MENS ET MANUS[i]: THOUGHTS ON THE ROLE OF ENTREPRENEURSHIP AND THE STARTUP CULTURE IN TECHNOLOGY TRANSFER MODELING

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Introduction

Since the advent of Bayh-Dole in 1980[ii] and its enactment in 1981[iii], universities have focused more intensely on the practical benefits of research, development and technology transfer. For certain reasons in the early 1980's, some universities were more ready, willing and able than others to take advantage of the accompanying increase in government-funded research that followed Bayh Dole's enactment.

For example in the 1980's, universities, such as Stanford University and MIT were already well acquainted with the concepts that motivated Bayh-Dole's enactment, and those universities were able to "hit the ground running."[iv] Stanford, MIT and other similar institutions were well positioned to rapidly develop and implement Bayh-Dole-compatible university policies and procedures, the likes of which were already in place, whether inherently or by design. Those particular universities had long been acquainted with the practical concepts of intellectual property development and transfer before Bayh-Dole, and they could easily adapt to manage technology transfer opportunities that presented themselves as a result of Bayh Dole.

However, for various reasons other universities, whether well established or not, did not enjoy such an advantage in 1980. And despite a lapse of 25 years since Bayh-Dole's

enactment, some universities are just now beginning to develop technology transfer programs.

This paper will include a discussion of selected historic events that contributed to university participation with startup cultures, and a brief overview of the economic thought process that might underlie a university's success with technology transfer. An attempt will be made to determine why some universities were prepared to take advantage of Bayh-Dole, while others were not.

A Comment on Entrepreneurship and the Start-up Mentality

Perhaps answers that concern Bayh Dole compatibility are based in human nature. Likewise, those answers might be the result of long-term university scientific research and development, state government priority (e.g., the establishment of Land Grant universities and the Bayh-Dole Act)[v], cultural influence, or the necessities and economics of community development. The reasons for success with technology transfer seem as complex as modern technology itself.

Nevertheless, after reading several papers, articles and reports that address various aspects of university technology transfer[vi], it is this writer's opinion that needs-based entrepreneurship and the "start-up mentality" make up the thread that distinguishes the fabric of one university's success, from another university's lack of success in developing and transferring technology that is useful to the community at large. One observation seems clearly evident. Those universities that have worked with entrepreneurs from their founding have developed the necessary "can do" infrastructure that compliments the Bayh-Dole technology ownership and transfer model.[vii] The entrepreneurship and start up

mentality that continues to advance technology and fuel its transfer at a more rapid pace is part of a venerable entrepreneurial tradition that began long ago.

The Influence of Practical Agricultural Economics on University Development

David Ricardo, an early Nineteenth Century experimental farmer was one of Britain's leading economists during that period .[viii] In the post Renaissance tradition, Ricardo divided his time between farming, politics and economics at a time when these endeavors were less sophisticated and more directly intertwined. The early Nineteenth Century was also a period when solo entrepreneurs, rather than universities were at the forefront of applied agricultural technology and the related economics of its development.[ix]

Ricardo lived in an age when individuals conducted agricultural experiments, not for the sake of curiosity, enjoyment or a philosophical endeavor, but to improve farming productivity and output to meet the basic needs of a rapidly expanding population.[x] In early Nineteenth Century Britain, farmers were experimenting with fertilizer testing, cultivation methods, and machine performance.[xi] Farms became centers of research and development, and many farm owners, including King George III, were the principal investigators of their day. Those individuals were responsible for prolific advances in agriculture, and they realized the importance of reporting their findings before agricultural societies, the likes of which subsequently spawned public and private institutional entrepreneurship.[xii]

During the experimental farm period, theories of distribution determined the share of output between economic class divisions, such as landowners, farmers and laborers.[xiii] As

an aside, one can analogize such early economic divisions, however, with modern day divisions such as intellectual property owners (landowners), businesses (capitalists) and principal investigators (figuratively, laborers), with the university acting as a managerial umbrella organization.

At the outset, however, the need for growing produce more rapidly and efficiently to feed an expanding population led to technological experimentation, and to more efficient management and distribution of resulting technologies.

As a matter of course, early Nineteenth Century farming, coupled with technological experimentation, naturally spilled over into the economics of production and distribution.[xiv] One of Ricardo's farm related economic documents provides us with the following analysis:

> "The improvements which increase the productive powers of the land, are such as the more skillful rotation of crops, or the better choice of manure. These improvements absolutely enable us to obtain the same produce from a smaller quantity of land. If, by the introduction of a course of turnips, I can feed my sheep besides raising my corn, the land on which the sheep were before fed becomes unnecessary, and the same quantity of raw produce is raised by the employment of a less quantity of land. If I discover a manure which will enable me to make a piece of land produce 20 percent more corn, I may withdraw at least a portion of my capital from the most unproductive part of my farm……If, for example, the successive portions of capital [invested in the same land] yielded 100, 90, 80, 70; whilst I employed these four portions, my rent would be 60, or the difference between
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> | | | |
> |---|---|---|
> | 70 and 100 = 30 | | 100 |
> | 70 and 90 = 20 | whilst the produce would be 340 | 90 |
> | 70 and 80 = 10 | | 80 |
> | | | 70 |
> | 60 | | 340 |
>
> …If, instead of 100, 90, 80, 70, the produce should be increased [through "improvement" such as employing a specific type of manure] to 125, 115, 105, 95, the rent would still be 60, or the difference between
>
> | | | |
> |---|---|---|
> | 95 and 125 = 30 | | 125 |
> | 95 and 115 = 20 | whilst the produce would be | 115 |
> | 95 and 105 = 10 | increased to 440 | 105 |

