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IMPROVED METHODOLOGY FOR THE COMMERCIALIZATION OF UNIVERSITY INTELLECTUAL PROPERTY

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ABSTRACT OF THESIS

Since the enactment of the Bayh-Dole Act in 1980, US universities have been given a tacit mandate to manage their intellectual assets in a commercializable way. However, university technology transfer offices have struggled to facilitate innovators and promote economic development because of asymmetric information and processes. After an analysis of premier university technology transfer offices (TTO), an improved methodology, which increases productivity of technology transfer, has been developed. The proposed methodology addresses many of the low level issues facing the commercialization and licensing process. Embedding TTO members with research institutes or colleges, assisting in funding procurement and marketing of research to external firms using innovative media are methods that can minimize technology transfer inefficiency. It is the conclusion of this thesis that improved technology transfer helps promote the overall mission of a university, which is diffusing knowledge for the public benefit.

KEYWORDS: Commercialization, Technology Transfer, University Entrepreneurship, Licensing, New Business Start-up

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November, 15 2007

Date
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UNIVERSITY INTELLECTUAL PROPERTY

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1.1 Background

At the turn of the twentieth century, engineering schools in America were predominantly focused with practical concerns of the community with little time devoted by faculty and students to research endeavors (Seely 244-5). The “pursuit of knowledge for its own sake” was not yet embraced by professors or administrators, but priorities were beginning to shift (Seely 346). A philosophical metamorphosis was underway as the engineering community recognized that original research was integral to the betterment of society through the diffusion of technology. Faculty members began to spend summers as consultants to private industry; students pursued cooperative education, alternating their class time with real-world experience (Seely 347, 51). By World War II, superior technology and scientific know-how were critical as a means of defending American liberty (Faley and Sharer 110). Research executed in university labs could be implemented by the defense industry and utilized on the battlefield. While engineering schools were still focused on addressing the problems of the community and the nation at large, their methods of execution shifted from tangible to abstract.

After the engineering successes of World War II, the government assessed the practicality of continuing its symbiotic financial arrangement with universities (Faley and Sharer 110). At the behest of President Roosevelt, prominent engineer and administrator Vannevar Bush outlined the role of research as part of federal economic policy (Faley and Sharer 110-1). His Reservoir Theory of Knowledge suggested that an extensive knowledge base could be fostered through government investment in scientific and technical research (Faley and Sharer 111). While research grants would establish a “reservoir of knowledge,” this was not an altruistic motivation. The main thrust of the theory was the expectation that “new discoveries would increase the competitiveness of existing industries, create new industries, and produce jobs
The government expected a return on its investment in the form of an increased tax base. Powerful business leaders also supported government intervention, believing an improved knowledge base would give the American economy an edge over international competitors (Faley and Sharer 110).

While the Reservoir Theory of Knowledge was groundbreaking and continues to be used in policy-making, economic dead-weight loss remains an unwanted byproduct. Prior to 1980, higher education institutions were not responsible for practical application, or commercialization, of their intellectual assets (Faley and Sharer 113). However, it is not the creation of knowledge itself that drives economy, but rather the efficient diffusion of intellectual assets into society. David Greenaway eloquently explained the process of diffusion in his editorial note in *The Economic Journal*, “‘[i]t is not the invention of new products/processes, nor their initial commercial exploitation, which brings major benefits, but rather their widespread use’” (916). Like packaged goods that sit unused on a warehouse shelf, intellectual assets are useless until they are utilized by those who need them. The Bayh-Dole Act, enacted in 1980, sought to “improve the outward flow of commercializable new knowledge from the reservoirs of knowledge into the commercial sector” (Faley and Sharer 113). The government speculated that universities and research institutes would be more efficient managers of intellectual assets (Faley and Sharer 113).

By reviewing the current mission of the University of Kentucky, as outlined in the *Statement of Vision, Mission, and Values*, it is clear that the school is embracing its new role as a mediator between knowledge and application. “Goal III” establishes the objective for the “expansion of the body of knowledge and the translation of basic research into practical innovations for the people of Kentucky and those beyond the state’s borders” (*Vision, Mission, and Values* 7). To reemphasize the university’s commitment to developing stronger regional economic ties between the university and industry, UK’s Board of Trustees appointed Dr. Leonard E. Heller as the Vice President of Commercialization and Economic Development in 2006 (“About CED”). The Office of Commercialization
and Economic Development (OCED) directly manages technology transfer, entrepreneurship, and business outreach, as well as development of university owned intellectual assets ("About CED"). Unlike firm-based research, which is conducted with a practical application in mind from the on-set, university-produced research often must be re-packaged in a marketable way. This is the daunting task of technology transfer offices like OCED.

