Capitalizing On the Entire Potential Innovative Capacity of Academia: Recommendations for Universities and Technology Transfer Offices

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Call to Action

Broaden outreach by technology transfer offices in a way that is inclusive to draw more women and underrepresented minorities into the innovation and entrepreneurship space to capitalize on the entire intellectual and creative potential of our university system and nation.

Why this article is important

Innovation and job creation are important goals in society and government at present. Capitalizing on all of our nation's intellectual potential is crucial for global competitiveness and for remaining an attractive destination for future innovators and entrepreneurs to obtain an education. Increasing engagement in this space requires identifying barriers to participation. Women make up 50 percent of the workforce, more than 25 percent of STEM employees, but hold less than 10 percent of the patents. At the Association for Women in Science (AWIS), we identify the problems that cause women to leave the STEM pipeline and propose solutions to increase retention. In this study, we sought to identify reasons why women patent at a lower rate than would be expected and develop realistic solutions.

In our research to identify the reasons women are not more successfully engaged in this space, we spoke to technology transfer managers and officers, patent attorneys, policymakers, and entrepreneurs. The following is our effort to highlight some of the barriers to participation and our subsequent policy recommendations to technology transfer programs and universities. The goals of the recommendations are to increase and assist in broadening the outreach and make the most of the human and intellectual capital at our universities.

Recommendations for Technology Transfer Offices and University Administrators

- Increase the entrepreneurship training opportunities for graduate students and postdoctoral fellows.
- Provide implicit bias training for technology transfer officers.
- Increase outreach to areas more heavily dominated by women, including the humanities and nursing.
- Track the gender of people disclosing technologies and earning patents; compare ratios to make sure unconscious discrimination is not occurring.
- Adopt policies that enable faculty to engage in entrepreneurial activities without penalizing their tenure success.
- Encourage those whose disclosures or patent applications were rejected to reapply in the future, implement policies to follow up with those individuals to avoid lost opportunities.
- Model change upon other programs that have been successful in reaching out to women, such as the University of Florida's eWITS, Stanford's StartX, and the University of Minnesota.

Introduction

Technology transfer is the process by which an individual, at a university or federal agency, transmits knowledge and information. This can be done through technology disclosures and patents, as well as through publications, professional conferences, and industry consultations. The intention of sharing this material is to make it more broadly available to the public. These ideas may then be licensed to other businesses to develop into a product, or they may be used to start a separate company. Through this process, over 70 drugs have been developed that treat diseases and improve lives. Hundreds of companies, some very successful like Google and Genentech, have been created and countless other products that improve the quality of life have been taken to market.

Today, technology transfer is an important part of the economic policy agenda for several reasons. Foremost, these inventions are the intellectual outgrowth of research supported by tax payer dollars. Like any investor, the public deserves to get some return on their investment. These returns benefit the public, whether via therapeutics, national security, improved efficiency in the home and business, or general elevation of the quality of living. More germane to the current discussion are the other advantages of commercializing these ideas, which include local job creation and economic stimulation. Additionally, as state and federal governments have less money to support their academic institutions, many are searching for alternative revenue sources. Revenue generated by a successful product or company is one way to subsidize these reduced or thoroughly diminished funding streams.

Although inventions have been derived from federally funded research performed at academic institutions for decades, due to a lack of clear ownership of their patents, industry did not have sufficient interest to invest in developing many of the most intriguing ideas (Loise, 2010). In order to increase the tax payers return on their investment and provide an impetus for universities to develop these potential technologies, legislation known as the Bayh-Dole Act (Sen. Bob Dole quipped that it sounded like a plan to induce people to buy bananas) was passed in 1980. Bayh-Dole frequently comes up in policy conversations as a starting point for places to improve and expedite the innovation pipeline. However, upon closer examination, the road by which innovations come to market is by no means smooth and many issues slow the process down.

The Bayh-Dole Act established an incentive for universities to commercialize the ideas produced within but offered no direct financial support to enable them to accomplish this task. Although most major universities at this point have created facilities to assist their faculty in commercializing or licensing their ideas, more than half of these offices operate at a deficit. Many of the institutions that do have a lucrative technology transfer office frequently depend heavily on revenue and royalties stemming from one or two really successful products. These "home-runs," however, are few and far between when compared to the total number of patents universities collectively receive annually and are also subject to a finite window of revenue generation.