95

60 440"[xv]

"From this, Ricardo argued that after technical change, the original output of 340 can be produced with just three units of capital, so that if the population was already fully provided for, the final unit of capital could be withdrawn bringing the net produce back to 345, but also reducing the rent by 30. Thus, in this account, technical change can affect both the amount of capital (that needs to be invested in agriculture) and rent." [xvi]

Today, a modern version of Ricardo's economic theory as it applies to a university engaged in scientific research and development might read as follows:

> Technological advances, which increase enterprise development, result from more skillful technology transfer, and from the choice of startups or other businesses to best implement that transfer. These technological advances absolutely enable the university to obtain the same output from a smaller number of internal and external entrepreneurial sources. If, by the introduction of new and different (pioneer) technology, the university can support its researchers besides building its infrastructure, the large capital expenditure from which those researchers received prior support becomes less important, and the same quantity of technological discovery results while employing less university capital. If the university associates itself with startups or other businesses that will enable the university to encourage group research, then discovery of pioneer technologies will result, and the university may withdraw at least a portion of its capital from the less productive part of its enterprise (mature or outdated technologies)…If, for example, the successive portions of capital [invested in all technologies] yielded, [figuratively], 100, 90, 80, and 70 [i.e., profit units from technology]; while the university employed these four portions of capital, the university's expenditure for its infrastructure would be 60 [a portion of that gross profit], or the difference between
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> 70 and 100 = 30 — 100
> 70 and 90 = 20 while IP production would be 340 — 90
> 70 and 80 = 10 — 80
> — 70
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> 60 — 340
>
> …If, instead of 100, 90, 80, 70, discovery of pioneer inventions and their development through startup enterprises could increase that number to 125, 115, 105, 95, the university's expenditures for infrastructure would still be 60, or the difference between
>
> 95 and 125 = 30 — 125
> 95 and 115 = 20 while IP production would be — 115

95 and 105 = 10	increased to 440	105 95
60		440

> From this, the university could argue that after increased technological advancement and implementation through startups or other businesses, the original output of 340 can be produced with just three units of capital, so that if the faculty and staff of the university were already fully supported, the final unit of capital could be withdrawn bringing the equivalent gross profit to 345, but also reducing infrastructure expenditures by 30. Thus, in this account, positive technical change can affect both the amount of capital (that needs to be invested in technology development) and real expenditures for university infrastructure.

The exercise, outlined above, might initially seem esoteric and somewhat removed from the subject of the university being well positioned to participate in technological development and technology transfer. Yet, that economic analogy is evident and unavoidable. Simply stated, universities that involved themselves from the beginning with solving practical problems greatly enhanced university infrastructure necessary for growth, and did so without exorbitant cost.[xvii]

One might expect that a common economic principle and common cultural roots formed the basis for such thinking. The benefits of experimental farm reasoning seems to have influenced the thinking and attitudes of those government benefactors and private educational leaders connected with Land Grant universities, such as the University of California and MIT.

Starting with the Right Attitude and Gradually Creating an Optimal Environment

Only a few decades after the experimental farm era, in 1861, MIT was founded as a private institution by an act of the Massachusetts State Legislature, and, shortly

thereafter, MIT received a Land Grant.[xviii] During that period, when the United States Civil War was testing American ingenuity, the Massachusetts State Legislature charged MIT with the "development and practical application of science in connection with arts, agriculture, manufactures and commerce."[xix]

From 1861 until 1900, MIT sought its professional faculty from commercial farming and industry. This practice distinguished MIT from other academic based universities, and provided unique opportunities for MIT's development.[xx] Thus by the end of the nineteenth century, MIT's faculty were already adept at persuading local companies to provide internships for MIT students. The practically oriented internships that resulted enhanced and reinforced creative interaction between university students and local industry.[xxi] By 1920, substantial consultation and interaction with industry had become the norm for MIT faculties. [xxii] Some companies that MIT started up at, or near, the beginning of the Twentieth Century, such as Stone & Webster (1889), Campbell Soup (1900) and, (Gillette (1901) are still providing products and services today.[xxiii]

It is fairly clear that MIT's leadership independently realized the desirable economics of Ricardo's experimental farming technology profit center as a practical model for later university technology development and transfer. And MIT was using these entrepreneurial principles on a much larger and more complex scale. In addition, stepwise progress at MIT, based on the practical problem-solving model has resulted in MIT becoming of one of the foremost technology transfer centers in the world.

