Academic Entrepreneurship: An American (Individualistic) Perspective

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Abstract
Universities have traditionally served as places for teaching and learning, generators of new knowledge and understanding, repositories and preservers of knowledge, transmitters of values and builders of citizens, and neutral spaces for debate. In the United States public universities also took early on the role of assisting local economic development. In recent years, universities across the developed world have been expected to serve as prime sources of new ideas, generators of new technology, founders of new companies, and critical contributors to economic growth. Ironically, however, while society increasingly focuses on this latter role, it still compensates universities and their faculty in pretty much the old way, that is primarily on the basis of research and teaching. This inconsistency has created deep tensions that policy makers are desperately trying to resolve. This paper deals with this newly acquired role of universities through the lens of incentives for both individuals and organizations. It argues that proper incentive alignment is badly needed, that the nurturing of individual learned entrepreneurs is achievable under the right conditions, and that all sides of the triple helix have an important role to play.

Keywords: University Entrepreneurship, University-Industry Relations, Cooperation

"Knowledge is not simply another commodity. On the contrary, knowledge is never used up. It increases by diffusion and grows by dispersion"

Daniel J. Boorstin (1914-2004)

1. Introduction

Government and industry are increasingly looking toward universities to help lift the United States out of the recent economic crisis. The hope is that research transferred from universities will generate new product innovations and inventions. Knowledge transferred from universities would take the form of expanded capacity of existing firms or increasing the number of start-ups and spin-offs created by graduating students or entrepreneurial-minded research professors. This appears to be more than just hoping. The number of spinoffs generated by universities research has more than doubled between 1996 and 2005, from 200 to 450 (Hayter, 2011). Most research universities have created Technology Transfer Offices (TTO's) to encourage the transfer of knowledge to industry or to help students and faculty members establish start-ups

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or spinoffs.

Universities were established to collect, refine, organize, and disseminate knowledge in a useful and productive manner. The word university comes from the Latin universitas magistrorum et scholarium, meaning "community of teachers and scholars." In Western Europe, the Latin word "universitas" was applied to degree granting institutions of higher learning. There has always been the presumption of academic freedom within the culture of higher learning. The acquisition of knowledge is seen as a goal in itself. This is at odds with the guild model that taught a trade according to standards that maintained high degree of quality and reliable standards for goods and services. Medieval guilds were specialized associations of teachers and students that took shape as urban life developed. Guilds usually had some legal standing guaranteed in the form of a charter issued by the state. The Guild members adhered to standards and practices that produced a useful and marketable skill (Boorstin, 1983). It was an organization built on the notion of learning for the purpose of acquiring a skill that was useful in the market place. Members of the guild were trying to acquire a skill that made its members money. This is at odds with some of those in the university system who see learning as something more than the pursuit of a moneymaking talent. To them, learning is a noble pursuit, an end in its self.

Learning is a noble pursuit. However, it is the practical application of knowledge that has changed the world and not merely the acquisition of knowledge. The acquisition of knowledge without the application of knowledge – as has often happened in the past (Mokyr, 1991) – may have private value but, from the point of view of society, it can be argued to be a wasteful endeavor. Thomas Edison was an inventor and entrepreneur, not an academic. He experimented and developed new products to make money. He invented and innovated to produce a marketable commodity so it could be sold in the market place and he abandoned research once he determined there was no profit in it. He is credited with the establishment of the world's first research laboratory in what is now Edison, New Jersey (Wikkisource; Thomas Edison). Edison did this without any formal schooling or university degree. The research laboratory was built to acquire the knowledge necessary to invent, market, and patent products or processes that made Edison money. This is not an indictment of the university system. Many people graduate from universities with marketable skills and apply what they have learned to their careers and are extremely productive. What does the student gain by attending the university? Was it the ability to make money or the motivation to make money?

Universities are storehouses of knowledge. They teach what has been learned through the course of time and produce new knowledge through research. For example, a student may have chosen engineering because he was interested in the field or because he had talent for math or because his parents were engineers. The ability to get a job or make a lot of money may have only been a secondary motivation. The school of engineering prepares the engineering student to enter the business world armed with all that the university could teach him in four years. The graduate understands the principles of engineering and has learned the newest engineering techniques. But, that is not enough to be successful. The graduate must apply the knowledge he has acquired and he must work hard. He must adapt to his new environment. He must become useful. He must earn income. He may have to change to do it. He must be motivated to become successful. Where would this motivation come from? Did it come from what was learned in the university or did it come from the individual?

Are individuals successful because they have applied what they have learned in a meaningful and marketable way? How does the individual measure success? Successful entrepreneurs may not have been successful academically and successful academics may not be successful entrepreneurs. They may in fact be different people with different talents.