Another issue is the funding gap between the idea and the tangible product that must be overcome, an area commonly referred to as "the valley of death." This chasm generally requires greater financial support than the university can alone provide, yet the idea hasn't been successfully proven to the point that venture capital is ready to fund the project, and this is thus a space where many good ideas wind up dying before they can be meaningfully vetted for commercial success. This problem is exacerbated by tough economic times.

Lastly, many offices struggle to break the mold for how they attract people to disclose their ideas in the first place, and when they do, disparities may arise in who is engaged. Some languish, simply waiting to be approached by faculty with an idea. Alternatively, technology transfer managers may sporadically sit in on lab meetings of primary investigators with a track record of patenting success to see if other ideas may have a marketable component, or speak with department heads to ask if they are acquainted with any research that may have commercial applications. However, none of these are adequate to attract new talent that may not have commercialization of their science on their radar. This paper will detail why it is important to be attracting more women and underrepresented minorities to patent their ideas, the strategies some universities have successfully developed to overcome this obstacle, and why providing more opportunity in this space advances everyone's interests.

Studies show that if schoolchildren are asked to draw a picture of a scientist, they generally illustrate a white man in a lab coat with disheveled hair (Chambers, 1983). It is quite likely that if you asked adults to draw a picture of an inventor, they would draw the same thing. Just as taking children to a lab and exposing them to real scientists of both genders and a wide range of ethnic backgrounds leads them to sketch a diversity of people in lab coats when the experiment is repeated, at the Association for Women in Science (AWIS) we aim to broaden the idea of what a typical inventor is as well.

Gender disparities in technology transfer activity are striking when one considers that women comprise half of the U.S. labor force, but only a quarter of the STEM workforce, and not even 10 percent of patent holders in this country (Rosser, 2009). In order to understand why this is the case, AWIS hosted a policy panel discussion of innovation experts from across the country. Our speakers talked about the history of the Bayh-Dole Act, the basic challenges faced by technology transfer officers, the legal and legislative issues which are promoting or stifling innovation, the perspective of a technology transfer office executive director with experience at multiple institutions, and the elements that go into creating a nurturing environment to promote successful startups. This event generated incredible discussion and thoughtful questions. We also spoke with technology transfer managers, academics, patent attorneys, patent agents, directors of technology transfer offices, innovation program managers, and other stakeholders to explore why women patent at a lower rate. At the heart of the argument is that if university technology transfer offices are designed to support the intellectual property of the faculty and staff, then they should be reaching out in such a way to ensure that they are capitalizing on all the innovative potential within the academic community, not just those of the serial entrepreneurs and others that meet their idea of what an inventor should be. In the following discussion we highlight some of the barriers to participation and offer recommendations for ways technology transfer offices can more broadly engage the members of their community.

Implicit Bias

While the number of women applying for patents is generally on the rise, a gender gap persists with regard to technology transfer and entrepreneurial activity. Several recent studies indirectly bring attention to this problem. A study coming out in the *Journal of Management* looked at hypothetical initial public offerings (IPO) and found that second year MBA students undervalued the company and offered the CEO less compensation if they believed it was being run by a woman (Bigelow, 2012). Another study recently published in the *Proceeding of the National Academy of Sciences (PNAS)* found that an applicant for a lab manager's position was seen as less competent, a less desirable hire, less worthy of mentoring, and offered a lower salary

if the identical application had a woman's name on it rather than a man's, regardless of if the evaluator was a man or a woman (Moss-Racusin, 2012). A current study is looking at the likelihood of technology licensing managers to encourage an entrepreneur to patent his or her idea (Scott Shane, personal communication). Using identical disclosures but changing the name of the inventor, the preliminary results suggest that the officers are more likely to encourage the entrepreneur if an XY is involved in the chromosomal arrangement.

Implicit bias, or unconscious bias, is the idea that while consciously many people outwardly condemn racism, sexism, and other forms of discrimination, we hold opinions informed by the culture, both domestically and broadly, in which we were raised, and as a consequence subconsciously associate different values based on this (Fazio, 1986; Nosek, 2002). Many interesting and compelling studies have been done in this field, including the Implicit Association Test from Harvard, which shows that subconsciously most people associate science with masculine traits (Nosek, 2007). The aforementioned *PNAS* study was one of the most important in this field in recent years because it demonstrated that both academic women and men in physics, chemistry, and biology hold these same biases, despite claims of immunity to prejudice by scientists who are inclined to think they only evaluate people and ideas on merit. Of course, most of those people would honestly say that they do not think women are less competent or deserve less pay for the same work, but the data suggests otherwise.