In fact, if the entire list of MIT related companies had formed a nation in 1994, the "MIT nation" would have ranked as the 24th largest world economy, because the estimated $232 Billion of world sales would have been roughly equal to a gross domestic product of $116 Billion. That figure would be a little less than the Gross Domestic Product of South Africa and more than that of Thailand.[xxiv]

More importantly, in fiscal year 2005, 20% of MIT's licenses were with start-up companies. This is remarkable because MIT does not help to write business plans, and it does not have any start-up incubators. Moreover, MIT does not assemble management teams, nor does it invest any money in start-ups.[xxv] Other than having a century of entrepreneurial technology transfer experience to work with, there are several additional reasons why MIT continues to perform its entrepreneurial role so well with so little attention to peripheral issues. Some reasons for MIT's success are:

- A wealth of technology from investigators underscored by an entrepreneurial spirit among the faculty;[xxvi]
- Opportunities for "hands on" research experience associated with "state of the art" projects, creating the best of all worlds for up and coming CEOs, to combine hands on practicum with laboratory work and didactic studies;[xxvii]
- Enthusiastic support from the upper administration of MIT who are committed to technology transfer; [xxviii]
- The support of MIT Organizations, including but not limited to: the MIT Alumni Association; the MIT Biomedical Engineering Society (BMES); the MIT Center for E-Business; Center for Innovation and Product Development; the MIT Club of Entrepreneurship Activities; the MIT Enterprise Forum; the MIT Entrepreneurs Club; Technology Capital Network (TCN); and, not least among those enterprises, the MIT Technology Licensing Office;[xxix]
- Straight forward licensing procedures and an experienced technology licensing staff with the ability to "commit at the negotiating table" (most agreements can be signed in the Technology Licensing Office without further review);[xxx] and
- A research budget of greater than $1 Billion in fiscal year 2005, about 90% of which is federally funded.[xxxi]

When asked if any university can perform as well as MIT does in technology transfer, the Technology Licensing Office has responded as follows:

> "Yes. Start with outstanding people; clear, articulated policies; and a streamlined process. To get started, however, you will need a sum of money to invest in filing patents and building a portfolio. Do not expect to break even for five years or more."[xxxii]

One might add that universities interested in participating in technology development and transfer should also know that first serving the community, and then the nation, by solving practical problems, while inspiring pure research and practical development, in the manner in which MIT has done for better than a century, will help as well.[xxxiii]

But what about those universities that have exemplary track records in academia and pure research; those universities that paid little attention to practical problem solving, but which have come to recognize Bayh Dole as a perfect opportunity to become significantly involved with technology transfer?

Transitioning from a Pure Academic Institution to a Technology Transfer Center in the Post Bayh-Dole Era

Unlike MIT, which had been chartered to develop scientifically based applications in connection with agriculture, manufactures and commerce[xxxiv], the University of Chicago (UC) under its President Robert Hutchins, forbade the creation of a graduate school of engineering.[xxxv] Hutchins did not want to establish a "trade school" where engineers would depart from the objectives of pure scientific research to commit the sin of actually

working towards a goal. And, commercialization was a worse and demeaning activity commanding even less respect.[xxxvi]

The pure scientific research approach that the leadership at UC had been taking since the first part of the Twentieth century began to coexist in discord with "bootleg engineering centres" (the "self-startups" of the era) that were fast emerging in and around UC in the 1950's.[xxxvii] Reportedly, some of those fledgling bootleg centers were sophisticated enough to build complex space experiments in the astrophysics department, and advanced prosthetic devices in the biological sciences division at UC.[xxxviii]

As time progressed, the UC faculty watched restlessly as Stanford University and University of California San Francisco encouraged development and commercialization of inventive ideas. The resulting Cohen-Boyer recombinant DNA inventions developed at Stanford-UCSF were generating revenue for those universities.[xxxix]

After the advent of Bayh-Dole in 1980, the University, under the direction of its recently appointed President, Hanna Holborn Gray,[xl] realized that UC had permitted significant amounts of UC discovered technology to slip through its fingers, and the climate was ripe for a change of attitude toward proper technology development and transfer.[xli] University leaders first had to address the reasons why UC had fallen behind in technology transfer, and thus why it could not take full advantage of Bayh-Dole.

In the latter part of the twentieth century, UC faced the formidable task of creating an organized; university based entrepreneurial culture from scratch. Realizing that it was

making up for lost time and lost opportunity, UC established an entrepreneurial unit called the ARCH Development Corporation (ARCH) as a not-for-profit affiliate corporation.[xlii] To further the ARCH initiative, UC recruited Steven Lazarus,[xliii] Chief Executive Officer of the Argonne National Laboratory/The University of Chicago Development Corporation, and associate dean at the Graduate School of Business, the University of Chicago.[xliv]

In 1987, Robert Nelson and Keith Crandell joined Steven Lazarus to formulate a commercialization strategy that would encourage technology licensing and, at the same time, create an environment for spinning off promising start-up companies.[xlv] At that time, the Arch Partners (Lazarus, Nelson and Crandall) realized that the Midwest did not have a significant early stage venture capital community to support their effort.[xlvi] The Arch Partners realized that they needed to establish and incorporate a specialized venture capital organization as part of the ARCH initiative.[xlvii]