Fostering new economic growth and making knowledge-based goods accessible to the public domain can only be efficient if the process is transparent to all parties involved. The role of the university technology transfer office should be primarily a practical extension of the University's mission to disseminate knowledge. Asymmetries of information between faculty innovators, technology transfer managers, and potential commercializers lead to wasted resources, not to mention produce exasperation with the transfer mechanism. It is the purpose of this investigation to streamline the process of technology transfer within the confines of existing university's policies. By analyzing comparable universities and unraveling the nuances of new business creation at UK, it is my goal to identify opportunities and best practices that will foster the debate about the University's tech transfer policies. The University has undertaken an achievable mission in its goal to become a leader in the “creation and application of new knowledge” ("About CED") but only if it adopts a philosophy of integration and effective communication.

1.2 Scope of Thesis

Within the field of engineering, technology transfer via commercialization is vitally important on multiple levels. However, many hurdles exist, which make the commercialization process seem insurmountable to creators and innovators bringing their ideas to market. Rather than tackling the idiosyncratic problems of all university technology transfer offices, this thesis attempts to present a streamlined methodology for commercialization within the confines and policies of the University of Kentucky.
Chapter 2 discusses the impact of technology on economic growth. By examining the changing face of American universities and the impact of the Bayh-Dole Act, this chapter demonstrates how universities have developed into economic catalysts for new business creation. The technology transfer practices of MIT, University of Colorado at Boulder, and Iowa State University are examined to determine the characteristics of a successful program.

Chapter 3 investigates University of Kentucky’s technology transfer performance. A basis for comparing UK to its benchmark institutions is established, and is consistent with the “Top 20” business plan. Key elements of technology transfer, such as invention disclosure, number of start-ups, patent disclosures and licensing revenue were chosen as comparative metrics. Those metrics were then normalized based on $10 million in research expenditures. Using the normalized metrics and the benchmark institutions as the foundation for comparison, a methodology consistent with other University of Kentucky internal rankings can chart the progress of technology transfer.

After appropriate technology transfer expectations for UK are established, Chapter 4 details the proposed, streamlined methodology for commercialization. The chapter begins by outlining updated organizational structures and goals, both qualitative and quantitative, associated with the implementation of the new methodology. Next, three scenarios are proposed: licensing to an existing company; licensing to an internal company of start-up; and utilizing SBIR (Small Business Innovation Research), STTR (Small Business Technology Transfer) and state funds to facilitate commercialization. For each scenario, a streamlined methodology is outline to improve the efficiency of the process.

The chapter closes with a section focused on a web-based, shared resource to reduce the imperfect and asymmetric information associated with the technology transfer practices at the University of Kentucky. The chapter then concludes with a discussion of additional roadblocks to the commercialization process, such as technology overvaluation by universities and organizational issues.
Chapter 5 details a walk-through of the commercialization process at the University of Kentucky. A technology developed in UK’s Center for Visualization and Virtual Environment (CVVE) was chosen to license and adapt into a marketable product. The chapter describes the application of the technology, gives an account of the licensing process and addresses how utilizing the improved methodology from “Chapter 4” would have aided in the process.

Chapter 6 concludes and evaluates the methodologies that are proposed in this thesis. The case is made that the processes outlined will improve the efficiency and addresses the asymmetric and imperfect information of technology transfer. The chapter concludes with proposed future work: the need to assess the methodology in practice and further understand the commercialization process once a technology leaves the confines of the technology transfer office. The importance of integrating education and bridging the gap between engineering and entrepreneurship also is discussed.
Chapter 2 Academic Technology Transfer

2.1 Changing Role of the University

“A university is what a college becomes when its faculty loses interest in students.”

This quotation by poet and educator, John Ciardi, demonstrates the disenchantment with the ever-expanding role of higher education institutions (“John Ciardi”). As more faculty devote time to research endeavors and spend less time with pedagogy, the purpose of universities and their role in society comes into question. The modern university mission has expanded beyond strict scholarship to an amalgam of administration, research and ever increasingly economic development. These developments have been met with cynicism, particularly when pecuniary and political interests are at the center of debate. Some of the loudest objectors fear that strong ties to the business community corrupt research and educational missions, deplete scarce university resources, and affect faculty productivity (Lowe and Gonzalez-Brambila 176). This discontentment is further exacerbated when political wrangling is added to the picture. In March of 2007, the Michigan state legislature introduced a bill requiring the State’s three major research institutions to outline the impact of university economic development activities (Lane 35). While the goal of the bill is to justify each university’s share of the budget, one could interpret the mandate as coercion. However, American universities are forging ahead with technology transfer despite some opposition.

One can not overlook the great opportunities that are possible with the changing university mission. From a student's perspective alone, the new university model could provide opportunities for an education, exposure to research and potential for employment and entrepreneurship. Faculty members could witness the fruits of their labor put into practical application. University administrators might see an increase of revenue from licensing and spin-off profits. Community members and politicians would all praise university research
endeavors if they are able to witness tangible economic growth and improvement to quality of life. Perhaps Ciardi’s quote could be amended to something more optimistic, which embraces the reality and benefits of the new university model in spite of potential abuses.