Thus, it was not surprising that upon mentioning the previously alluded to survey in which the technology transfer managers had engaged, many of these people who had participated in the study got very defensive. They both rejected the idea that they were biased (frequently because they *were* women) and thus were openly offended by the suggestion that they might be actively participating in discrimination. They were also quick to point out that many tech transfer officers are women, as though that is further support for the argument that they cannot be part of the problem. This is, of course, contrary to the findings of previous studies which demonstrate that women are just as likely as men to be subconsciously biased against other women. And thus while most people probably are not consciously discriminating against anyone, the data from multiple studies suggest at an unconscious level, they are.

The upside to this situation is that one of the best ways to combat implicit bias is to simply make people aware that they hold these unconscious preconceptions and they will most likely impact judgment if one fails to take them into consideration. It is the same kind of treatment that works when school kids are exposed to the gamut of backgrounds real scientists represent. This will not solve all problems, certainly, but it is a step in the right direction. Once people start to examine one set of biases, they usually cannot help but begin to think about other preconceptions they hold because of their upbringing rather than because they really cling to the stereotypes and prejudices.

Data Collection of Disclosures

Part of the challenge to combatting implicit bias is convincing people there is a problem. Most technology transfer managers do not collect data on the demographics of those who approach the offices to disclose technologies. Most data on women are based off publically available data on the United States Patent and Trademark Office website, which does nothing to reveal disparities in the numbers disclosing technologies compared to the numbers earning patents.

The Association of University Technology Managers (AUTM) is the premiere trade organization for technology transfer professionals. AUTM collects data from universities

regarding revenue, patents, licenses, expenditures, employment, number of startups, and other data relevant to operating a technology transfer office. Annually, AUTM releases a report comparing these metrics from university technology transfer programs all over the country. However, there are many different ways to measure success and multiple institutions struggle with how to define fulfillment of their mission. One piece of data not listed is the total number of campus employees who approach the technology transfer offices with the intention of disclosing an idea, only the total number of disclosures submitted for patents.

We encourage AUTM to ask universities to include gender and ethnicity in the metrics for its annual reports, both in terms of members from the academic community that come to disclose a technology as well as in terms of the actual number of patents granted, technologies licensed to companies, and startups formed. If part of the function of technology transfer offices is to support the academic community, then this would provide a valuable metric for enabling university administrators to gauge the effectiveness of outreach to the entire academic community. Furthermore, this is a metric that may be of interest to outside funders considering supporting proof of concept or incubator ventures.

To proactively engage in this space and affect a positive change to encourage AUTM to take up these metrics, we are planning a pilot program to partner with several universities and provide implicit bias training. This should have a positive impact not just on women approaching technology transfer offices to disclose their technologies, but underrepresented minorities as well who are also poorly represented in these activities.

Entrepreneurship Training

The model for undergraduate and graduate training is undergoing a shift in this country due to several factors. Perceived impending workforce shortages in high-tech fields are leading to an increased push to get more children and college students in to STEM fields. At the same time, attrition rates are increasing because students are arriving in college ill-equipped to succeed at required math courses, frustrated by the lack of connection to real world applications, and realizing they could earn substantially more money with a business degree. The rise of massive online open courses (MOOCs) may lead to big shifts in how pre-requisites for majors are fulfilled and perhaps even how a university degree is earned in the first place. Universities are struggling with shrinking budgets and reduced state funding while being asked to do more with less. An increasing number of articles and editorials suggest many scientists complete their Ph.Ds. and are not qualified to do anything else besides be experts in their one subject area. They are thus struggling to find jobs because there are more people being trained than there are traditional careers available. Although the unemployment rate for Ph.D. chemists and biomedical scientists, currently at four to five percent, may be lower than the national level that does not mean it is acceptable after individuals have invested that much time, energy, and sacrificed earning potential for their education. To that end, universities need to consider and reevaluate their current approach to training.

Previous generations valued a liberal education whereby students emerged with a greater worldview and well-rounded base of knowledge. A wide range of institutions, from first-tier academic research universities to small liberal arts colleges, are beginning to offer entrepreneurship and innovation studies minors as they recognize the value not only of possible returns to the university, but to developing better citizens with a broader understanding of how business works. Many different voices have stressed that the most important technology transfer that goes on at universities is education, sharing knowledge with future generations. William

Butler Yeats said (though the attribution is questionable), "Education is not the filling of a pail, but the lighting of a fire." Regardless of who said it, this sentiment perfectly expresses why creating more opportunities and encouraging more scientists and engineers to take a few electives to broaden their horizons will benefit them and the university. Give students the keys to unlocking their imagination, as well as the ground on which to build a foundation for those ideas, and who can say what possibilities the future may hold.