As a result in 1989, ARCH created the fledgling ARCH Venture Fund I, raising a modest $9 million dollars. ARCH then provided seed capital to 12 start-up companies.[xlviii] A year later, Clinton Bybee, an experienced seed investor and colleague joined the initiative as ARCH's fourth partner.[xlix]

Only a few years later in 1993, ARCH launched ARCH Venture Fund II, a $31 million dollar effort that was instrumental in seeding 22 new companies reaching as far as the eastern seaboard.[l] In addition to its original focus of serving UC as a technology transfer center, ARCH, through its Venture Fund II, created working relationships with Columbia

University, Sandia National Laboratories, Los Alamos National Laboratory and University of Washington.

Subsequently in 1996, ARCH launched ARCH Venture Fund III, infusing an additional $107 million to establish 25 new high technology ventures with specialties ranging from information technology to life sciences. For further opportunities to develop spinoffs and entrepreneurial concerns, Venture Fund III looked into the further development of successful startups that had resulted from Venture Fund II.[li]

Between 1996 and 2000, ARCH launched ARCH Venture Fund IV, a $175 million effort to continue investing with 27 companies in information technology, with an emphasis on internet-based emerging technologies.[lii]

In 2000 and 2003, respectively, ARCH launched ARCH Venture Fund V, a $380 million fund and ARCH Venture Fund VI, a $350 million fund, making ARCH one of the largest providers of seed capital in the United States with over $1 billion under management. Reportedly, as a result, "ARCH is uniquely positioned to capitalize on important discoveries and trends as formerly distinct technologies begin to converge.[liii]

In its brief but exceptional and successful history since its establishment in 1986, ARCH has participated in forming a substantial number of start-up companies in diversified fields.[liv] According to ARCH, the Harvard Business School published two case studies examining ARCH's successful model of technology commercialization.[lv]

As of 2000, ARCH's team members included business professionals, researchers, academicians and graduate students all working in conjunction to optimize commercialization of university and laboratory research results. ARCH's Board of Directors consisted of the University Head Counsel, the Vice President for Research, and the Deans of the Biological and Physical Sciences Divisions.[lvi]

The Process behind UC's Technology Transfer

At UC, the process of technology transfer occurs in the following manner: first, UC requires its faculty to disclose their inventions to the University. UC then offers the disclosed inventions to ARCH for consideration. ARCH then has 90 days to decide whether or not to elect title to the disclosed inventions.

As of 2000, ARCH was receiving on the average of 50 to 100 new disclosures per year. In addition, ARCH was filing on the average of 30 to 40 U.S. patents and executing between 15 and 20 license agreements annually. ARCH's project managers consist of graduate students who are recruited from the ARCH Associates Program, where graduate students in business and science are exposed to the start-up environment.[lvii]

ARCH "creates a licensee" (i.e., starts a company) whenever the expected value of the created licensee's return minus the costs to achieve that return substantially exceeds the expected return from licensing to an existing company. Nonetheless, a created licensee must be paired with a private sector manager willing to take a risk with ARCH in starting the company. ARCH is dedicated to supporting the at-risk manager/CEO to assure that the manager can focus on product development.[lviii]

"The ARCH deals [are as follows]:

- Returns from licenses: 25% to the inventor; 10% to ARCH management incentive pool; and 65% for expenses.
- Proceeds from the sale of shares in start-ups: 20% to ARCH management incentive pool and 80% for expenses;
- Company creations, premoney: 50% to ARCH; 25% to founding scientist; 25% to management of start-up. (Each company gets up to about $50 thousand in cash to buy outside services as necessary and of course the guidance of ARCH management and staff.)"[lix]

At first blush, the UC/ARCH technology model seems to have been a whirlwind success. However no success story exists solely within the vacuum of its success.

A Caution Against Losing Control of Technology Transfer

In general, the process of decision-making demands a comprehensive thought sequence that addresses all material issues affecting a project from start to completion. In the words of Nobel Prize recipient, Ronald H. Coase:[lx]

> "It would be clearly desirable if the only actions performed were those in what was gained was worth more than what was lost. But in choosing between social arrangements within the context of which individual decisions are made, we have to bear in mind that a change in the existing system which will lead to an improvement in some decisions may well lead to a worsening of others. Furthermore, we have to take into consideration the costs involved in operating the various social arrangements (whether it be the working of a market or a government department), as well as the costs involved to moving to a new system. In devising and choosing between social arrangements we should have regard for total effect. This, above all, is the change in the approach which I, am advocating"[lxi]

Bearing in mind Ronald Coase's statement concerning regard for total effect, it seems evident that UC realized that it needed to find a way create an innovative environment that would provide high technology for new companies.[lxii] Faced with the need to create such an environment in a short period of time, UC turned to a trusted group of individuals it knew possessed notable skills to create such an environment.

