The New Role of Land Grant Research Universities in the 21st Century: An Essay

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Part 1. A Time of Change and a Call to Action

Recently, higher education celebrated the 150th Anniversary of the Morrill Act. It is nothing short of astonishing that land grant universities were conceived and birthed during some of the darkest days of this nation's history. It was this visionary act in the 19th century that set the country on the path to the American Century. It was the land grant universities that provided broad access to needed higher education for people of all backgrounds, especially from the "industrial classes." With new curricula in agriculture and mechanical arts, experiment stations and agriculture extensions, the land grant universities played a significant role in advancing the state of agriculture and industry in the United States. By the end of the 20th century, the mission of the land grant institutions rested firmly on the three strong pillars of teaching, research and outreach.

Today, just 14 years into the 21st century, many land grant universities, including the University of Missouri, have added economic development as a fourth pillar under their missions. Multiple factors brought on this change at the confluence of several potent socio-economic factors that have had a significant impact on the nation in less than two decades. In 2000, the stimulation of the stock market by the seemingly unlimited potential of new web-based technology companies came to an abrupt end when the dot-com bubble burst. After a slow recovery, the economy suffered mightily again and merely eight years later in 2008, when the housing and mortgage bubble burst. After these two shocks, jobs lost in the downturns were not added back as the economy slowly improved. Over several decades, prior to these economic downturns, our nation's economy had been steadily shifting away from manufacturing.[i] The economic crises of 2000 and 2008, and the retrenchments that ensued in their wake precipitated an irreversible loss of jobs. These job losses in turn diminished the middle class and widened the gap between the upper and lower economic classes in the US.

Other factors are also in play that have spurred the land grant universities to embrace economic development as a social responsibility. Whereas in the post-world War II decades from the 1940s to the 1980s large corporations prospered, and in turn they richly supported research laboratories that conducted fundamental research. Bell Laboratories epitomized such laboratories. Staff scientists at

Bell Labs were doing basic research of such a high caliber that it led to many Nobel Prizes. Breakthroughs included the solid-state transistor, the detection of the "background" radiation in the universe, and the development of the laser. Many of the programming languages used today to write computer code stem from basic research done at Bell Labs and RCA-Sarnoff Labs.[ii] In the 1970s, 80s and 90s, the post-war economies of Japan and Asia rose from the ashes of their earlier destruction and became excellent manufacturers and effective competitors. This new global competition caused many of the largest American companies to cut back on their budgets for fundamental research. They either shuttered such laboratories outright or transitioned them into tech-service organizations doing little or no fundamental research. When scrutinized from a financial perspective, investments in fundamental research could not be justified. Fundamental research had not continued to lead to significant returns in an acceptable time frame, and the returns were episodic. With the loss of these corporate laboratories, the nation lost a source of seed corn for a continuous new crop of technologies. It was the new technologies based on science done in these labs that had led to so much economic growth and prosperity. Without the steady flow of new science to lead to new technology, what would be the effect on the economy? To whom would the responsibility for doing fundamental research be transferred?

Another factor affecting land grant universities and their thought leaders were analyses from think tanks and other academic observers. Many began to note that the pace of innovation in the United States was slowing measurably during the last 20 or so years. A new global competitor, China, was on the scene. By many measures, from the numbers of patents issued to the possession of the world's fastest super computer, China appeared to be ascending while the US was descending. The argument that these prognosticators made ran along these lines. Because China was funding fundamental research more innovation is expected from China. China will have continued economic growth while, in this country, we will not. Instead of investing in new research, we seem to be rending the last remnants of innovation from research done in the past. We cannot do this for much longer and maintain growth; we need investments in basic research to foster innovation and prosperity again. The argument continues that growth is sputtering because the current investments in basic research do not rival those that were made by prior generations. Hence, the pace of innovation will slow even more in the US and with it the rate of economic growth will diminish further. Some economists contend that we are reaching a point in the US where there are real limits to further future growth that will lead to economic stasis or secular stagnation.