It has long been recognized that invention and innovation are essential to a strong economy. An educated work force is the keystone of invention and innovation. Governments have done much to improve the level of education of their citizens and attract talented individuals to enhance existing or

start new industries. In fact, the federal government has promoted education since the nation was formed. President George Washington was a strong proponent of education to the end of his presidency, calling for in his farewell address to congress "Institutions for the general diffusion of knowledge" (Ellis, 2002). The Morrill Act of 1862 started universities in every state. The federal government gives billions of dollars to universities to do basic research and acquire new knowledge. The Bayh-Dole Act allows universities to patent their discoveries from federally funded research. A university can sell licenses on the patents they produce or researchers can start companies of their own and profit from their discoveries. The money from the federal government is meant to ensure that innovations and inventions reach the market place.

This paper discusses the concept of academic entrepreneurship and the effects of university-derived research on the economy. It also discusses the researcher and the entrepreneur as individuals. The paper intentionally takes a provocative stand in order to elicit discussion on the topic.

2. Morrill Act of 1862

President Abraham Lincoln passed the Morrill Act into law on July 2, 1862. Under the act each state received 30,000 acres of federal land for each member of congress the state had as of the 1860 census (Homer A. Neal, 2008). The land was to be used for the establishment and funding of universities to educate the populations of each eligible state. The universities were originally intended to enhance the skills of the citizens in existing industries. They supported agriculture and mechanical arts. The universities were known as Land- Grant Colleges. The curriculum was formulated by the state legislature with a few conditions set by the federal government. Provision six of the act did not allow states in rebellion or insurrection to benefit from the act. This excluded several southern states until after the civil war. Most of the universities were public with the notable exceptions of the Massachusetts Institute of Technology and New York's Cornel University. The universities were established "in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions in life" (Homer A. Neal, 2008). This act was intended to give the population access to practical and useful knowledge. A university-educated workforce trained with skills that were applicable to the market place enhanced agriculture and industry. The federal government gave land to the states that could be sold or used to educate the state's population in order to produce positive results in the market place and expand the economy. The federal government saw the benefit of investing in education: money spent on education transferred into market efficiencies and increased innovation in the market place. The more the economy expanded the more the country could generate in revenue. There are certainly altruistic motivations behind the passage of the act, but there was also a bottom line consideration. The federal government saw the Land-Grant Universities as a profitable investment.

3. Bayh-Dole Act

Passed on December 12, 1980, the Bayh-Dole Act gives the Intellectual Property Rights (IP) to Universities, small businesses, and non-profit organizations for their discoveries and inventions that resulted from government funding. Prior to the passage of Bayh-Dole only, 5% of the federal government's 28,000 patents were commercially licensed and less than 250 patents were issued to universities each year (Homer A. Neal, 2008). Most of university patents were not commercialized and the public did not receive a marketable benefit from the research. The law provided a vehicle for the transfer of inventions and innovations from universities into the market place. Prior to the passage of the act there was no formal process. The Bayh-Dole Act created and incentive for university researches to work with industry and pursue research that had practical applications. The act also was passed with the intention of making research universities less dependent on money from the federal government (Lipinski 2008). While there are certainly descending voices (Mowery and Sampat, 2005; Pascoe

and Vonortas, forthcoming), there is widespread belief that Bayh-Dole Act has lived up to its promise. In FY 2005 universities received 3,300 new patents and had reached almost 5,000 new licensing agreements producing over a $1 Billion of revenue (Homer A. Neal, 2008).

This process ensures that industry has access to useful research findings and can develop and exploit the findings into new innovations. It also allowed for the technical transfer of knowledge and skills to a wider range of users. More than 5,100 new companies or "start ups" have been created since 1980 based on the transfer of technologies created by academic institutions (Homer A. Neal, 2008).

The number licenses have granted by universities has grown from 936 in 1970 to 3,295 by 1999 (Feldman M., 2003). The act encourages researchers to disclose their discoveries to the universities. In return, the universities share a portion of the royalties with the researchers. The university share of royalties, if any, must be applied to future research. A small portion may also be applied to university technical transfer efforts.

Despite the oft-called success of the Bayh-Dole Act, there has been criticism (Pascoe Vonortas, forthcoming). There is a deep-rooted fear that research departments of universities are becoming too commercialized. It is also feared that university faculties are losing their objectivity and are pursuing profits rather than teaching students. This has, until now, been primarily a philosophical argument. This argument is only a short step from the semi religious "knowledge for knowledge's sake" philosophy that robs universities of much of their usefulness. There is also the criticism that the federal government has already paid for the research once with taxpayer money and the benefits of the research should be free to the taxpayer. This is a fair criticism and deserves a fair hearing. However, before the Bayh-Dole Act the pace of technology transfer from universities to industry was glacial compared with pace of nowadays. The purpose of the act was to improve communication and collaboration between researchers and industry and take advantage of the capabilities of both institutions to stimulate the economy. The financial incentive was necessary to ignite the entrepreneurial fires of university researches by creating an incentive for research with practical applications. It also gave university students a chance to see the importance of their research in the market place. University research developed in conjunction with industry provides the economy with competitive advantages that would not normally be affordable to most companies. It also encourages the formation of start-ups by individuals associated with the university. This creates jobs in the economy and the taxpayer is rewarded for their investment.