2.2 Importance in Economic Development

To clarify the role of technology transfer in economic growth, let us examine the widely accepted macroeconomic New Growth Theory. This theory states that aggregate production \( Y_t \) is a function of human capital \( K_t \), physical capital \( L_t \) and technological know-how \( A_t \) over a set period of time (Faley and Sharer 116).

\[
Y_t = F(K_t, A_t, L_t)
\]

**Figure 2.1**

Based on this model, any change in the economic inputs \( K_t, L_t, A_t \) directly correlates to a change in aggregate output \( Y_t \) (Faley and Sharer 116). Because university technology transfer offices act as a conduit between the other capital inputs, they can have a significant influence in economic output based on the introduction of new technologies and human capital to industry.

From analysis of the New Growth Theory, it is clear that the availability of technologies plays an important role in the economy (Faley and Sharer 116-8). Moreover, the University of Kentucky has founded part of its mission to be a Top 20 research institution with aspirations to foster regional economic development. This mission could be facilitated by the findings of this thesis. However, the New Growth Theory is a very macroeconomic analysis and cannot fully explain the intricacies of regional economic growth. A more reasonable extension of this model is proposed below (Figure 2.2) to illustrate the dynamic aspects of the university technology transfer.
This model proposes that the rate of aggregate output ($Y_t$) can be modeled as a multi-input positive feedback system. The input variables are defined as human capital ($K_t$), physical capital ($L_t$) and technological know-how ($A_t$). The model suggests that the aggregated output has a positive effect on the three input variables. The additive component to each input variable is proportional to the aggregate output by the gain factors ($G_K, G_A, G_L$). The New Growth Theory by itself does account for changes in physical capital, human capital, and technological know-how interrelate to impact aggregate output. My model suggests that graded changes in economic output will correlate to changes in the input to the regional economic system. Furthermore, an economic transfer function could be approximated for a well understood system, i.e. a research park, where the system variables and aggregate output can be monitored in a relatively controlled environment. Though economic theory is beyond the major scope of this thesis, I would like emphasize the importance of technology in a growing regional economy.
2.3 Bayh-Dole Act

In December of 1980, Jimmy Carter signed into law what the *Economist* stated as “[p]ossibly the most inspired piece of legislation to be enacted in America over the last half-century…” ("Innovation's Golden Goose"). This legislation was the Bayh-Dole Act. The act itself survived a very fragile senatorial coalition and the threat of a presidential veto, only to pass though a lame duck session of congress and be signed into law on the very last possible day (Stevens). In retrospect, the act was a revolutionary piece of legislation creating a new vehicle of economic development (Stevens 93-4). This was in essence accomplished by granting intellectual property rights to small businesses and university stemming from government sponsored research (Stevens 94). The intent was to remove the government ownership of intellectual assets, which in some cases was inhibiting the development of promising technologies or was waiving the rights to the benefit of large government contracting companies, which were typically big corporations (Stevens 94). This Jeffersonian ideal was to remove the government bureaucracy from the equation to allow individuals to work out the best solution (Stevens 94).

By allowing the universities to retain the rights to intellectual property, university technology managers became the main arbiters for any technologies stemming from university research. As universities risked financial resources to protect intellectual property rights, they expected a return on their risky investment in the form of commercial revenue. In a survey of licensing officers and university administrators, the most important goal given in regards to a technology transfer office was to maximize revenue (Lowe). The university’s interests are not perfectly aligned with the interests of economic development represented in the Bayh-Dole Act. As quoted by The Council on Government Relations “the mission of the university technology transfer offices is to transfer research results to commercial application for public use and benefit.” Yet the main economic development most universities were concerned with was their own, as revealed in the Lowe survey (Lowe). Even institutions such as Stanford
see licensing revenue as means to offset a reduction in federal funding (Carlsson and Fridh). The fact that universities seek to profit from the licensing revenue is not in itself a bad practice because it helps to drive more research and create more technologies to potentially commercialize. However, when profiteering universities seek to maximize revenue as their main impetus to commercialization, they may actually hinder regional economic development (Golob).

As with most theoretical economic policies, implementation rarely lives up to expectation. This applies to the Bayh-Dole Act’s goals for small business development. The bill intended that small businesses would benefit from university ownership of intellectual property (Stevens 94). This provision was one of the concessions that helped garner support from senators, who viewed patents as a “tools that big businesses used to beat down small businesses” (Stevens 96). Evidence of this is seen in the statistics of a 2005 survey, which describes how over 30% of university licenses were granted to what are considered big businesses, having over 500 employees (AUTM).