Finally, in 2008 a new administration took office in the midst of a financial crisis that was nearly as bad as that which ensued after the stock market crash of 1929. Their goals and objectives also affected land grant universities. The Obama administration set out on a course of neo-Keynesian stimulation of the economy with extra governmental (deficit)

spending. This spending went to corporate enterprises critically in need of support (General Motors), into new technology firms that were also aligned with the administration's agenda to move toward sustainable energy (Solyndra) and into academic research aimed at spurring innovation. Through the America Response and Recovery Act (ARRA), the Federal Government[iii] invested over $830 billion in the economy beginning in 2009. Spending included "shovel ready" infrastructure projects, education programs, tax incentives, and new energy initiatives. Funding of about $ 7.6 billion was allocated for scientific research with the greatest portion of that spending (~$6 billion) going to NSF, DOE and NASA.

With this federal largesse for academic research came some harsh criticism that such spending would not stimulate the economy, or at least that it would not do so in the near term. The administration responded by creating metrics that would indicate that it had indeed been economically stimulating in an appropriate time frame. Thus, ARRA funding for universities brought with it new reporting requirements about metrics such as job growth per dollar of funding expended. Soon after this the NIH along with the NSF and OSTP created STAR METRICS - Science and Technology for America's Reinvestment: Measuring the Effect of Research on Innovation, Competitiveness and Science. STAR METRICS is a federal agency and research institution collaboration aimed at creating a repository of data and tools that would be useful to assess the impact of federal R&D investments.[iv]

John Holdren is the Assistant to the President for Science and Technology and Director of the White House Office of Science and Technology Policy. In June 2010 he said, "It is essential to document with solid evidence the returns our Nation is obtaining from its investment in research and development. STAR METRICS is an important element of doing just that." At the same time Francis Collins, Director of the NIH said this: "STAR METRICS will yield a rigorous, transparent review of how our science investments are performing. In the short term, we'll know the impact on jobs. In the long term, we'll be able to measure patents, publications, citations, and business start-ups." The President, Dr. Holdren, Dr. Collins and others in the federal government, made clear that research universities, including the land grant universities, were to take on the challenge of driving economic growth. They were to do fundamental research and convert its outcomes into new products, processes, and innovation and in a transparent, demonstrable way.

Clearly, for all these reasons astute land grant universities began to pay even more attention to technology transfer as it relates to economic development. The land grants are well suited for this because of their historical role as socially responsible institutions that seek to improve the well-being of citizens in their states and the nation. Thought leaders and top administrators in Washington, D.C. challenged research schools to be more relevant and active in economic development. They tied demonstrated success in technology transfer and economic development to potential for continued

success in bringing federal support for research to these campuses. Whereas, in previous times, the linkage between federal investments in basic scientific research and their economic impact was left mostly unstated and implicit, almost taken on faith, now it was to be explicitly demonstrated. The new metrics would go considerably beyond the usual academic measures that universities had tracked for decades. Hence, adaptation to this new paradigm was essential. As a result, many land grant universities assimilated this new thinking, and many of these institutions added economic development as the fourth pillar upon which their missions rested. To its credit, the University of Missouri had added the fourth pillar of economic development to its mission in 2004.

Part 2. A Plan of Action at the University of Missouri

At the University of Missouri, the research strategy is to become an even larger and more powerful engine of innovation and economic impact in the Midwest than before. With total research expenditures well over $270 million per year, our research engine's displacement is significant, but we expect and need this displacement to grow. Our goal is to become the very best among midwestern land grant institutions at the conversion of the products of research and scholarship into innovations that will make life better. By growing new businesses, by supporting and improving existing businesses and by growing jobs, we can play a significant role in raising prosperity. The leadership of the federal agencies that provide our funding expect nothing less of us. The achievement of this goal will benefit our state and region as we meet these new federal expectations. There is harmony between achieving success at the federal level with sustained research funding and success at the state and regional level in terms of economic growth.

If we accept the idea that land grant universities, such as the University of Missouri, are to be engines of innovation and economic lift, then we have to consider how best to do this. In the past, especially in the early to mid-20th century, outcomes of research in agricultural science and engineering were "translated" to the agricultural community through the agricultural extension. At the same time, the agricultural community "translated" their needs and experiences back to the university also through the conduit of the extension. The key to the success of land grants universities in agriculture was this involvement of the community in informing our research. Knowledge gained from agricultural research and field-testing was brought to the classroom as the most up-to-date curricula for students of agricultural science and engineering. When it worked well, the integration of research, outreach and teaching created an upward spiral of progress.

