the innovation ecosystem.

BAYH-DOLE PREFERENCE FOR AND DIFFERENTIATION OF SMALL BUSINESSES

Congress enacted the Bayh-Dole act to facilitate collaboration within the government-university-small business-company innovation ecosystem and promote utilization of patented inventions derived from federally sponsored research and development.[14] (Note, I will subsequently refer to those patented inventions derived from federally supported research and development as Bayh-Dole patented inventions.) While many erroneously stipulate that Bayh-Dole requires that inventions derived from federally sponsored research be patented, Bayh-Dole simply requires that the subject inventions be reported or disclosed. Consequently, universities need to balance the decision to file patents on Bayh-Dole inventions with their mission to educate students and disseminate knowledge. Further, as discussed below, a university decision to file for patents related to Bayh-Dole inventions may be at the expense of industrial sponsored research monies.

Most generally refer to Bayh-Dole in the context of government sponsored university research and development activities. However, as noted above, Bayh-Dole is equally directed towards government sponsored research and development activities at small businesses. In fact, Bayh-Dole actively promotes university-small business linkages by requiring that universities give first preference to small businesses when granting licenses to university derived Bayh-Dole patented inventions.[15]

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[13] Data from Inknowvation, www.Inknowvation.com

[14] Public Law 96-517, amended November 1, 2000; 35 U.S.C. §200 "It is the policy and objective of the Congress to use the patent system to promote the utilization of inventions arising from federally supported research or development; to encourage maximum participation of small business firms in federally supported research and development efforts; to promote collaboration between commercial concerns and nonprofit organizations, including universities; to ensure that inventions made by nonprofit organizations and small business firms are used in a manner to promote free competition and enterprise without unduly encumbering future research and discovery; to promote the commercialization and public availability of inventions made in the United States by United States company and labor; to ensure that the Government obtains sufficient rights in federally supported inventions to meet the needs of the Government and protect the public against nonuse or unreasonable use of inventions; and to minimize the costs of administering policies in this area."

[15] Public Law 96-517, amended November 1, 2000; 35 U.S.C. §209(c) "First preference for the granting of any exclusive or partially exclusive licenses … shall be given to small business firms having equal or

However, Bayh-Dole makes an important distinction between universities and small businesses regarding the disposition of their respective Bayh-Dole patented inventions. Namely, small businesses may either license (i.e. exclusively or nonexclusively) or assign (i.e. sell) their Bayh-Dole patented inventions. By contrast, universities may only license (i.e. exclusively or nonexclusively) their Bayh-Dole patented inventions.[16]

At first glance, the difference between an exclusive license of a patent and ownership of the subject patent may appear *de minimis*. However, this distinction can be critical to the company desiring rights to the patented technology. Specifically, during an infringement proceeding at the Court of Appeals for the Federal Circuit, only the owner (i.e. assignee) has standing. Consequently, if a company simply desires "freedom to operate" regarding the patented technology, an exclusive or nonexclusive license of the patented technology may be adequate to protect its interests. However, if a company desires the competitive advantage associated with a patented technology, ownership of the patented technology is likely required to protect its interests. Consequently, regarding Bayh-Dole patented inventions, companies that require the competitive advantage associated with ownership should naturally gravitate to partnerships with small businesses.

Recently, Chesbrough has analyzed transfer of patent ownership or patent reassignments as evidence of a "secondary market for innovation", i.e. open innovation. Specifically, he analyzed patents issued in the seventeen years prior to 1980 and 2003. The seventeen-year time period roughly represents the legal term of enforcement for the patents. Chesbrough reports that for patents issued in 1980 and seventeen years prior, less than 0.1 percent of were reassigned. However, for patents issued in 2003 and seventeen years prior, approximately 4 percent were reassigned. Based on trend analysis, Chesbrough estimates that a patent issued in 2003 has a 25 percent chance of being reassigned during its pendency.[5] Small businesses with their unique ability to reassign Bayh-Dole patented inventions are playing and will continue to play an important role in the innovation ecosystem.

However, the critical role of small businesses in the innovation ecosystem is not at the exclusion of universities, rather small businesses need collaborative partnerships with universities. I would further suggest that the small business-university collaboration within the innovation ecosystem is actually symbiotic.

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greater likelihood as other applicants to bring the invention to practical application within a reasonable time."