Despite some drawbacks to the policy, the Act should still be viewed as a success, which can be seen across a spectrum of US universities. The University of Florida’s ‘Gatorade’ and University of Wisconsin’s use of vitamin D in milk are shining examples of how universities can lucratively commercialize their intellectual properties (Nelson 4). University patenting activity has risen exponentially as a result of the Bayh-Dole Act, though often these increases do not categorically equate to financial achievement. For example, the number of university patents has increased ten fold from 1979 to 1997 (Brouwer), yet data show that the average university revenue from royalties and start-ups is only 3% of the schools research budget (Nelson 3). Yet even marginal return on investment is preferable to the bureaucratic backlog caused by federal management of intellectual property. Countries such as Germany, Japan, United Kingdom, Taiwan, Portugal and France have adopted similar policies in the hopes of emulating American technology transfer (Nelson 2).
2.4 University Performance

Assessments of university performance of technology transfer have revealed some underlying difficulties inherent in the process. Universities found themselves ill-prepared to handle the challenges of diffusing new technologies into the marketplace during the decade after the enactment of Bayh-Dole. Just as the university’s overall mission had changed, so would the responsibilities of the individuals within the organization. Faculty and staff would be forced to cross “strongly defended boundaries” and take on roles that were not “traditionally ascribed to them” (Gunansekara 102). Initially, there was a dearth of qualified technology transfer managers, who could handle the idiosyncrasies of university research commercialization, as well as a reluctance by school administrators to devote scarce resources and staff to the upstart offices (Nelson 2). By the 1990’s, technology transfer offices garnered much interest in their activities for several reasons internal and external to the university (Nelson 2). Theses offices were no longer concerned just with licensing intellectual properties, but were creating university start-ups. Some of the factors which lead to this development include:

1. **Emphasis on short-term earnings by firms**: Private firms balked at the time-consuming and risky process of bringing university technologies onto the market.

2. **Outsourced research**: Firms cut costs by “outsourcing” research and development to universities.

3. **Availability of venture capital**: Primarily driven by pension-fund investment, funding streamed into the market that was used for new business creation.

4. **Expectations of high returns on investment**: Venture capitalists and university administrators were compelled to repeat the achievements of well-publicized university success stories.

5. **Copy-cat phenomenon**: Faculty members became conscious of their colleagues’ accomplishments and showed interest in commercialization (Nelson 2).
These factors still affect the decision making of TTO managers, university administrators and business leaders. Unrealistic expectations and mismanagement of an intellectual assets can cause TTOs “to become bottlenecks rather than facilitators of innovation dissemination” (Litan, Mitchell and Reedy 3-4). However, when TTO managers act as facilitators of commercialization rather than gatekeepers, the whole system of diffusion becomes much more effective (Litan, Mitchell and Reedy 8). The best way to ameliorate these inefficiencies is to minimize asymmetric information between innovators and the commercial market. A streamlined methodology that tackles these issues will be proposed later in this paper.

2.5 Best Practices

2.5.1 Introduction

In order to better understand the complexities for taking a university technology and transferring it into the commercial market, several “successful” US university programs were analyzed. Given the vast number of technology transfer programs, the scope was narrowed to focus on MIT, the University of Colorado at Boulder and Iowa State University. MIT was chosen because of its long-standing history of tech transfer success. University of Colorado at Boulder was selected because of its significant progress in generating licensing revenue and start up activity. Iowa State University will be examined because it consistently ranks among the top schools for licenses executed. By analyzing these programs, a fair comparison could be made to the University of Kentucky’s technology transfer practices.

2.5.2 Massachusetts Institute of Technology

It is no surprise that MIT is one of the most successful universities in transferring technology from government sponsored research into commercially viable
innovations—the university was built for this purpose. When William Barton Rodgers founded MIT in the late 1800s, he envisioned a university similar to European polytechnic institutes, one that would promote and complement the industrial development of the Boston area (Etzkowitz 1-3). However, MIT was first set on the path to becoming one of the world leaders in commercializing university technology when Vannevar Bush started the original university based technology firm (Etzkowitz 1-3). By setting the precedence for consulting, university industry cooperation, and the transfer of university developed technology into the commercial market, Dr. Bush created a model for success that would be copied by universities across the globe (Etzkowitz 1-3).

The history of MIT is not one perennial success; during the 1930's depression the Institute was on the brink of collapse (Etzkowitz 43-45). After state support was withdrawn, administrators were left facing a financial crisis at one point even considering to becoming a part of Harvard University (Etzkowitz 43-45). The crisis helped to define MIT as the organization it is today. The Institute wanted to keep it autonomy and the only place left to turn was industry and private equity (Etzkowitz 43-45). By strengthening institutional ties to industry and recruiting researchers that were focused more on practical applications of research, MIT benefited substantially from the onset of the World War II. When the US government pushed a portion of military research into public research universities, MIT was seen as one of the few universities capable of delivering timely results. However, the new policy of distributed funds by perceived performance rather than need-based allocation, which was used by the land grant model (Etzkowitz 46-49). The in-pouring of funds greatly benefited institutions such as MIT, as well as Stanford University, Columbia University, and University of Chicago (Etzkowitz 46-49). MIT, for example, almost double the number of student and faculty over the course of the war (Burchard).