This broadening of opportunity to undergraduates, however, may not translate to graduate students or postdoctoral fellows who toil for long hours in the labs, develop a niche skill set, and wind up even more pigeonholed in their discipline. A recent study looked at the intellectual property rights forms incoming graduate students sign at most universities and the results revealed that most students didn't really understand what the terms even meant. Thus, universities seek to claim rights to their innovations, but for many, if innovation is not on their bandwidth or encouraged, they may have ideas that are never shared. Ergo, offering graduate students and postdoctoral fellows opportunities to expose themselves to entrepreneurship, business plan development, and networking for funding will be a mutually beneficial arrangement for both the university and the trainee. Furthermore, if universities wish to keep accepting graduate students and postdocs as cheap labor sources, it is important to recognize that de-stigmatizing the pursuit of careers outside academia and helping their graduates leave better prepared for other career opportunities benefits everyone, especially in times of economic downturn and recovery when job prospects are limited and the pool of competitors is large. Lastly, to encourage more opportunities for those graduate student or postdoctoral trainees interested in broadening their skill set, the impetus for this change must be on the university administration because it is not necessarily something their advisors will support.

Tenure Considerations

For those scientists and engineers that do choose to remain in academia, programs do exist that have successfully created ways to incorporate entrepreneurship training into their tenure-track pursuit. Technology transfer officers understand that faculty members, particularly those at an early stage of their career, are busy people, trying to juggle many responsibilities. To this end, many tech transfer offices try to participate in outreach that is minimally invasive, such as by sitting in on lab meetings to see what ideas may be potentially commercialized or by hosting "Pizza and Patents" gatherings to educate interested parties. However, many universities do not yet have policies in place to encourage entrepreneurship or to support their faculty if they do have an idea worth pursuing beyond the patenting process. To this end, some universities have proactively tried to develop policies to facilitate the potential entrepreneurial activity of their faculty.

A study in 2011 suggests that only 25 percent of universities count patents, licensing, and startups as a part of the consideration for tenure in addition to publications and the other more traditional prerequisites for that promotion, though that number is expected to increase (Stevens, 2011). Those institutions which do encourage technology transfer activity clearly delineate this in their tenure and promotion policies and tend to be public schools, such as the University of Virginia. The University of Maryland has included language in their tenure policy for sabbatical leave that can be used to pursue the startup of a company. In addition to counting patents towards tenure considerations, the University of Minnesota has begun offering an entrepreneurship workshop five times a year which is available to all faculty, postdocs, and graduate students. Half of the participants generally are women, and in 2012, 139 out of 321 (43

percent) disclosures had a woman listed as the sole inventor or as a co-inventor, a number which surprised even the executive director of the technology commercialization office. Examining the steps different universities took to put these policies in place and identifying which ones might best suit the disciplines and interests of their own departments could prove to be a worthwhile endeavor for schools, as well as giving them a competitive edge in recruiting entrepreneurial-minded employees.

Broadening Outreach

One of the points to consider when examining why women are underrepresented in the number of patents is that women make up a low percentage, roughly 10 percent, of the fields that patent most frequently, including electrical and mechanical engineering. By extension, schools that produce a high proportion of engineers and other fields where women are poorly represented would presumably expect to see a lower rate of disclosures and patents from women. However, as most fail to track these numbers, it is hard to compare those rates to schools that produce more biologists and chemists, where women are much more strongly represented. Instead of looking at that as a problem, one might also view it as an opportunity.

Technology transfer programs should be certain to reach out to not only the typical areas from which serial entrepreneurs, like Robert Langer, Sc.D., emerge and cultivate a legacy of entrepreneurial activity amongst their protégées, but also to areas that may not seem as obvious. For example, there is recent increased emphasis on areas such as language, online learning, and electronic medical records; areas where there are many unmet needs and opportunities for new approaches. These are also disciplines in which women are more heavily concentrated, such as the humanities and nursing. Many people working in these fields may have identified areas of inefficiency or have ideas about how to streamline processes but have never considered taking further steps to implement change or develop solutions in a tangible manner. A failure to reach out to these groups is a failure to capitalize on all present potential out there. Developing a culture of supportive engagement and outreach to a wide range of departments may increase the opportunities and productivity of universities. Additionally, a shift in the mentality of "who" patents may lead to beneficial solutions to problems in areas of unmet need. This is particularly necessary in health care where cost-containment and the need for increased efficiency are paramount.