According to one report, UC gave the group a mandate to license technologies to established firms and to fund startups.[lxiii]

The group launched the ARCH initiative as a venture fund. At first, the venture fund was successful in fulfilling the UC mandate. However, the relationship between ARCH and UC was "restructured." As a result of that restructuring, the ARCH partners received permission from UC to raise [the above mentioned] second venture fund that would also provide the venture capitalists, themselves, with higher compensation.

In addition to providing increased compensation for its founders, the new agreement allowed ARCH to invest outside of UC, while reserving a "right of first look" at UC's technology. Thereafter, ARCH rapidly expanded, as noted above, raising several additional funds, and UC's share of new transactions fell dramatically.[lxiv]

ARCH's departure from serving as a dedicated adjunct facilitator for technology transfer, in favor of acting as a start-up "guru" for UC, gave the impression to many at UC that ARCH partners had neglected technology licensing to become venture capital investors.[lxv]

After a decade of venture capital activity at ARCH, diversified economic gain seemed to have superceded the university's original goal of creating a technology transfer center. As a result of this unforeseen transition, students at UC were receiving less "real world" experience.

Faced with uncertainties of capital formation and management that are associated with start-up ventures, students will not start new businesses unless they feel comfortable in the industrial environment. And this real world confidence cannot be taught in the classroom or laboratory; it has to be experienced first hand.[lxvi] Either students have to reach out of the university to industry or industry has to reach into the university so that students can experience real problems.[lxvii] By the same token, universities that are new to modern technology transfer are no less inclined than students to be wary of complex contractual and licensing relationships that arise in the ordinary course of business with government and with private concerns.

With those complexities in mind, it is tempting to identify and to tap into a group of experienced individuals, such as those entrepreneurs who assisted in creating ARCH, to serve as an effective technology transfer liaison between the university, government and industry. It is even more attractive to attempt to address nagging complexities involved with technology transfer, such as conflicts of interest, personnel recruitment, tax concerns, and certain regulatory issues, in one felt swoop.[lxviii]

Faced with the need to "catch up" with other large universities in the post Bayh-Dole era, UC thought that it had found in ARCH, a creative and effective solution to address most of its technology transfer concerns. Notwithstanding UC's careful effort, and the ARCH initiative's good faith intentions, the ARCH structure became unstable from a technology transfer point of view, and the total venture/transfer experience proved to be elusive and largely disappointing to UC.[lxix]

In the aftermath of such disappointment, it is of great interest that ARCH recently has transferred all licensing and patenting activities back to UC. As a result of that reversion, ARCH will continue to concentrate mainly on providing high-end services for UC's start-ups.[lxx] ARCH, therefore, has returned management of those activities that are the crux of technology licensing back to the UC. That transfer has occurred because UC is in the best position to address technology transfer problems and procedures. ARCH has realized that entrepreneurs who are more concerned with efficient and expedient venture capital formation are neither equipped nor motivated to manage the University's technology transfer program in the University's best interest.[lxxi]

Tilling Fertile Fields at Iowa State University

In general, cutting edge models of entrepreneurial technology transfer are not usually associated with State Universities. For example the Ohio General Assembly only recently passed Senate Bill 286, allowing Ohio State University's Board of Trustees to approve formal university rules for faculty participation in startup companies.[lxxii] Ohio State University, however, cannot take equity positions in startup companies.[lxxiii]

On the other hand, Iowa State University (ISU) has been involved with technology licensing and transfer for over 75 years.[lxxiv] ISU's success, in conjunction with The Iowa State University Research Foundation (ISURF), in "moving research results from the laboratory to the marketplace" is not unlike MIT's accomplishment of providing over 100 years of technology transfer and entrepreneurial success.[lxxv]

Approximately fifty years before Bayh-Dole, ISU realized that technology development and transfer was a means for academic and community growth. ISU further recognized that engineering was an important means for developing technology. Moreover, ISU viewed the university setting as a primary source for creating technology incubators that could also serve as technology transformation centers.[lxxvi]

More importantly, however, ISU, like MIT had always viewed engineering as a worthy academic endeavor. Therefore, the ISU-ISURF technology transfer model has resulted in a "natural progression" toward, and successful integration with the Bayh-Dole technology transfer model. And ISU has enjoyed continued success with technology transfer through ISURF and the Office of Intellectual Property and Technology Transfer (OIPTT).[lxxvii]

Technology Transfer at ISU

Intellectual property management at ISU takes place in the following manner: Technologies disclosed to OIPTT are reviewed in conjunction with ISURF, often during early stages of development, to determine whether licensing is appropriate.[lxxviii] Together, ISURF and OIPTT select potential licensees that are adequately financed or that can procure such financing. Licensees must be able to meet market demand and must be motivated to establish a market for the technology.[lxxix]

ISURF seeks reimbursement for patenting costs and royalty income from exploitation of the licensed technology. The resulting income provides further incentive to university inventors to participate in the complex technology transfer process.[lxxx]

Start-up companies may find it difficult to provide cash for both licensing and development. In which case, ISURF can elect to take equity as partial consideration in the start-up, in lieu of other capital investment.[lxxxi]

As an affiliate organization, ISURF has to avoid conflict of interest issues. In particular, ISURF, ISU, and the inventor/entrepreneur must avoid even the appearance of manipulating stock prices through issuing or using information that may later prove incorrect.[lxxxii] Both ISURF and ISU have separate conflict of interest policies that outline potential conflicts of interest, equity management, as well as accepting equity, and equity sharing and distribution.[lxxxiii]

Despite complex analyses, including regulation, conflicts and finance that take place on several different levels, ISURF and the OIPTT have been quite successful at transferring technology to businesses, including start-ups.