Though analyzing MIT's technology practices is interesting, a university on the scale of UK should be warned about trying to emulate them. MIT was built to be an economic engine for the Boston area and has benefited greatly from serendipitous circumstances and advanced geographical infrastructure. The
successes of the policies and practices at MIT have created a positive feedback system where success has generated success. Over the past century MIT has also created a globally recognizable brand name and is identified as a hub for high-tech licensing and entrepreneurship.

MIT has centralized their approach to commercialization and technology transfer through their Technology Licensing Office (TLO). At this office, innovators can find a ten-step methodology (adopted from the University of Michigan) called “An Inventor’s Guide to Technology Transfer at the Massachusetts Institute of Technology,” which outlines how to locate funding and start a business. The guide also provides detailed contact information as well as what to expect while an inventor navigates the process. While the purpose of the guide is to assist MIT researchers, many schools utilize similar strategies. This may not necessarily translate into effective technology transfer, which becomes evident on further analysis of several of the guide’s steps.

Step “7a FORM A START UP” describes the pathway for new business creation and outlines the TLOs responsibilities in the process.

If creation of a new business start-up has been chosen as the optimal commercialization path, the Technology Licensing Office will work to assist the founders in planning, creating and finding funding for the start-up.

This step reinforces the “gatekeeper” role, which is does not effectively foster innovation dissemination (Litan, Mitchell and Reedy 3-4). TTO managers and staff members use their expertise to determine if research is appropriate for commercialization, but they risk of preventing important technology for entering public domain if fails to meet their criteria. Additionally, not all TTOs have the resources to commit to “planning, creating, and finding funding for the start-up.”

Section “7b EXISTING BUSINESS RELATIONSHIP” prepares researchers for the task of building relationships with existing firms.

If the invention will best be commercialized by one or more existing companies, the technology licensing officer will seek potential
licensees and work to identify mutual interests, goals and plans to fully commercialize this technology. However, according the “Inventor’s Guide,” MIT’s TLO typically only finds matches for inventors and business in less than 30% of licensing deals (MIT 7), leaving most of the burden on the researcher to market their technology. This also raises the question of how small universities with less experience, staff, and resources would be able to achieve match or exceed the performance of MIT.

### 2.5.3 University of Colorado at Boulder

A more appropriate comparison could be made against the University of Colorado at Boulder (CU). In early 2000, CU found itself at a crossroad. The university took bold steps to correct its declining licensing revenue and bolster its fledgling commercialization program. CU not only strove to improve its technology transfer process but mandated that the university’s technology transfer initiatives would be the recognized leader in the U.S. among public universities (Allen).

To examine the impact of the new strategy, data was compiled from the AUTM database covering a ten year span from 1996 to 2005 (AUTM). Empirically, the data suggest that the CU’s measures have been extremely successful. From 2001 to 2005 the University of Colorado more than doubled the number of active patents and tripled the number of start-up companies (see Figure 2.1). What is even more impressive from the universities stand point is that licensing revenues increased over ten fold from the inception of the new strategy.
Table 2.1 University of Colorado Technology Transfer Metrics.

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<tbody>
<tr>
<td>1996</td>
<td>$292,547,000</td>
<td>100</td>
<td>$2,274,887</td>
<td>111</td>
<td>28</td>
<td>0</td>
</tr>
<tr>
<td>1997</td>
<td>$343,300,000</td>
<td>118</td>
<td>$3,552,899</td>
<td>80</td>
<td>29</td>
<td>4</td>
</tr>
<tr>
<td>1999</td>
<td>$331,579,000</td>
<td>79</td>
<td>$3,127,303</td>
<td>108</td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td>2001</td>
<td>$367,665,087</td>
<td>79</td>
<td>$2,238,792</td>
<td>90</td>
<td>13</td>
<td>3</td>
</tr>
<tr>
<td>2002</td>
<td>$470,400,000</td>
<td>121</td>
<td>$2,098,578</td>
<td>155</td>
<td>26</td>
<td>3</td>
</tr>
<tr>
<td>2003</td>
<td>$531,800,000</td>
<td>124</td>
<td>$3,083,185</td>
<td>167</td>
<td>34</td>
<td>6</td>
</tr>
<tr>
<td>2004</td>
<td>$571,342,900</td>
<td>147</td>
<td>$34,148,514</td>
<td>163</td>
<td>41</td>
<td>9</td>
</tr>
<tr>
<td>2005</td>
<td>$497,762,300</td>
<td>177</td>
<td>$27,352,470</td>
<td>223</td>
<td>60</td>
<td>9</td>
</tr>
</tbody>
</table>

So, how did CU achieve this dramatic turn around? The answer is by identifying the weaknesses of its technology transfer program and proposing new initiatives to improve the process. A few examples of the initiatives are creating a roadmap for licensing procedures, educating inventors and staff in TTO procedures, enhancing communications, creating a web site detailing information on commercialization practices, and creating a database to manage intellectual property (Allen). CU also proposed more quantitative goals as a part of its strategy. For example, the university sought to increase patent application by 20% and grant licenses to 6 start-up companies within one year of the “strategic thrust” (Allen).