Today, in the 21st century, we need to do something quite similar. As we approach the problem of spurring economic growth, we need to bring together research, teaching and outreach once again. To be successful, we need the "community" to be our partners in the endeavor. Today, the "community" is those engaged day-in and day-out in the real economy, which is to say business people. From the smallest new company led

by an entrepreneur to the largest corporation faced with daunting global competition, we need to become partners for growth. Extending the metaphor of the land grant university as an engine of innovation, then it is through the business community that its power is transmitted to the wheels and provides traction in the real economy. The challenge of seeking to drive economic growth is too multifaceted for universities to attempt to take it on alone. Without broadly based partnerships with established businesses and entrepreneurs, we will not be successful. In an earlier era of our history, we would not have been successful in advancing agricultural progress without a partnership between our agricultural research and the agricultural practitioner in the field. This kind of a deeper partnership between the university and community we have dubbed "communivation" as shorthand for community-university partnerships for innovation.

Next, to organize our thinking and our action at the University of Missouri, we have developed a strategy consisting of five themes that will allow us to achieve our goals. These are as follows:

1. *Cooperate and collaborate rather than compete.*
2. *Grow our own entrepreneurs and innovators.*
3. *Be smart with intellectual property.*
4. *Unleash the power of the willing.*
5. *Don't be jealous; shamelessly borrow the best ideas of others.*

Each of these is essential to the overall strategy and they are explained as follows.

1. Cooperate and collaborate rather than compete. For decades, land grant universities have cooperated at the margins but they have mostly competed for research funds and revenue streams. As state appropriations have decreased, and student mobility has increased, these institutions increasingly compete for students from around the nation and overseas. Competition is often very good in that it drives toward higher efficiency and leads to better outcomes, but only up to a point. Today, in the University of Missouri System, it is to MU's advantage to seek ways to leverage all investments. One important way to do so is by cooperating with the other campuses at Kansas City, Rolla and St. Louis. As we seek to drive economic lift through better partnerships with the community, having access to and partners in the two largest urban areas of the state is invaluable. Capitalizing on the engineering strengths at Missouri S&T in Rolla, provides even more potential success. As partners, we can do much more for the benefit of the state than we can as mere competitors. In the same way, wherever and whenever possible, we seek to cooperate with all the public universities around the state of Missouri.

Cooperation within the University of Missouri System and the state of Missouri is better than mere competition. It also seems logical to seek greater cooperation among the top public research universities in the Great Plains region. As one example, consider the expenditures that must be made today to provide the kinds of tools that are required to do nanoscale science. Given the high cost of instruments, it makes sense to cooperate in seeking funding for such tools and to

avoid duplication if sharing can be effective. Leveraging capital to the greatest extent possible is paramount today, and it will be going forward in time. From this perspective cooperation and collaboration are more necessary than optional.

2. ***Grow our own entrepreneurs and innovators.*** Missouri and the Midwest are wonderful places, but seeking to attract entrepreneurs to our regions and away from Boston, Austin and Palo Alto is not a winning strategy. On the other hand, many of our graduates would rather stay in their home state and region, but opportunities for them to do so may be limited. Hence, there is a real drain of talent from the Midwest toward the east and west coasts. If we can begin to foster entrepreneurship among our students, then we can begin to grow our own entrepreneurial communities up from the grassroots. To do this, we must put resources into new programs that foster entrepreneurial learning and that make it attractive for our graduates to stay with us and to build these communities. If we can begin to retain entrepreneurial graduates in our college towns, then we can over time begin to overcome the "management" gap and attract investment capital to our regions. To do this successfully, we must partner with our communities to create the entrepreneurial ecosystems that nurture and support the growth of seasoned entrepreneurs.

3. Be smart with intellectual property. Since the passage of the Bayh-Dole act, universities have been granted the ownership of intellectual property that stems from federally supported research. The act was a brilliant piece of legislation, because it moved the possession of the intellectual property from the federal agency that funded the research, to the university. Ownership created a financial incentive for the university to drive the invention to the marketplace, something the federal agencies had not done. The Bayh-Dole act, however, was never meant to chill the funding of research at universities by industry. In fact, one may surmise the authors of this legislation would have wanted the opposite to happen. Nonetheless, it is the case that for the better part of the last 30 years, most universities have had a rigid position on the disposition of intellectual property derived from industry-funded research. They often cite their interpretation of the Bayh-Dole act as the basis for that rigidity. That rigid stance is one of absolute ownership of all inventions, even if the source of the funding was from a private company. Universities also found it necessary to point out during the negotiation of a research contract that the cost of a license on intellectual property that might emerge ultimately would be set by the university. The university also asserted the right to license that intellectual property to a competitor if an agreement could not be reached with the original sponsor of the research. In some other cases, a bit more liberal position on licensing was taken. Often in industry-funded academic centers and consortia, all sponsors might be offered a royalty-free, non-exclusive license. It is the case that when asked, industrial research leaders will identify the argument over the disposition of the intellectual property as the number one problem they face in work-