[16] Public Law 96-517, amended November 1, 2000; 35 U.S.C. §202(c)(7) "In the case of a nonprofit organization[Bayh-Dole defines nonprofit organization to include universities], (A) a prohibition upon the assignment of rights to a subject invention in the United States without the approval of the Federal agency, except where such assignment is made to an organization which has as one of its primary functions the management of inventions (provided that such assignee shall be subject to the same provisions as the contractor)"

A SMALL BUSINESS PARADIGM WITHIN THE INNOVATION ECOSYSTEM

Universities often think of small business partners in terms of start-ups and spinouts formed by professors and/or graduate students. Companies often think of small business "partners" as acquisition targets for their innovative technologies. However, as recently noted by Dr. Kesh Narayanan (Director NSF Division of Industrial Innovation and Partnerships)[17], there are a large number of established small businesses with substantial research, development and engineering capability. These established small businesses act as technology transfer agents by demonstrating engineering and manufacturing readiness levels relevant to commercial and government markets as well as positioning the appropriate intellectual property protection. Furthermore, these established small businesses have a distinct advantage relative to university start-ups/spinouts in that they have developed critical business support functions such as human relations, accounting, and payroll. Research sponsored by the Small Business Administration (SBA) indicates that while these highly innovative businesses are on average younger than large companies, they are not start-ups. Additionally, many of these established small businesses participate in the SBIR/STTR program. These established small businesses are an important, albeit often overlooked, part of the nation's innovation ecosystem.

A model and rationale for a government-small business-university-company paradigm within the innovation ecosystem is presented in Figure 1. (Note, I consider federally

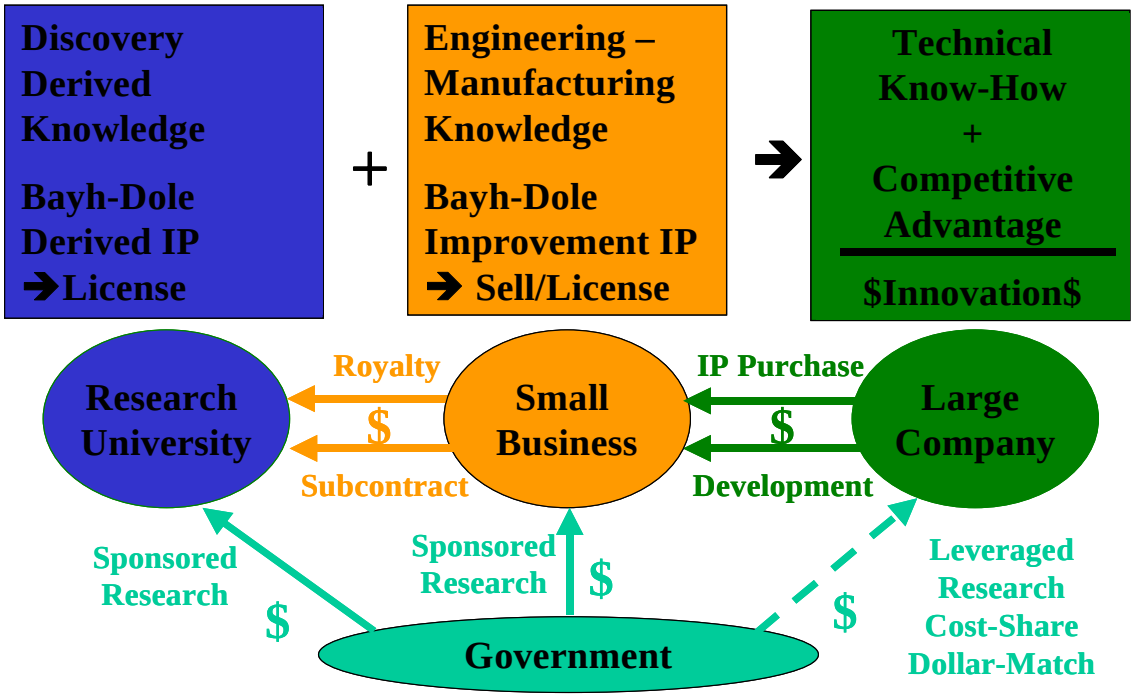

Figure 1. Innovation Ecosystem.

[17] DR. Kesh Narayanan, UIDP Workshop "Investigating the Discovery-To-Innovation Process" The National Academies Beckman Center, Irvine, CA July 27 – 29, 2008. (http://www.uidp.org/Kesh_Narayanan_DI.pdf)

funded laboratories as analogous to universities from the standpoint of knowledge generation.) This paradigm "transforms government investment dollars into knowledge and knowledge into large dollars in the marketplace" by aligning the interests of universities, small businesses, large companies and government. The flow of funding, technology and intellectual property rights via partnerships results in a win-win arrangement for all parties.

Government provides research and development funding directly to universities and small businesses. Companies benefit indirectly from government sponsored research at universities via cost-share and memberships to technology focused university centers. Additionally, companies benefit indirectly from government sponsored research at small businesses via dollar-match to small businesses resulting in leveraged government research and development funding and funding enhancements. In addition, the small businesses often subcontract to universities for basic discovery research activities resulting in additional sponsored research for the university.