4. The Researcher

What is an academic entrepreneur? Is he a scientist who is trying to make money? What motivates the researcher to leave the laboratory and enter the business world as an entrepreneur? Is success as a researcher indicative of someone's potential for success as an entrepreneur? Are the same talents required? If not can these talents be learned?

Researchers are creative people. A recent study conducted by MIT indicates external motivation does not ensure that the researcher will perform better. It may actually have the opposite effect. External motivators like a year-end bonus appear to be most effective on those people doing rote or routine tasks (Glei, 2011). Monetary rewards do not seem to be a significant incentive to create.

Researchers are self-motivated or motivated intrinsically. They are self-motivated by three key factors: autonomy, mastery, and purpose (Glei, 2011). Autonomy, working alone in the researcher laboratory, is a motivator that could easily be shared by an entrepreneur. It appears to be a primary motivator for the researcher and may only be secondary for the entrepreneur, but there is a connection. The effect of the motivation is, however, different. The process of developing new technologies is time consuming and expensive. The researcher is concerned with the answering of questions. To discover the how and why things work the way they do. They are discoverers. The process of discovery does not stop

when a commercial application for the research is stumbled upon. The research is stopped when the answer is found. That was the purpose of beginning the research. This is not the same motivation an entrepreneur has when he tries to answer a question. In fact, the entrepreneur is not motivated by the how or the why something works. He is motivated by the commercial application of what he has found. Once the commercial application of something is found to be successful or unsuccessful he stops his research and moves on to something more promising.

Mastery of a subject is closely linked to autonomy. The researcher is motivated by curiosity to discover what can or may be learned. He will pursue a particular area of study and strive to learn all that can be learned. The end of the pursuit is signaled when the researcher has answered his question or made his discovery. This gives the researcher a feeling of self-satisfaction. His discoveries earn him the respect of his peers. The researcher is a scientist in search of all available knowledge in his area of exploration. If he cannot answer all the questions he has by reading the work of others he will conduct his own research until he has taken it as far as he can. His is the quest for knowledge. It is possible that an academic may actually stop at some point during his research and try to assess the marketability of a discovery or a particular line of research, but it is not clear that he would recognize it if he was not searching for it from the start. Or if industry did identify a commercial application for the research, would the researcher change the direction of the research to satisfy the commercial requirements.

The purpose of the research is perhaps the strongest of all motivators to some researchers, whether they are seeking the cure for cancer or just making the world a better place to live in for the rest of us. Their name linked to an important discovery or their name listed on a ground breaking research paper may be the reward they desire. Money gained from royalties could be quickly spent and offer no lasting reward compared to the linking of their name to something that benefited the human race. Altruism comes to mind. Doing good for good's sake.

Research from Duke Medical Centre indicates that there is a section of the brain that is responsible for altruism (Booth, 2007). Researchers conducted an experiment that identified the part of the brain called the posterior superior temporal sulcus as the likely root of altruism. This is the same part of the brain that is associated with understanding relationships. The results also showed that people with a more sophisticated understanding of social situations are more likely to act on the behalf of others. It can be clearly seen that being able to understand social settings or society has advantages to the researcher and the entrepreneur. However, the researcher is motivated by his understanding of society in order to help satisfy the needs of society. The entrepreneur uses this same insight to make a profit by exploiting the needs of society. Some academics would characterize the contrast between the use of knowledge by researcher and the use of knowledge by the entrepreneur as reminiscent of the contrast between good and bad. This hardly is the case, but the two groups are motivated in fundamentally different ways.

5. The Entrepreneur

The entrepreneur pursues opportunities. Entrepreneurs view opportunities in the economy by measuring their profit-making potential. Profit is their primary motivation. The entrepreneur will not pursue a societal need unless he can successfully make a profit. He does not choose to satisfy society's greatest needs. He rather seeks to satisfy his greatest needs summed up by the accumulation of wealth and the need to achieve (Scott Shane, 2003). Entrepreneurs are risk takers. They do not seek out the most risky opportunities, but they are willing to take on a certain amount of risk to satisfy their needs. Entrepreneurs evaluate opportunities in the market place differently depending on how each perceives the level of risk and his capacity for mitigating the risk. There are a number of external factors that influence the level of risk such as environmental regulations, political attitudes, industry regulation, health of the industry, current state of technology, market size, and the availability