In its latest comprehensive Annual Report, ISURF lists the following recent technology transfer achievements: (a) growth of estimated sales of non-Iowa Companies totaling more than 100% in fiscal year 2005 (FY05); (b) receipt of 27 R&D 100 Awards for its inventions; (c) federal funding of 63% of disclosed technologies; (d) the issuing of 75% of ISURF's U.S. patent applications into patents over the last eight years;[lxxxiv] (e) 43% of FY05 disclosed technologies was germplasm;[lxxxv] (f) 45% of FY05 licenses and options were issued to Iowa companies; (g) five start-up companies received licenses or options from ISURF; (h) ISURF ranked second among all U.S. and Canadian Universities in the

number of options and licenses signed in FY03; (i) ISURF earned $4.9 million dollars in revenue from technology and germoplasm licensing in FY05; (j) 43% of license and option agreements generated income in FY05; (k) 56% of patent prosecution and maintenance expense was reimbursed; and (l) ISURF disbursed $3.6 million dollars to ISU and ISU inventors in FY05.[lxxxvi]

It is quite evident that ISURF turned out to be a better fit for ISU than the ARCH initiative was, originally, for UC. Perhaps the main reason for ISURF's superior and seamless compatibility might lie in ISU's realization that ISURF had to remain an internal and well-controlled venture effort with an emphasis on community based technology transfer.[lxxxvii]

Observations

The quid prop quo of Bayh Dole extends from the government through participating universities to industry and to the public at large.

Technology transfer has evolved from the basic exchange of information between small numbers of entrepreneurs, for example, the Early Nineteenth Century owners of British experimental farms, into the worldwide and rapid exchange of high technology between universities, governments and private concerns. That evolution has resulted in the advent of large, public, private, and non-profit technology research complexes that have largely replaced the solo inventor as a staple of such investigation and transfer. The newer private for profit and non-profit entities are highly efficient technology transfer centers

that are responsible for the year-to-year managing of thousands of complex technology licensing transactions.

Implementation of the Bayh Dole Act has allowed universities to own and to manage intellectual property. As a result, most universities have realized the potential technological and economic benefits of fostering research and transferring the resulting technology to well-established concerns and to startup organizations.

On the day of its enactment in 1980, several universities were ready and able to take full advantage of Bayh Dole. Universities such as MIT and ISU already had successful technology transfer programs because of lengthy involvement over the years with government research and community development. Other universities, some as prominent as UC did not have the necessary management or organized entrepreneurial know how to take full advantage of Bayh Dole.

It is a difficult if not an impossible task for universities, whether large or small, to acquire technology transfer know-how in a short period of time. Therefore, universities that are not well acquainted with technology transfer should not proceed too rapidly toward establishing and implementing technology transfer models. Instead, those universities should take the advice of Ronald Coase and develop a comprehensive, beginning to end result, strategy for controllable and efficient transfer.

In addition, universities should maintain control over all aspects of technology transfer, including licensing, participation in startup businesses, and procurement of venture capital. There seems to be no easy answers and certainly no "quick fixes."

Lastly, newer university technology transfer centers should focus upon solutions that assist with community business development. By emphasizing community needs, those universities will emulate more successful and well-established universities and succeed in attracting the best and brightest faculty and students. Consequently, it is highly likely that a university staffed with a formidable faculty will establish formidable infrastructure, and provide excellent opportunities for successful technology transfer at all levels.

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[i] History; "A Tradition of Innovation," MIT Entrepreneurship Center, One Amherst Street, E40-196, Cambridge, MA 02142, http://entrepreneurship.mit.edu/history.php (last visited on October 8, 2005). MIT's motto "Mens et Manus" means "mind and hand", and refers to transforming theoretical into the practical to benefit humanity.

[ii] See Public Laws 96-517 (1980) and 98-620 (1984). This year (2005) is the Silver Anniversary of the Bayh Dole Act, which is probably the most important intellectual property management milestone in modern times. See also, Editor's Preface, Journal of the Association of University Technology Managers, XVII, 1 (Summer 2005).

[iii] The text of the Bayh Dole Act is set forth in 35 USC, §§200-212.

[iv] "The Bayh-Dole Act was passed in 1980. The purpose of the policy is to encourage the utilization of inventions produced under federal funding.

This policy promotes the participation of universities and small businesses in the development and commercialization process. It also permits exclusive licensing with transfer of an invention to the marketplace for the public good. The government gets a royalty-free, non-exclusive license to use for government purposes (including use by government contractors)

The policy permits universities (all non-profits) and small businesses to elect to retain title to inventions made in performance of the federally funded program.