The TTO web site at CU, like MIT, provides a “technology roadmap” through detailed web content for faculty, staff, and students at the website <https://www.cu.edu/techtransfer/investigators>. The information that is provided is much more thorough and comprehensive than the MIT’s “Inventor’s Guide.” CU’s web site is also more interactive than MIT’s site because it includes links to email addresses, references and pertinent forms.
2.5.4 Iowa State University

Iowa State University (ISU) consistently ranks among the best in the metric of technology licensing. Even with a research budget that is a fraction of schools such as MIT and the University of California System, ISU was ranked second in licensing in 2005 with 218 licenses and options granted (Palmintera 77-80). How did such a university become a “licensing powerhouse” is worth investigating because the school prevailed against obvious disadvantages such as being located in a rural community and having limited research budget.

Further investigation of ISU technology transfer data revealed that the results of the 2005 AUTM survey were somewhat misleading. Of the all of the licenses and options granted from 1996 to 2005, 85% were related to two specific technologies—a plant germplasm and an altered fatty acid soybean variety. Many successful technology transfer offices are able to exploit niche markets, so it is not unusually to generate a large amount of licenses from only a handful of technologies. However, even with the volume of active licenses that ISU has, it only procured around $4 million dollars in revenue in 2005 (Table 2.2). Many other schools generate ten times that amount with fewer active licenses (AUTM; Palmintera 77).

<table>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1996</td>
<td>$182,000,000</td>
<td>155</td>
<td>$3,500,000</td>
<td>338</td>
<td>114</td>
<td>4</td>
</tr>
<tr>
<td>1997</td>
<td>$185,500,000</td>
<td>115</td>
<td>$6,971,226</td>
<td>418</td>
<td>133</td>
<td>6</td>
</tr>
<tr>
<td>1998</td>
<td>$181,400,000</td>
<td>158</td>
<td>$2,786,617</td>
<td>589</td>
<td>191</td>
<td>5</td>
</tr>
<tr>
<td>1999</td>
<td>$186,700,000</td>
<td>160</td>
<td>$1,874,014</td>
<td>696</td>
<td>163</td>
<td>2</td>
</tr>
<tr>
<td>2000</td>
<td>$198,900,000</td>
<td>114</td>
<td>$1,232,562</td>
<td>871</td>
<td>218</td>
<td>5</td>
</tr>
<tr>
<td>2001</td>
<td>$202,100,000</td>
<td>115</td>
<td>$2,502,462</td>
<td>891</td>
<td>208</td>
<td>2</td>
</tr>
<tr>
<td>2002</td>
<td>$212,100,000</td>
<td>100</td>
<td>$10,864,229</td>
<td>1038</td>
<td>287</td>
<td>2</td>
</tr>
<tr>
<td>2003</td>
<td>$224,800,000</td>
<td>134</td>
<td>$5,769,282</td>
<td>1016</td>
<td>187</td>
<td>1</td>
</tr>
<tr>
<td>2004</td>
<td>$239,223,000</td>
<td>110</td>
<td>$2,118,000</td>
<td>916</td>
<td>166</td>
<td>2</td>
</tr>
<tr>
<td>2005</td>
<td>$238,838,000</td>
<td>142</td>
<td>$4,019,000</td>
<td>745</td>
<td>218</td>
<td>5</td>
</tr>
</tbody>
</table>
Arguably, ISU is adhering to the fundamental mission of the Bayh-Dole Act, in that it is transferring technology for the benefit of society. This is also evident in ISU TTO’s strategic plan, which highlights the office’s efforts to impact society and improve the quality of life in Iowa ("Strategic Plan 2005-2010"). Because ISU provides cost effective licensing deals, many potential licensees are willing to work with ISU’s TTO. A note of caution—ISU policies could be construed as too altruistic. A balance should be made between maintaining the university’s status as an attractive licensing partner and generating enough revenue to sustain the staff and programs within the TTO. ISU has thirteen individuals that work in the area of technology transfer and provides grants for early stage technology development. If a university wants to sustain and grow commercialization efforts revenue targets should be addressed as a key metric for the success of a technology transfer office. As seen in Table 2.2, ISU licensing revenue vacillates yearly with no clear trend towards growth.
Chapter 3 Technology Transfer at the University of Kentucky

3.1 Introduction

A press release in late 2006 by the University of Kentucky touted the institution as “a leader in translating research from the laboratory to the marketplace” (Blanton). However, this statement does not correlate to the data from AUTM licensing reports, at least in respect to the University of Kentucky’s selected “benchmark” institutions. The reality is the University of Kentucky needs to implement innovative strategies to truly be considered a leader in technology transfer.