of resources such as, venture capital, skilled labor (Hayter, 2011). This is a much more complicated set of constraints than the researcher typically encounters. But, there are similarities between what motivates the researcher and the entrepreneur. A 2005 study of entrepreneurial motivators by the San Francisco State University conducted interviews and a survey of the explosive growth of high-tech start-ups in India. The first three items listed by the respondents were autonomy 57%, making money 43%, and saw business opportunity 27% (McCline, 2005). The first motivator compares well with the first priority of the researcher. They both enjoy autonomy. This does indicate that both groups are self-motivated and seek to achieve for achievement's sake. However, autonomy may mean different things to these groups. It can be that the researcher desires autonomy so they may pursue their own goals without interference, to discover what may be down the next road to satisfy a personal curiosity. Autonomy to the entrepreneur means he has the freedom to take risks, to turn down the next road to exploit an opportunity. Each group feels the need to create or attract creative people. Creativity requires freedom. However, the second item in the survey, making money, indicates that there are fundamental differences.

Another major motivator noted by a number of respondents was that they enjoyed the excitement of being an entrepreneur. This is shown in the comment: "We are not sure what's coming down the curve but it is a thrill." The interviews also showed that money was never the primary objective or pursued for its own sake. These comments must be balanced by the method in which this research was conducted. It was a collection of interviews, not an analysis of empirical data. It is probable that the respondents placed money secondly to show themselves in a more favorable light. The fact that money was listed as high as second does seem to at least partially attest to the honesty of the respondents.

Bill Bither's Insights lists five personality traits of an entrepreneur:[1)]

1. Desire to build a better mousetrap
2. Willing to take risks
3. Supportive family and friends
4. Motivated to the point of being obsessive
5. Jack of all trades

The first thing that jumps out at the reader is that making a profit is not listed. Here again, this is a list of personality traits that we are being provided by someone who wants be viewed favorably. He is probably talking about his personality traits or the traits he believes he possesses. However, Bither does list the willingness to take risks as second most prominent personality trait.

Researchers and entrepreneurs are different people motivated by the desire for autonomy and the desire or need to create. This describes two groups of self-motivated and intelligent people. But, the fundamental difference between the two groups may be the willingness to take risks. It may not be that researchers are risk adverse, but they do not need to take risks to achieve success. The entrepreneur may actually need to take risks to validate his successes.

It is clear that the economy needs both researchers and entrepreneurs to be successful. And membership in one group does not exclude membership from the other. Universities and industry are linked together by the two groups. But how is the relationship best formed to the best advantage? A number of approaches could be used. The university could ask industry what appeared to be the most promising areas for product innovation and invention or industries could ask what current research had the most commercial applications. Each must see the value of the relationship in order for any approach to be successful.

6. The University

As indicated earlier in this paper, American research universities have traditionally been seen by the federal and state governments as a source of innovation and invention for industry. The role of universities as

1) Bill Bither is the Founder and Chief Executive Officer of Atalasoft a leading software development toolkits. The five personality traits were on his company's blog.

engines of innovation and invention is deeply rooted in the country. Nevertheless, the relationship between universities and industry has not always been a close one. Since they gained international preeminence around the middle 20th century, however, universities have appeared content with graduating students and publishing the results from their research. The primary motivation for a university research department has been more closely linked to the recognition it received from its research findings or its ability to promote its "star scientist" (Hayter, 2011). University presidents measured the success of their university by level of prestige it attained. Working with industry to conduct commercially applicable research for sometime was almost considered impure.

The passage of the Bayh-Dole Act in 1980 allowing research universities ownership of the intellectual property rights resulting from federally funded research did stimulate the entrepreneurial appetites of some research departments. Universities now attempt to shift their emphasis and make commercially viable research a priority. Technology Transfer Offices (TTO) are a part of almost every major university campus with the purpose of creating and maintaining a productive relationship with industry and establishing the intellectual property rights in the form of patents and copy rights. This is not an indication of a sure source of revenue. Only a small number of university patents generate income. The success rate is generally considered to be rather slim: one hundred invention disclosures will generate ten patents, which will in turn generate one successful product (Feldman M. , 2003). Some universities have always been more commercially orientated than others. The University of Wisconsin was the first to establish a TTO (Feldman M. , 2003). The Wisconsin Alumni Research Foundation (WARF) was established in 1925 to maintain patents derived from Professor Harry Steenbock's work on Vitamin D. Today WARF lists over 1,800 new patents on its web site. WARF was so successful in generating income for the university that it became a template for other TTOs.

The University of Wisconsin proved the benefits of patenting research results over 80 years ago. That university does have the two key factors associated with the early adoption of technical transfer, the presence of a medical school and the status as a land grant institution (Feldman M., 2003). The success could be traced back to the Morrill Act, which invested in the state with the hope that the citizens of Wisconsin would become self sufficient and less dependent of the government. Why did it take other universities so long to follow this example?