It was understood that stimulation of the U.S. economy would occur through the licensing of new inventions from universities to businesses that would, in turn, manufacture the resulting products in the U.S." (Excerpt taken from "*Bayh-Dole Act*", Office of Intellectual Property Management University of New Hampshire www.unh.edu/oipm (last visited October 28, 2005)).

[v] One of the reasons why the United States has the most efficient agricultural systems in the world stems from Land Grant universities such as the University of California. See Rausser, G. (1999), Public/Private Alliances, *AgBio Forum*, [*The Journal of Agrobiotechnology Management & Economics*], 2(1) 5-10, Available on the World Wide Web: http://www.agbioforum.org/v2n1/v2n1a02-rausser.htm (Last visited on October 28, 2005).

[vi] This author specifically refers to those scholarly articles throughout this paper.
[vii] MIT is a good example.
[viii] Morgan, M.S.(2005), *Experimental Farming and Ricardo's Political Arithmetic of Distribution*, Department of Economic History, London School of Economics, Available on the World Wide Web: http://www.lse.ac.uk/collections/economicHistory/pdf/FACTSPDF/FACTS3-MorganFINAL.pdf (Last visited on October 28, 2005).
[ix] *Id*., Generally.
[x] Ibid. 1.
[xi] Ibid. 2.
[xii] Ibid. 3.
[xiii] Ibid. 4.
[xiv] Ibid. 7.
[xv] Ibid. 25.
[xvi] Ibid. 25, Footnote 36.
[xvii] See examples that follow with proper references.
[xviii] "MIT was designated a Land Grant College and so established a Department of Military Science and Tactics at its inception, as specified in its state charter." See Gallop, S.E. (1996), *Interim Report of the ROTC Task Force: Section 4*, Available on the World Wide Web at http://web.mit.edu/committees/rotc/report-4.html (Last visited on October 28, 2005).
[xix] See Hersey, K., "M.I.T. as Catalyst for High-Technology Start-Up Companies," taken from "Models, Practices and Experiences from Europe and the United States that Provide Examples of the Successful Production of University Based Start-ups - An Experience Exchange 2000," EXIST international – University Start-ups, Volume 2, April 2000 (pp. 29 – 32, 29).
[xx] Ibid. 29.
[xxi] Ibid. 29.
[xxii] Ibid. 29.
[xxiii] Campbell, K, Sudulko, R., Eds., MIT Briefing Book, Massachusetts Institute of Technology, p. 48, (September 1997). (A.D. Little, the first MIT backed company founded in 1896 has only recently dissolved).
[xxiv] *Id*., at 47.
[xxv] *Questions Frequently Asked*, Technology Licensing Office, Massachusetts Institute of Technology, at http://web.mit.edu/tlo/www/qfa.html p. 4, (Last visited on October 14, 2005).
[xxvi] *A Proposal for Establishing Illinois Ventures, LLC*, The University of Illinois Start-Up Company Services Organization, Office of the Vice President of Academic Affairs, The University of Illinois, p. 47, March 2000.
[xxvii] See Note xviii above at p. 31.
[xxviii] See Note xxiii, at p. 5.
[xxix] *MIT Organizations*, MIT Entrepreneurship Center, at http://entrepreneurship.mit.edu/mit_orgs.php (Last visited on October 14, 2005).
[xxx] See Note xxiii at p.p. 5 and 6.
[xxxi] *Id*. at p. 6.
[xxxii] *Id*. at p. 6.
[xxxiii] This is the author's informed general observation.
[xxxiv] See Note xviii.
[xxxv] Lazarus, S., "The VC View", Intellectual Asset Management magazine supplement, March 2005, http://www.archventure.com/archview.html (last visited on October 8, 2005)
[xxxvi] Ibid.
[xxxvii] Ibid.
[xxxviii] Ibid. ("The VC View" provides a comprehensive overview of the history of technology transfer, and it is well worth reading in its entirety).
[xxxix] Ibid. .
[xl] *The Presidents of the University of Chicago A Centennial View*, The University of Chicago Centennial Catalogues, Available on the World Wide Web at http://www.lib.uchicago.edu/e/spcl/centcat/pres/ (Last visited on November 1, 2005).
[xli] *Id*.