It was evident that there was not a standard approach to the technology transfer process from studying practices at several universities as outlined in Chapter 3. MIT provides statistics regarding start-up, licenses granted and revenue. However, MIT does not have a publicized methodology that pits itself against competing institutions. The University of Colorado at Boulder has revamped its commercialization approach with undeniably positive results. CU has adopted a clear strategic guide detailing goals, strengths and weaknesses and a methodology for assessing their progress. The methodology for assessing progress is not unique to CU. This practice has also been incorporated at other universities such as Iowa State University. The University of Kentucky has not publicly provided a strategic plan and currently does not have a standardized process for assessing its commercialization activities.

The subsequent sections propose a methodology that the University of Kentucky could incorporate to assess its commercialization practices.

3.2 University of Kentucky versus Benchmark Institutions

In an effort to discern what factors in technology transfer affect the relative success of an institution, I compared UK to its “benchmark” institutions (see Table 3.1) listed in its Top 20 plan (“Benchmark Institutions”). The data was compiled from an AUTM database, which collects TTO data by survey from
participating institutions. The analysis does not contain any data with respect to the University of California Los Angeles due to the University of California system reporting collectively for all state institutions. It should also be noted that the University of Illinois at Urbana Champaign data includes the Chicago campus.

Table 3.1 University of Kentucky Benchmark Institutions

<table>
<thead>
<tr>
<th>Michigan State University</th>
<th>University of Florida</th>
</tr>
</thead>
<tbody>
<tr>
<td>Univ. of North Carolina Chapel Hill</td>
<td>University of Georgia</td>
</tr>
<tr>
<td>North Carolina State University</td>
<td>University of Iowa</td>
</tr>
<tr>
<td>Ohio State University</td>
<td>University of Maryland College Park</td>
</tr>
<tr>
<td>Penn State University</td>
<td>University of Michigan</td>
</tr>
<tr>
<td>Purdue University</td>
<td>University of Minnesota</td>
</tr>
<tr>
<td>University of California Los Angeles (not included in results)</td>
<td>University of Virginia</td>
</tr>
<tr>
<td>Texas A&amp;M University</td>
<td>University of Washington</td>
</tr>
<tr>
<td>University of Arizona</td>
<td>Univ. of Wisconsin at Madison</td>
</tr>
<tr>
<td>University of Illinois Chicago Urbana</td>
<td></td>
</tr>
</tbody>
</table>

To further understand how the University of Kentucky compares to its “peer” universities, a side-by-side comparison was made using data concerning three important metrics of technology transfer: licensing revenue (Figure 3.1), invention disclosures (Figure 3.2), and total research expenditures (Figure 3.3). Although the metric of invention disclosures is not a reflection of the total number of technologies that a university attempted to protect, it was an initial gauge of the overall “inventiveness” of each university. A further study of the effectiveness of a university’s technology transfer office would be to collect data on how many technologies were licensed versus the total number of technologies that a university has protected. This data is presently not available on the AUTM surveys. Universities report active licenses and licensees executed, but they do not distinguish if a single intellectual property has been licensed more than once. For example, in 2006 the University of Kentucky has 281 active patents and only
95 active licenses which would equate to around a 33% success rate if each active license corresponds to only one intellectual property.

Figure 3.1 Ten Year Average of Invention Disclosures for UK and Top 20 Benchmark Schools
The amount of total research expenditures reported by the University of Kentucky Research Foundation (UKRF) is the most significant data point in the analysis. Over a ten year period from 1996 to 2005, UKRF averaged $113,923,134—last in total expenditure (see Figure 3.3). This is only 28% of the 10 year average of the other 17 institutions considered. The University of Virginia Patent Foundation (UVPF) was next to last, but UKRF expenditures were still only 55% of what UVPF devoted to research over a ten year period (AUTM 1996; AUTM FY: 1997; AUTM FY:1998; AUTM FY: 1999; AUTM FY: 2000; AUTM FY:2001; AUTM FY:2002; AUTM FY: 2003; AUTM FY:2004; AUTM FY: 2005). The University of Kentucky is clearly not on par with the research funding of its benchmarks.
From the result of the study UK compares poorly to its benchmark institutions at first glance. UK ranked last in total research expenditures and last in invention disclosures. One promising note from the results was that UK only ranked 15th (see Figure 3.2) in licensing revenue but taking away from that fact is that UK’s licensing revenue declined at a rate of 10.7% from year 1996 to 2005 (AUTM 1996-2005). After extensive analysis of the data regarding the different metrics from expenditures to number of patents filed no definitive correlation could be made in linking the output of the TTO i.e. start-ups and licensing revenue to research funds being put into the universities.

To expand on the study of UK versus its benchmark institutions new metrics were needed to gauge UK’s performance in technology transfer. This is needed due to the fact that UK is not on par with arguably a key variable in the technology transfer equation, total research expenditures. Upon further
investigation of technology transfer web pages, universities such as Iowa State normalize their data on a per ten million dollars spent in research basis (ISU Annual Report 5). Furthermore, Iowa State lists in their annual report a ranking of invention disclosures per ten million dollars spent in research versus land grant universities (ISU Annual Report 5). A similar method is proposed to compare UK and its benchmark institutions. For our study start-ups, invention disclosures, license revenue and new patent applications were compared for each university over a ten year period on a per ten million dollar in total research expenditures basis.