The answer may be rooted in the basic culture of the university. Research is the systematic investigation to establish facts, solve problems, and prove or develop theories. Discovering what is yet unknown in directions divined by intellectual curiosity rather than the bottom line. Scientific research relies on the application of the scientific method to explain the world around us. The "ivory tower" culture associated with a noble yet disconnected institution may accurately describe part the problem. The atmosphere of the research laboratory may yet be permeated by the esoteric pursuit of knowledge that is fundamentally disconnected from practical concerns of everyday life. The researcher devotes countless hours pursuing answers to questions that may have no immediate or obvious practical application. Once an area of research reaches an end the findings are published or recorded. Papers are written and published in the appropriate scientific journals and the researcher moves on to other pursuits. A patent may be applied for by the university and registered with the TTO. Researchers may be discovers of a different kind, motivated by their private inner workings. George Mallory who took part in the first three British attempts to climb Mount Everest famously replied to the question "Why do you want to climb Mount Everest" with the retort "Because it's there" (Anker, 1999). There was nothing practical about Mallory's search for the summit. Mallory wanted to go where no man had been before and do what no man had done before. Researchers at some universities may be searching for summits of their own. Once the answer is found the journey is ended.

Technology transfer begins when the answers are found. People facilitate the transfer of technology and knowledge, not papers. The next step is to make the

work meaningful. The university either through the TTO or the researcher himself must get the research into the right hands. The researcher could, by chance, have an entrepreneurial spirit and shop his discovery around to local industry. This is expecting much of the researcher who is trained in the scientific methods of discovery. It would also take the researcher out of the laboratory and away from his work. The TTO should be the marketing and advertising department of the university.

The research department should exploit the successes of their researchers much the same way the athletic department exploits the successes of its athletes. Successful and popular sports programs such as football or men's basketball are viewed as a revenue generating resource for all university sports programs. University sports teams generate millions of dollars and raise the visibility of the entire university. A successful football program can support all other university sports and still return a profit to the university. Stadiums and athletic facilities are built with the revenue generated from profitable programs and are used by the entire student body.

The coaches still coach the athletes and the athletes still play the games but the marketing of athletics is handled by marketing professionals. For a university TTO to be successful it must adopt a similar posture. The researcher should be focused on his research and leave the marketing of the research department to those in the TTO with the ability to market.

Technology transfer has been called a "contact sport" (Foley, 1996). This requires that individuals from research departments and individuals from industry interact on a personal level and establish relationships. This cannot be accomplished by reading each other's work. Knowing each other on a personal level and developing an understanding each other's perspectives is essential to establishing a productive relationship. The two must get together and learn from each other. This is not a task that the researcher is ideally suited for and individuals conducting industrial research may not see any need for the relationship. The university TTO should be the conduit for these relationships. TTO's must become the marketers for the research departments.

7. The Community College

Community Colleges do not conduct research. They are discussed in this paper to add some perspective to the meaning of higher education and the role higher education plays preparing students for their part in the economy.

There are more individuals enrolled in community colleges that any other kind of higher education (Bus, 2010). Community Colleges or Junior Colleges are two-year institutions that serve the local community. Many of the students take only one or two classes during the evening after work or on the weekends. They are funded by state and local tax money and allow any student to attend. The curriculums of a community college are designed to give students' job training or technical skills that can be applied to the students' current position or be used to seek a better position.

As an example, an automotive technology program gives the student working at the local Ford Dealer the skills to move from the parts room as a shelf stocker into the garage as a mechanic. This is a direct link from the community college to the economy. There is an obvious and direct benefit to both the student and to the dealership. This is not a technical transfer of research findings from the community college to the dealership, but it is the direct application of knowledge learned by the student at the community college. Community Colleges must keep in constant contact with the auto industry advances to maintain a relevant curriculum for the student. The Ford dealership and the Community College in this example need each other and maintain a close relationship.

Community Colleges employ part time professors still active in their professions in an effort to maintain a direct link with local businesses and ensure the relevancy of course material. The professors also gain by keeping abreast of aspects of their profession that they may have not known if not for their interaction with other faculty members.

There are two points that are worth noting. The

first, knowledge gained at the Community College is intended for immediate use by the student and provides immediate benefit to the economy. Community colleges are established by local governments to provide a vehicle for local citizens looking for a way to help themselves. This was the intent of the Morrill Act. The second, the college administration, the local government, and local businesses maintain a close and personal relationship. They need each other. This may be the element that is lacking at universities without successful Technology Transfer Offices.