ing more closely with academia. Therefore, the hardline approach that we have taken on intellectual property when working with industrial sponsors has diminished the number of collaborations that might have been.

It is impossible to determine accurately the amount of research *not done* between academia and industry in the United States over the last three decades because of this stance. With a more supple approach perhaps as much as three to four times *more* research could have been done over this time. Also, we cannot estimate accurately the value of the lost innovation that could have occurred had industry and academia been working more closely together. One wonders why in other regions of the world, most especially in Europe and more recently in Asia, cooperation and collaboration between industry and publically funded universities is both active and productive. One thinks of such schools as Eindhoven University and Delft University collaborating with Phillips and Royal Dutch Shell, or the Royal Institution in Copenhagen and Chalmers collaborating with Volvo as examples of healthy university-industry partnerships.

Aside from driving innovation, fostering collaboration between industrial practitioners and professors provides invaluable benefits to both. For the professors, many of whom may never have practiced their disciplines, these collaborations are valuable because they give them a chance to grapple with practical problems. The benefit is that they can bring this experience with them into the classroom, thus informing their teaching. At the same time, by working more closely with practitioners on particular problems, faculty researchers can identify new and important problems of a more general kind to work on that are fundamental in their nature. For industrial specialists, collaboration with scholars also reaps benefits. Academics are often at the leading edge of research in terms of theory, simulations and experimental methods. Thus industrial professionals, who collaborate with academics, can bring cutting edge approaches to bear on difficult problems encountered in practice. This can lead to breakthroughs and to more innovation.

Another benefit of collaboration of this kind is that it brings seasoned professionals together with students, which leads to sharing of experience. Coaching may take place that otherwise would not happen, and that mentoring can accelerate the effective performance of young professionals when they enter the workforce. When it comes to entrepreneurs in startup companies, all the same benefits and more accrue from them when they collaborate with academics. In fact, these collaborations are central to the growth of many technology-based entrepreneurial enterprises.

For all these reasons, we as universities are in the controlling position and we must reevaluate our stance on how we handle intellectual property. If we are to stimulate innovation and to have a real impact on economic growth, then land grant universities that receive state and federal funding should reconsider how they manage the formation and disposition of intellectual property. Whether we accelerate innovation and job growth within established companies or in new,

startup companies through collaboration, we must do both since we have a broader social responsibility to help spur sustainable growth. Public research universities have a social responsibility to improve economic conditions for the benefit of the citizenry.

A more nuanced stance can be taken to the disposition of intellectual property. The more nuanced stance is in effect a new approach to intellectual property management.[v] In the first place, when it comes to industry-funded research, universities need not insist on owning intellectual property that may result from the research. In coming to this conclusion, consider the following points. Most research projects do not lead to invention disclosures, patents, licenses and revenue streams. Furthermore, even fewer industry-funded projects do so. Thus, when a university negotiates for ownership of intellectual property that may result from a research project, it is negotiating for something that does not yet exist and that probably will not come into existence.

This hardline stance over something that may not come to pass, (and usually does not) can result in the project never being undertaken. If, on the other hand, the contract negotiation does succeed, the project is undertaken, and actual funds will flow to that principal investigator. Even more, a successful research project creates a relationship between the faculty member and a sponsor that can be ongoing and beneficial for both. From many such relationships can begin a partnership between the university and the corporation that can pay much higher dividends than can imagined, but not real intellectual property.