From the technology perspective, the university focuses on discovery research leading to new knowledge and/or knowledge enhancements. The small business focuses on taking the university-derived knowledge and making it "ready for innovation" by engineering pre-production processes and prototype products for manufacturing validation. Companies focus on acquiring the technical know-how in order to insert the new processes into production or the new products into existing market channels.

From the intellectual property rights perspective, universities and small businesses are both governed by Bayh-Dole legislation. However, universities may only license their Bayh-Dole patented inventions while small businesses may either license or sell their Bayh-Dole patented inventions. The university desires to receive a reasonable royalty for its patented inventions. However, the university does not want to jeopardize its opportunity for sponsored research, which is considerably higher than royalty revenues. For example, for MIT, license income in 2001 was less than 2% of its sponsored research income.[18] Additionally, universities, in particular public universities, cannot be bound by the publication restrictions often required by large companies in order to maintain patent protection. The small business desires reasonable consideration for its Bayh-Dole patented inventions and know-how and respects the need for restriction of publication. Companies want the competitive advantage associated with ownership, i.e. assignment of patents. So in this model, the university provides "freedom to operate" regarding its Bayh-Dole patented inventions in the form of an exclusive or nonexclusive license to the small business. The small business provides competitive advantage of its Bayh-Dole patented inventions via assignment to companies. These patents are related to the university-broad-based patents as improvement or workability patents but nonetheless impart the critical competitive advantage needed by the company strategic partner.

As depicted, the model is rich in partnerships between small businesses and universities and small businesses and companies. Legislation recently enacted promotes the formation

[18] J. Strother Moore, CRA Snowbird Conference, July 15, 2002.
(http://www.cra.org/Activities/snowbird/2002/slides/ip-talk.pdf)

of such collaborative research and development partnerships. Specifically, in 2004, President Bush signed into law the Cooperative Research and Technology Enhancement (CREATE) Act to encourage joint research among inventors in separate research organizations.[19] Specifically, CREATE allows the sharing of confidential information between researchers in different organizations without creating an obviousness rejection based on the subject confidential information for joint inventions as long as the organizations are parties to a joint research agreement. Prior to CREATE, researchers from different organizations were discouraged from collaborating in terms of subsequent patent validity.

As evidenced in a recently published case study, small businesses must proactively align the technology, intellectual property and financial trajectories associated with their innovation thrusts.[20] This alignment requirement is precisely the reason the established small business is uniquely suited to fulfill its critical role regarding preparing "knowledge ready for innovation." In order to survive, the established small business must continually redirect its scientists and engineers to develop the skill sets needed to adapt its core technical competencies to the market needs of potential company partners. These redirected skill sets are acquired through close ties and working relationships with potential university partners. In this manner, the established small business is an invention factory downstream of the university and upstream of companies. The established small business must "serve both masters" in order to survive.

From a policy perspective, I consider sustainability of the established small business invention factory. Since the economic rewards of the small business are a fraction of the commercial value to its company partner, the small business must find additional revenue for economic viability. Thomas Edison's invention factory with its staff of inventors faced a similar challenge. (Note that the U.S. Census used the job title "inventor" until the mid-1940s.[21]) In order to pay the bills, Edison's inventors balanced their time between internal projects directed to specific market driven opportunities and external contract fee for service work.[22] The modern day analogy is the established small businesses conducting research for hire and testing services for companies to supplement their revenue portfolio even though these activities do not directly lead to strategic revenues from patent licenses and assignments. Another potential source of research for hire and testing services funding is the DoD. Specifically, much of the SBIR/STTR funding from the DoD is directed to data modeling activities and/or report generation, which provide a source of non-strategic revenues but valuable knowledge generation for DoD mission critical systems.[23]

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[19] Public Law 108-453 amended December 10, 2004; 35 U.S.C. §103(c). [CREATE was in response to a ruling that confidential, non-public prior art be used in an obviousness rejection (OddzOn Products, Inc. v. Just Toys Inc, Fed. Cir. 1997)]

[20] E. J. Taylor and P. Miller, "Innovation Case Studies at an R&D Company…Alignment of technology, Intellectual Property, and Financial matters" *les Nouvelles* Vol. XXXVI (No. 2) June 2001.

[21] Intellectual Ventures Homepage; www.intellectualventures.com

[22] Andrew Hargadon, How Breakthroughs Happen: The Surprising Truth About How Companies Innovate, Harvard Business School Press, 2003.

[23] C. Wessner and R. Gaster, "The Myth of the 'Mills": SBIR and Multiple Award Winners" May 2008; www.innovationecologies.com.