8. The Technology Transfer Office

Technology Transfer Offices (TTO's) are meant to be the entrepreneurial arm of the university. They establish the intellectual property rights (IP) for inventions and innovations produced by the university in the form of patents, copyrights, and trademarks (Feldman M., 2003). The transfer of technology depends on the marketability of the innovation and the ability of the TTO to get the innovation into the hands of a company or entrepreneur willing to invest in a license. The TTO must do more than establish the rights to every submission they receive, however, they must determine the value of the submission or at least be able to separate the more promising innovations from the rest. The assessment and transfer of knowledge is difficult. This would seem to put the TTO in the unenviable position of trying to market products that they do not understand to customers that do not want what they are selling.

The purpose of the TTO is to protect and to sell university IP. This has been successful to some degree, but more could be done. The Association of University Technology Managers (AUTM) purports to support and advance academic technology transfer globally. Their web site (www.autn.net/Public_Benefits) admits that many of the benefits of technical transfer are not immediately visible, taking the form of educational advancements and contributions to the academic research enterprise. Instances of technology licensing are recorded in the annual AUTM U.S. Licensing Activity Survey. The 2010 report includes an impressive number of 657 commercial products introduced by TTO's. What was not clear from the report was the effect these new products had on the economy and what revenue was generated for the university. The AUTM does provide statistics that are required for the tracking of the number of technical transfers, but not the quality and usefulness of the transfers. AUTM's White Paper In the Public Interest: Nine Points to Consider in Licensing Technology (March 2007) listed eight of the nine points legal protections.

A TTO's function should be much broader than patent protection. They should function as a profit seeking organization. They should make money. It should be influenced by the needs of the market. This would require the TTO's to be on equal footing with research departments and have some influence on the direction of research. This could be done by having the TTO facilitate an active relationship with researchers and their industrial counter parts by allowing industry to be involved from the earliest stages of research. TTO's would have to evolve from an administrative organization into an entrepreneurial organization.

9. Innovation Clusters

Science-based innovation is commercialized by the triple helix of: universities, industry, and government (Etzkowitz, 2006). Clusters are geographic concentrations of interconnected companies and specialized suppliers associated with a particular industry that are present in a definable area. High tech clusters are typically composed of a number of new technology companies with connections to one or more research universities. On aggregate, clusters follow a traceable path. A student graduates from the university with an idea for a new product innovation. The graduate starts a new company to market his idea and becomes an entrepreneur. The entrepreneur acquires angel and venture capital and expands his company while maintaining a close relationship with the university. As other graduates leave the university they seek employment from the entrepreneur or emboldened by the entrepreneur's success they seek

to start companies of their own by leveraging what the entrepreneur has established. As the number of successful companies increase the cluster takes form.

This appears to be a straightforward process, but it has proven difficult to repeat. What motivated the university graduate to start his own company? How did he acquire venture capital, and how did he market his innovation successfully?

Maryann P. Feldman suggests in her work on biotech firms in the U.S. capital region that there are three exogenous sets of factors that are necessary to provide a region with the proper environment to generate cluster growth: pre-existing resources, entrepreneurship incentives, and infrastructure provided by the government (Feldman M.P., 2007). The biotech cluster is concentrated along interstate 270 and is located predominately in three cities in Maryland, Frederic, Gaithersburg, and Rockville.

The National Institutes of Health (NIH) is located in Bethesda Maryland and provides the biotech companies with the financial resources necessary to conduct research. The research by several of these companies has proven to be successful. Maryland ranked fourth in the number of patents issued in 1997 (Feldman M.P., 2007).

Placing a company near a prime revenue source like the NIH is an obvious advantage, but it would seem hardly enough on its own to start an innovation cluster. There are other recourses that must be available locally. The location of Johns Hopkins University and several other research universities nearby are necessary for the generation of basic research, but also to supply the biotech firms with a steady supply of talent. There must be a continuous supply of new talent and new ideas to make a cluster viable.

Silicon Valley is perhaps the most famous innovation cluster, a glowing example of what can happen when all the right ingredients are in place. However, this may not have been a case of spontaneous generation as popularly believed. Silicon Valley may not have begun in 1955 when William Shockley invented the transistor at Bell Laboratories and founded Shockley Transistor Corporation in Palo Alto, California. And Fairchild Semiconductor may not have been the first spin-off. An engineer named Cyril Elwell employed at the Federal Telegraph Corporation (FTC) based in Palo Alto may have signaled the true start of the region's development in1912 (Sturgon, 2000).

In January 1909, the United States navy was soliciting bids for a ship to shore radio system capable of reaching a ship 3,000 nautical miles at sea. The system had to function day and night and in all weather. This was outside the capabilities of radio equipment at the time. The contract went to the lowest bidder, NESCO. However, a few years later Elwell demonstrated a new radio technology, the Poulsen Arc, which generated continuous long radio waves with an electronic arc operating in an atmosphere of hydrogen contained by a strong magnetic field. The system became the first global scale radio communications system. (Sturgon, 2000)

Cyril Elwell graduated from Stanford University in 1909. Cyril had seen Dr. Vladimir Poulsen of Copenhagen Denmark demonstrate his invention of the spark-based transmitter in Paris in 1900. Elwell's own attempts to produce the technology were unsuccessful. In 1908, Elwell went to Denmark and acquired the patent rights from Dr. Poulsen. Elwell had trouble attracting investors and eventually turned to Stanford University to acquire financing. Stanford University agreed to finance the company and the Poulsen Wireless Telephone and Telegraph companies was born. Elwell marketed his wireless system by holding public demonstrations and engaging the public.