Other Barriers to Participation and Models of Success

Women need to feel invited

Jane Muir, the director of eWITS (Empowering Women in Technology Startups) at the University of Florida has developed a very successful program to engage women in startup business development. The participants learn how to write a business plan, work in teams that balance their skill sets, and are partnered with an experienced entrepreneur. One of the most frequently cited claims is that women aren't interested or are too busy having kids and raising a family to take the time to start a company. Contrary to this belief, there was so much interest in this program when the initial solicitation went out that they had to open more groups. They are currently developing a model that can be scaled by other programs to meet their own needs and interests. StartX, a Stanford-based accelerator program, has attracted many women to its competition, with nearly half the companies in 2012 engaged in the process led by women in a variety of fields. One of the biggest barrier to participation, suggests Ms. Muir, is that women feel they need to be invited. "So, ladies, consider yourself invited," she stated with conviction.

Many lack confidence in an idea's value or need

Many may feel that they need to have a stroke of genius to create a marketable product. However, one of the best ways to develop new ideas is to examine unmet needs. The Business for Science Center housed at the University of California, Los Angeles conducts a competition to identify unmet needs for biomedical devices and develop a prototype as a part of a bioengineering course for graduate and professional students. This course provides an opportunity for students to partner with industry and technology transfer and expand their professional network.

Valley of death is wider, deeper, for women

Women have a harder time attracting capital to get their ideas off the ground. Part of this problem stems from implicit bias, but part of it is also that women often fail to cultivate social networks that are as expansive as men's. Women are underrepresented on science advisory boards for many startups, and are usually about 10 percent of the mentors on different panels for some of the student programs, which have been more successful at starting up companies by men as well as women. Engaging more positive female role models for women shows that entrepreneurship is not just a man's game. Teaching them how to pro-actively network could go a long way to improving their ability to attract capital and be more successful, thus expanding the field of possible advisors and mentors.

Women less likely to reapply after rejection

A study analyzed the rates at which men and women apply for biomedical research grants from the National Institutes of Health. They found that men and women apply at similar rates for the first round, but if the grant application is rejected, women are less likely to reapply (Hosek, 2005). Extrapolating from this, it is not unreasonable to expect that women initially discouraged from pursuing a patent might be less inclined to attempt to disclose another idea later on. However, this would be to the detriment of both the individual as well as the university in terms of lost opportunities.

Conclusion

Finally, it is worth noting that the Honorable Birch Bayh, one of the co-sponsors of the original bill which developed the necessary legal framework to enable universities to own and develop the technology generated by research performed on campus, was also a champion of equity and the sponsor of Title IX, which prohibits discrimination by sex at educational institutions receiving federal funds. He described it from the Senate floor as "an important first step in the effort to provide for the women of America something that is rightfully theirs—an equal chance to attend the schools of their choice, to develop the skills they want, and to apply those skills with the knowledge that they will have a fair chance to secure the jobs of their choice with equal pay for equal work." Given his strong record of supporting opportunities for women, it is not inconceivable that those sentiments could be applied to technology transfer.

In summary, we offer several recommendations to increase the number of women disclosing ideas, getting patents, licensing technologies, and starting up companies.

1. Provide implicit bias training for technology transfer officers.

2. Track the gender of people disclosing technologies and earning patents; compare ratios to make sure unconscious discrimination is not occurring.
3. Increase the entrepreneurship training opportunities for graduate students and postdoctoral fellows.
4. Adopt policies that enable faculty to engage in entrepreneurial activities without penalizing their tenure success.
5. Increase outreach to areas more heavily dominated by women, including the humanities and nursing.
6. Encourage those whose disclosures or patent applications were rejected to reapply in the future, implement policies to follow up with those individuals to avoid lost opportunities.
7. Model change upon other programs that have been successful in reaching out to women, such as the University of Florida's eWITS, Stanford's StartX, and the University of Minnesota.

Acknowledgements
Thank you to the dozens of members of the Association for University Technology Managers who took the time to speak and meet with me. Mark Crowell, Dr. Henry Etzkowitz, Lila Feisee, Dr. Joan Herbers, Mike Waring, and Jim Woodell participated in our Policy Symposium Panel and provided thoughtful discussion. Particular thanks to AWIS CEO Janet Bandows Koster, Dr. Gautam Prakash, and Dr. Walter Valdivia for critical reading of the manuscript and detailed discussions.

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