Lastly, we must also keep in mind that whether an invention is disclosed to us or not, is ultimately a decision that rests with the principal investigator. The researcher may share the results publically as an article in a journal rather than disclose them as an invention. There is no university that would or should take action against such a decision maker. In industrial laboratories research management closely monitors results and progress. Disclosure to the public without permission would have dire consequences. By contrast at the university, administrators have little or no knowledge of that which is coming to fruition in a given faculty member's laboratory at any given time. Unless that faculty member divulges it to us, we do not know about it. Universities give faculty members tremendous latitude in making these decisions on their own, as is appropriate.

Therefore, at the University of Missouri, we created a process whereby the decision to negotiate or not for the retention of intellectual property is deeply informed by the faculty member *before* the negotiation begins. If the faculty member contends that there will not likely be intellectual property developed in the course of the research, then we do not negotiate for the sole rights to the intellectual property. Alternatively, if the faculty member does want us to retain the intellectual property that may issue from the research, we negotiate for those rights. If the faculty member is not sure how they want to proceed, which is sometimes the case, the new process catalyzes a deeper analysis with the technology management office. This analysis can lead to much better strategies for handling that

faculty member's research and their intellectual property. The early inclusion of faculty in the decision-making process is a critical part of being "smarter" about intellectual property.

At the same time, we need to be even better about how we handle invention disclosures that we will not likely ever convert to a patent. Whereas some private and some public universities have enough revenue to file a patent application on almost any and all invention disclosures, most public land grant universities do not. Therefore, to be "smart with intellectual property," most schools will need to create a transparent rubric for making decisions on which disclosures that they will fund filings. The rubric should layout the areas of science and technology of highest interest to the university, and these areas should be tied logically back to the school's strategic strengths. Once established, this rubric must be shared widely on campus, so that the faculty members know what is likely to lead to a filing and what is not. With limited resources and the ever-increasing costs of patent filing and management, creating a rubric is not only logical, it is expedient and necessary.

Of course, at the same time, there needs to be some flexibility in the use of the rubric so that something truly novel outside of the areas of strategic strengths will not be squelched. Getting this detailed balancing act right is not and will not be easy, but it is a part of the art of managing an academic technology office with a limited budget. At the University of Missouri, not surprisingly, we view plant and animal sciences, nuclear medicine and new media as areas of strategic strengths and into which we will invest our limited funds. But we will remain open to and alert to the possibility of new products, processes and technologies stemming from any discipline or interdisciplinary research center on our campus.

When a disclosure is made that will not lead to a filing by the university, it is important to waive the rights to that property back to the faculty member to pursue privately. Again this is a part of smart practices around intellectual property management. The university can stand on its rights and not immediately move on a disclosure, but it should do this only under extraordinary circumstances. For instance, if there is reason to suspect that the results upon which the disclosure is based are not valid, or if the results appear to have been purloined. Another reason could be that the person making the disclosure is not in good standing with the institution. Under such circumstances, a disclosure may be held pending some other action. Otherwise, action should be take including waiving the disclosure back to the inventor makes good sense.

Finally, the ways that industry brings capital to the university to drive new technology and innovation to the market are in flux. In the past, large, well-established companies would often license a technology directly from the university, and then develop it within their laboratories and engineering organizations. Today this route is being taken less frequently. Instead, large corporations increasingly prefer to purchase a pre-revenue venture company that has developed the technology sufficiently to reduce the risk of making an investment too early. If

this trend continues, then universities will need to support this new pathway to the market by taking equity in new ventures. Aligning capital from external investors for such ventures will also be part of the university's role as it works closely with entrepreneurs to take the technology to a more advanced stage that is closer to market.

4. Unleash the power of the willing. Faculty in many disciplines must be highly entrepreneurial by the very nature of their appointments and the expectations that their institutions have of them. To operate a well-funded and active research group in the sciences, in medicine or engineering takes no small amount of entrepreneurship and is not all that different from managing a small business. For the university researcher, the "customer" is the agency that provides the funding. The point is that many of our faculty members have strong entrepreneurial skill sets and strengths that have not been fully unleashed.

When it comes to creating an entrepreneurial entity, universities vary considerably as to the way they handle the activities of their faculty members so engaged. We need to rethink the messages we send with our policies and their implementation regarding work on technology transfer and entrepreneurship. It is the case that at most public land grant universities, our views about faculty entrepreneurship have evolved over the last decade. There is little doubt that they will continue to evolve over time, but in the meantime there are some basic practices to follow.