Cyril Elwell is an important figure if we are to understand innovation clusters and the birth of the Silicon Valley. He is important for two reasons. The first, if he did start Silicon Valley, he started it long before 1955. Innovation clusters may take much longer to take shape than previously thought, even when all the conditions are right. The second, who he was and what he was in the innovation process. He was a Stanford University graduate. He was an engineer that could not produce the product he desired. He was an entrepreneur. He believed in his product. He worked hard. And he took risks. These are ingredients provided by the individual and cannot be provided by others.

10. Start-ups and Spin-offs

University start-ups and spin-offs are viewed as a means to energize local economies by transferring new product innovations and new more efficient production process directly into the local community. Local entrepreneurs can license patents from the research university and spark economic growth in the area. A university may license a patent to anyone and are not constrained to the local economy; however, entrepreneurship is seen as a local activity. Local governments fund university research in the hope that there will be some benefit to local or regional firms. University TTO's serve as the conduit between university researchers and the local government, industry, and entrepreneurs.

There are three mechanisms that the TTO can use to transfer technology to the local economy, sponsored research, licensing, and spin-offs. Sponsored research by a local industry is the most traditional form of university to industry technical transfer (Foley, 1996). For example, a company, such as U.S. Steel, funds research at Carnegie Mellon University to develop a more efficient method of steel production. Once the research is complete the research findings are transferred to U.S. Steel and the process ends. The relationship also ends. U.S. Steel gains efficiency, but no new firms are started in the economy. This may benefit the local economy by keeping U.S. Steel competitive in the global market and preserve existing jobs, but it does not create new jobs for the local economy.

Licensing of university patents to local firms is beneficial to local industries and to the university by providing the university with a means of revenue for more research. Industrial products, including but also extending well beyond IT and biotechnology, are becoming increasingly science based. Increasingly, governments hope that the license purchaser will start a new company or even lay the foundations of a new industry. University start-ups and spin-offs are becoming fast the great hope of economic development agencies.

The research required to bring most high tech innovations from concept to the market place is expensive and time consuming. Investors bridge the gap between invention and innovation. For each innovation a business case must be developed and supported to attract entrepreneurs and investors. Some innovations are worthless without the researcher and will attract no interest unless the researcher agrees to become part of the spin-off. Some high tech spin-offs generate extraordinary returns to their investors (Branscomb, 2003). The purchasing of a license and the willingness of the researcher to participate in a start-up or spin-off will not guarantee the interest of investors. However, there are sources of financing for new technology.

The tremendous profits generated by some high tech start-ups and spin-offs do tempt some investors. These include venture capital firms, corporate venture funds, incubators, law firms, university TTO's, and local governments (Branscomb, 2003). The key to making an innovation an attractive investment may lay with the entrepreneur. He must be the one person that ties the entire venture together. He must first recognize an opportunity and find a way to exploit the opportunity for profit. He must be able to distinguish between what appears to be a good idea and what is a marketable invention. He must also have a proven track record of success. For the entrepreneur to be a creditable advocate and sell the product to investors he must be able to prove he has been successful in the past. The guarantee of the researcher is a foregone conclusion. He believes in his invention and is certain that others will see its value. He has invested himself in the pursuit of an answer and has found it. He has the backing of other researchers and the university to attest to the value of the research. The entrepreneur is investing himself in the venture and using himself as collateral.

The successful entrepreneur is the most elusive member of the community. There are plenty of researchers, investors, and government officials all brimming with good ideas and intentions. Each is certain that they have something to contribute to the marketplace, an idea that is certain to work if only someone would just start the ball rolling. Once

someone else has taken the initiative and made progress, they would be right there to help. But nothing happens until someone is willing to take a chance and put himself at risk. There are examples of researchers who have taken chances and left universities and started highly successful companies, but these are rare when compared to the number of patents issued. Investors are risk averse. They are only willing to take a chance when there is collateral against the risk of failure and will only take the smallest share. Government officials have the answers to all of the problems all of the time, but they do not take chances with their own money. They can facilitate entrepreneurship, but they cannot create it.