I direct a final comment toward the recent emergence of business models based on patents only, so called pure patent play business models. An example of a pure patent play business model is Intellectual Ventures.[24] In these business models, the core competency of the organization is to create and/or acquire patents and package and sell these patents to others. As noted by Chesbrough, a serious potential limitation of the pure patent play business model is that the company does not have the know-how and engineering expertise to fully demonstrate the value of the underlying patent portfolio. I suspect this limitation could lead to these pure patent play companies turning to collaborative efforts with the established small businesses described herein.

SUMMARY

In this white paper, I have attempted to make the case for an emerging innovation ecosystem model including established research and development small businesses. The model aligns the strengths and interests of the various organizations within the innovation ecosystem. To paraphrase, an organization's business model must fulfill two functions in order to be viable:

1. The business model must create value within the supply chain in which it operates, and
2. The business model must allow the business to capture a portion of the value created.

Below are recommendations specific to universities, large companies, small businesses, and government for facilitating partnerships within the innovation ecosystem.

The mission of research universities is to educate the nation's next generation of scientists and engineers. During the performance of this mission, universities create knowledge, which ultimately provides the basis for new products and processes. In order to perform their mission, universities need monies to support their research activities. These monies come from the government, both state and federal, as well as businesses. The business monies can be in the form of sponsored research and/or licenses. To avoid the difficulties of university-large company interactions, universities are encouraged to look to collaborations with small business to manage this interface. In particular, universities are encouraged to engage in partnerships with established research and development small businesses in addition to university based small business spinouts. Finally, universities should not as a matter of policy patent every invention. Recall from above, Bayh-Dole requires that inventions be reported, not that they be patented. The decision to patent an invention should consider the trade-offs between subsequent sponsored research dollars vis-à-vis licensee fees as well as the impact on knowledge dissemination.

Large companies, including both those in commercial markets as well as government prime contractors, need a continual influx of new products and processes in order to remain competitive. Large companies are encouraged to embrace open innovation and

[24] www.intellectualventures.com

augment their internal research and development activities via partnerships with outside organizations. In particular, large companies should look for partnerships with established research and development small businesses, such as those who are active participants in the SBIR/STTR program. To facilitate matchmaking, large companies need to advertise their problems and engage small businesses by attending grantee conferences and technical society meetings. By partnering with small businesses early, large companies can most effectively communicate their needs and provide the market pull necessary for innovation.

In order to remain economically viable, small businesses must meet the needs of their strategic large company partners by collaborating with universities and government sponsors. In meeting these multiple demands, small businesses must continually balance considerations with investors based on intellectual property maturity and risk. In order to successfully compete for government SBIR/STTR funding, small businesses must establish a strong research and development competency and demonstrate a track record of successful commercialization and/or transition of products and processes to commercial or government markets. In order to meet the innovation needs of large companies, small businesses must understand and address the engineering and manufacturing requirements of new products and processes. In addition, small businesses must be cognizant of the need for competitive advantage by their large company partner and thereby maintain and manage a sophisticated intellectual property portfolio in the form of patents as well as know-how. Furthermore, small businesses must be good at market and technology landscape assessment in order to determine the direction in which to deploy and develop their technical competencies. Additionally, in order to engage large companies, small businesses should include trade shows as part of their meeting attendance. In collaborating with universities, small businesses must negotiate sponsored research agreements, which facilitate the university mission of educating students and dissemination of knowledge while protecting the critical intellectual property needs of their large company partners. Finally, I recommend that small businesses develop a financial model that includes research for hire activities in order to remain sustainable.

The rationale for government sponsored research and development is to stimulate economic development via technological innovation. The government currently directly sponsors research at universities and small businesses. Large companies indirectly participate in government-sponsored research by memberships in university centers and participation with small business on SBIR/STTR projects. Universities collaborate with small businesses via SBIR/STTR subcontracts. With the recognition of the role of small businesses in the innovation ecosystem, the government needs to actively promote small business-university collaboration by requiring that university “centers of excellence” and similar technology focused programs include small business participation. To encourage small business-large company partnerships, the government should actively promote large company leveraged funding of small business projects with supplemental funding or enhancement funding. Finally, in accessing commercialization and/or transition of products and processes to commercial or government markets, government funding agencies should recognize agency specific missions and each agency should develop their own specific assessment metrics. In this manner, specific agencies are encouraged to

assess commercialization/transition only in terms of their specific agency mission and not negatively impact small businesses “commercialization” track record based on funding from other agencies or for research for hire activities.

In summary, for the innovation ecosystem to function effectively, universities, large companies, small businesses and the government must recognize the unique mission and competency of each other. In this manner, partnerships are established that result in a “win-win” for each organization and more importantly the U.S. remains economically vibrant.

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