Perhaps the most important change we need to embrace is a change in our culture. We need to move from a culture that has been at best ambivalent to faculty starting new ventures to one that is more supportive and that values such activities. Many schools allow faculty to be more entrepreneurial today than in the past and others even support it with incubators and accelerators on their campuses. More than anything else, we as administrators need to speak plainly about entrepreneurship, what it is, why it is important and how best faculty members can pursue such activities. We need to invest in educating faculty (graduate students, and post-doctoral fellows) on issues that relate to the new environment in which research is being done. Most faculty members have not typically had the time to do so on their own. At the University of Missouri, we will be educating our faculty, post-docs and graduate students with three introductory sessions on intellectual property, entrepreneurship and industry funding. We call these meetings the "Let's Talk Series". Each session will run about two and a half hours but not more. We will have experts from around the campus and community give the participants the "what, why, how, when and where" about each of these topics. If participants want to learn even more, they are then provided maps to guide them to further resources. In the case of entrepreneurship, follow-on courses and boot camps will be offered for those who want to delve in and try this. At the end of the "Let's talk series," faculty members will know we are changing our school's culture, why we are changing it and how they can better align with it, if they choose to do so.

5. Don't be jealous of others and borrow their best ideas shamelessly. The idea of shifting a University's culture to one that is more open for innovation, more collaborative than competitive and more embracing of entrepreneurship can be daunting. It seems to be such a significant departure from the past. One can imagine that in the minds of many academic leaders, the risk of making changes of this kind may seem considerable. However, the risks are more apparent than real, more imagined than actual. Furthermore, the old business model for the public land grant university has run its course. There is no alternative to change, and we must find new business models. Change is all a part of that creative disruption process.

Bringing about change at most land grant universities will not be as intimidating as it may seem. The reason is that many schools have been making changes to how they operate and have been experimenting with new approaches for some time. Experiments that create new dynamics in support of the university's fourfold mission are underway at progressive schools such as Arizona State, the California System, Penn State, Minnesota and now the University of Missouri. Learning from these experiments is one way for other schools to reduce their risk as they also seek to make changes to their cultures and modes of operation. As schools do experiments, take some risks and learn, there should be more sharing of outcomes, amongst universities, especially among the public, land grant universities. For sharing to happen, university leaders need to be more willing to divulge information, and to embrace ideas developed other schools, to see if the idea will work at their university.

At the University of Missouri, we have borrowed approaches to managing intellectual property related to industrial contracts developed at Penn State and the University of Minnesota, and have adapted these for our use. We also will be engaged with the MIT Venture Mentoring System, in order to align the entrepreneurial assets that we have among our alumni and within our community. Similarly, when we see other good ideas at other institutions around the country or the world, then we will borrow them shamelessly.

Conclusions. The land grant universities have survived and thrived for 150 years. Our mission in the 21st century remains consonant with our past. At this point in our history and that of our nation, we are asked to do even more than before; we are expected to drive innovation to help the country achieve renewed prosperity through sustainable economic growth. To do this, is to be an "engine of innovation." To succeed at this, we need to bring our institutions closer to the real economy and to the business community. We need to do so locally, regionally, nationally and internationally. We cannot proceed with the same approaches that we have taken in the past. Instead, we need to test new approaches that will set the course for the land grant university for the rest of the 21st century. The new course will integrate the strengths of our past with entrepreneurship to bring forth more innovation from our research and scholarship than ever before.

Endnotes

i. In 1955, just six decades ago, the United States had an economy based on manufacturing. The top five employers were General Motors, US Steel, General Electric, Chrysler and Standard Oil. Today, the top five employers are quite different – they are Walmart, Yum! Brands, McDonalds, IBM and the United Parcel Service, now known simply as UPS. Our economy has shifted away from manufacturing. We can see how profound this shift is when we consider that the top five companies in the US based on their market capitalization are Apple Inc., Exxon Mobil, Google, Microsoft, and Berkshire Hathaway.

ii. http://en.wikipedia.org/wiki/Bell_Labs

iii. http://en.wikipedia.org/wiki/American_Recovery_and_Reinvestment_Act_of_2009

iv. https://www.starmetrics.nih.gov/

v. Foley, H. C. (2012). A New Approach to Intellectual Property Management and Industrially-Funded Research at Penn State," Research and Technology Management. Research and Technology Management, 55, 12-17.