11. Conclusion

Knowledge is a commodity. The triple helix of universities, industry, and government provide the source, the vehicle, and the mechanism for trading knowledge. The economy of the United States could be greatly improved by the proper application, marketing, and selling of scientific knowledge domestically and internationally. The United States has a well-established educational system. Education is available for every child through the 12th grade. If a student performs well scholarships for higher learning are available on a competitive basis. The founders of the country viewed education as essential to the economic and military strength of the country. The Morrill Act established universities throughout the country to provide the citizens of each state the opportunity to acquire an education and better themselves. A series of legislation in the past few decades including the Bayh-Dole Act gave universities the ability to profit from research they conducted using money provided by the federal government.

The state of Wisconsin established a university in Madison, the state capital, in 1848. It became a land-grant institution in 1866. It is now organized into 20 schools offering 135 undergraduate majors, 151 masters degree programs, and 107 doctoral programs. UWM is categorized as an RU/VH Research University (very high research activity) in the Carnegie Classification of Higher Education. The university has grown and now has nine universities and four freshman-sophomore branch campuses. (University of Wisconsin, 2011) To highlight a just a few scientific discoveries from this university: The first Ph.D. in Chemical Engineering in 1905; Vitamin A discovered in 1913; Vitamin B discovered in 1916; Invented the process for adding vitamin D to Milk in 1923; The drug Coumadin was developed in 1951; The first isolated and cultured human embryonic stem cells in 1998 (University of Wisconsin, 2011). Those are the accomplishments of one land grant university. There are 57 land grant universities including those residing in the U.S. territories and many more institutions of higher learning.

Industry is doing their part to improve the economy and contribute to innovation and invention. They do this by seeking profits. This requires industry to be innovative and efficient in the market place. Greater collaboration with university researchers would benefit the production and transfer of science based innovation. University TTO's should facilitate coordination between university researchers and their industry counter parts. TTO's need to be part of the entire process, from the formulation of new product ideas, to the direction of university research, to the active promotion of the university as a source of profits for industry. TTO's should become the entrepreneurs and risk takers of the university. They need to develop business plans and have the authority to conduct business and make contracts between the university and industry.

The government cannot innovate or invent. The government cannot produce entrepreneurs or develop an innovation cluster. They can only fan the flames of entrepreneurship once someone else produces the sparks. They can do this by giving tax breaks, by passing helpful legislation, and by staying out of the way and allowing the marketplace to choose the winners and the losers.

Thomas Edison, Cyril Elwell, and Steve Jobs achieved success by hard work and believing in themselves. They would not take no for an answer. They had an idea and the motivation to succeed. They certainly got lucky here and there and they also had

help along the way, but they were successful because they believed in what they were doing and were willing to take risks. They were entrepreneurs.

The university researcher is not a risk taker. He may take some risks, but this is not what he does best. The researcher is doing his best by conducting research and pursuing answers. The university should take risks by directing TTO's to become more engaged in the technical transfer process and fostering an entrepreneurial spirit in the TTO by hiring fewer technocrats to run the TTO and hire more creative and entrepreneurial-minded people. This would require more than a policy statement from the university president. It would require a change in institutional attitude. Some universities, like UWM above, seem to have always had that attitude or at least enough of it to make a difference. It may take hiring someone away from a successful university TTO and investing in an aggressive campaign. It would require taking a risk.

The entrepreneur is the one person that everyone needs. Industry and the government need him to start new businesses and preserve existing industries. He is the idea man. He will work until he succeeds or fails trying. The government needs the entrepreneur to employ people and generate revenue to pay salaries and taxes. Universities need the entrepreneur to attend their institutions and transfer knowledge into the economy. The entrepreneur is society's risk taker. He is the winner and the loser. He places himself, his fortune, and his family at risk to succeed. He is the one we all rely on to take risks for the rest of us.

The academic entrepreneur is out there right now. He is sitting in a classroom preparing to take advantage of what opportunities he can find. There are not many of them and some will never get their chance, but some will go out and do great things. We cannot really create them. We can only help them.

Universities can attract the academic entrepreneur and help him by engaging in the market place and adopting aspects of the community college model. The university should also employ researchers who hold jobs in industry. Industry experience directly related to the research being conducted may even be turned into a requirement for part of university research employment. This should encourage undergraduate and graduate students to hold positions in industries related to their majors while they are attending school and allow them to receive credit and payment for their work. It would also create a direct link between the research laboratory in the university and research efforts in industry that have a practical and marketable application. The researchers and students could work on school projects at work and work projects at school, because it would be similar work. This would be the same network of people working together on the same projects.

While a lot of complications remain to be resolved, such an approach will take a fundamental shift in institutional thinking by universities. It will be resisted by those invested in the traditional role of the university. However, education is a lifelong activity, for students, teachers, employees, employers, entrepreneurs, industries, and universities. Some universities will fail and some will succeed. The fittest will survive.

"Technology is so much fun, but we can drown in our technology. The fog of information can drive out knowledge."

Daniel J. Boorstin (1914-2004)

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