[xlii] See above. Arch Venture Partners, About the Company, "ARCH Venture I" http://www.archventure.com/history.html (last visited on October 7, 2005).
[xliii] *Id*. (ARCH derived its name from the "AR" in Argonne and the "CH" in Chicago).
[xliv] Forbes.Com http://www.forbes.com/finance/mktguideapps/personinfo/FromPersonIdPersonTearsheet.jhtml?passedPersonId=395887 (last visited October 7, 2005). According to Forbes.Com, Steven Lazarus has also been director of Amgen, Inc. since May 1987.
[xlv] Arch Venture Partners, About the Company, "ARCH Venture I" http://www.archventure.com/history.html (last visited October 7, 2005)
[xlvi] *Id*.
[xlvii] *Id*.
[xlviii] *Id*.
[xlix] See Footnote xlv, above.
[l] *Id.*, ARCH Venture Fund II
[li] *Id.*, ARCH Venture Fund III
[lii] *Id.*, ARCH Venture Fund IV
[liii] *Id.*, Arch Venture Funds V, and VI
[liv] *Id.*, 15+ Years of Achievement.
[lv] *Id.*
[lvi] *A Proposal for Establishing Illinois Ventures, LLC*, The University of Illinois Start-Up Company Services Organization, Office of the Vice President of Academic Affairs, The University of Illinois, p. 41, March 2000
[lvii] *Id*. 42.
[lviii] *Id*. 42. The program lends support in areas such as: building the business plan; marketing research; forming the entity and supplying proper documentation; finding and closing financing; establishing accounting and financial management systems; patent management and strategy support; general office and computer support; creation of legal documents; and understanding cost of investment issues.
[lix] *Id*. 43.
[lx] This author is grateful to Craig S. Jepson, Professor of Law at Pierce Law for the brief introduction to Coase theorem that he received during a Patent Law class lecture in 2005.
[lxi] Coase, R.H., *The Problem of Social Cost*, Journal of Law and Economics (October 1960). Accessible from the World Wide Web at http://www.sfu.ca/~allen/CoaseJLE1960.pdf (Last visited on October 29, 2005).
[lxii] See Hersey, K., "M.I.T. as Catalyst for High-Technology Start-Up Companies," taken from "Models, Practices and Experiences from Europe and the United States that Provide Examples of the Successful Production of University Based Start-ups - An Experience Exchange 2000," EXIST international – University Start-ups, Volume 2, April 2000 (pp. 29 – 32, 32). http://www.bmbf.de/pub/EXIST_international_Band_2.pdf (last visited October 7, 2005)
[lxiii] See above. Arch Venture Partners, About the Company, "ARCH Venture I" http://www.archventure.com/history.html (last visited on October 7, 2005).
[lxiv] Lerner, J., *The University and the Start-Up: Lessons from the Past Two Decades*, Journal of Technology Transfer, 301/2, 49-56, 50, 2005.
[lxv] *Id*. 50.
[lxvi] Hersey, K., "M.I.T. as Catalyst for High-Technology Start-Up Companies," taken from "Models, Practices and Experiences from Europe and the United States that Provide Examples of the Successful Production of University Based Start-ups - An Experience Exchange 2000," EXIST international – University Start-ups, Volume 2, April 2000 (pp. 29 – 32, 32).
[lxvii] Ibid. 32.
[lxviii] Author's informed observation.
[lxix] Lerner, J. (2005), *The University and the Start-Up: Lessons from the Past Two Decades*, Journal of Technology Transfer, 301/2, 49-56, 52.
[lxx] Ibid. 43.
[lxxi] Author's informed opinion.
[lxxii] *University Startup Guidelines; General Overview*, The Ohio State University, Office fro Technology Licensing , http://otl.osu.edu/information/f-startup.cfm (Last visited on October 12, 2005).

[lxxiii] Mezger, R., *Case Prof: More Research Fosters Spinoff Companies,* The Plain Dealer, CLEVELAND.COM (2005). Roger Mezger can be reached at rmezger@plaind.com.
[lxxiv] *Id*.
[lxxv] *Id*.
[lxxvi] *Id*.
[lxxvii] *Id*.
[lxxviii] Iowa State University Research Foundation, Inc. (ISURF) Policy on Accepting Equity at http://www.techtransfer.iastate.edu/documents/ISURF_Equity_Policy_052405130459.htm (Last visited on October 14, 2005).
[lxxix] *Id*.
[lxxx] *Id*.
[lxxxi] *Id*.
[lxxxii] *Id*.
[lxxxiii] *Id*.
[lxxxiv] The combined U.S. and Canadian university average was 37% (same reference).
[lxxxv] ISU's specialized germplasm research promotes genetic diversity through the introduction of unrelated breeding materials into basic and advanced breeding pools of plant cultivars. In practical use, the genetically altered cultivars present less opportunity for epidemic disaster. See, Duvick, D.N. 1990. *Genetic enhancement and plant breeding*. p. 90-96. In: J. Janick and J.E. Simon (eds.), Advances in new crops. Timber Press, Portland, OR.
[lxxxvi] *Annual Report* (July 1, 2004 to June 30, 2005), Iowa State Research Foundation, Inc. 310 Lab of Mechanics, Ames, Iowa 5011-2131 (www.techtransfer.iastate.edu; isurf@iastate.edu.
[lxxxvii] Individuals from the following entities and departments at ISU serve on ISURF's Board of Directors: Vice Provost for Research at ISU; Vice President of Salomon Smith Barney, Inc.; President of ISU; a member of the State Board of Regents; Vice President for Business and Finance at ISU; Associate Dean, College of Engineering at ISU; a medical doctor from OB-GYN Associates; a professor of finance from the College of Business at ISU; President of Dayton Road Development Corporation; and an Associate Dean, College of Family and Consumer Sciences at ISU.