**Figure 3.4 Ten Year Average of Start-Ups for UK and Top 20 Benchmark Schools on Basis of Ten Million Dollars in Research Expenditures**
Figure 3.5 Ten Year Average of Invention Disclosures for UK and Top 20 Benchmark Schools on Basis of Ten Million Dollars in Research Expenditures
Figure 3.6 Ten Year Average of Licensing Revenue for UK and Top 20 Benchmark Schools on Basis of Ten Million Dollars in Research Expenditures
The results of this analysis show that the University of Kentucky performs favorably when compared on a basis of per 10 million dollars in research expenditures. UK ranks first in start-ups and second in invention disclosures (see Figure 3.4 and Figure 3.5) compared to the benchmark institutions. It can be inferred from the data that UK, despite lacking comparable research funding, has relatively high levels of inventiveness and entrepreneurialism. This potentially bodes well for the university as it seeks to expand its research efforts in a push to become a “Top 20” research university. However, even though UK ranks highly in invention disclosures that success is not translating into a high number of actual patent applications (see Figure 3.7). Many reasons exist why an invention disclosure is not submitted as a patent application, from quality of the invention
disclosure to issues with the intellectual property office. Regardless, further analysis of the intellectual property practice could be warranted based on the drop-off.

The licensing revenue generated per ten million dollars in research by UK is 9th best when compared to benchmark schools (see Figure 3.6). It can be argued that this metric is not a true measure of technology transfer efficiency due to some institutions benefiting greatly from “home run” technologies. However, as UK moves forward and expands its technology licensing practice, revenue needs to maintain a level that can sustain and grow the technology transfer office.

3.3 Summary

Exploring further into the myriad of TTO licensing reports, it was observable that the success of a university in the realm of technology transfer can not be predicted solely based on data points, such as research expenditures and invention disclosures. Furthermore, it is not valid for a university to blame a lack of technology transfer success on insufficient research expenditures relative to a Stanford or MIT per se. Iowa State University is consistently in the top ten in regards to active licenses while operating on research expenditures on the order of one quarter of what a school like MIT expends. From the results of the licensing study it is evident that there are other contributors that influence the quantitative results of technology licensing.

This analysis does provide a new method for the University of Kentucky to assess its technology transfer practices. Comparisons against its “Top 20” benchmark institutions would also give consistency to the universities own self assessments. Currently, University of Kentucky technology transfer is not given any kind of internal assessment against competing institutions. The Office of Commercialization and Economic Development (OCED) sites arbitrary reports and cherry picks data points that offer no real insight into how it is performing year to year (“UK’s TTO”). This proposed ranking methodology has been proposed to the OCED. Even if the University of Kentucky’s OCED does not choose to adopt this type of evaluation methodology, the methodology can still
be incorporated into the practices at the Center for Visualization and Virtual Environments (CVVE) to assess its own practices.
Chapter 4: New Methodology to Commercialization in the University Environment

4.1 Introduction

From my experience working in the Engineering and Commercialization Group (ECG) at the University of Kentucky’s Center for Visualization and Virtual Environments (CVVE), it became apparent that a new approach to commercializing the center’s technologies was needed. The CVVE does not currently have any clear commercialization “roadmap” or policies in place to assist an inventor or entrepreneur. Commercialization successes at the center were mainly driven by individual maneuvering without a centralized oversight. The goal of my proposed methodology is to streamline the commercialization process in the hope of increasing participation and transferring more technology out of the center.

Currently, most researchers are burdened with the challenging and time-consuming task of finding a licensee. However, some fortunate innovators happen upon an interested company that was referred to the CVVE by a third party. There currently is not a single documented instance where the Office of Commercialization and Economic Development (OCED) successfully marketed and licensed a CVVE technology individually. The Engineering and Commercialization Group (ECG) mission will be to work with the OCED to help facilitate commercialization. If the ECG group is successful, it could be used a model for other research centers at the University of Kentucky to emulate.

The success of universities’ licensing efforts is directly related to how well the technology transfer office is staffed and organized (Markman et al. 353-64). The methodology I propose builds upon office mechanics by assigning greater responsibilities to the teams working within research centers or any area of the university that is generating significant amount of IP. Instead of staffing an autonomous office that is disconnected from research centers (e.g. the CVVE), a small team or individual is embedded within the research centers or colleges themselves (see Figure 4.1). The satellite group or individual would be
connected to the larger technology transfer office, yet would have more intimate interaction and knowledge of the potential commercializable technologies through the connections to innovators. This approach minimizes the asymmetric information between the groups, which often causes inefficient diffusion of technology. Through this model, the satellite groups alleviate many day-to-day responsibilities of the larger TTO such as identifying potential licensees and managing and marketing IP.

Figure 4.1 Satellite structure of TTO organization

Currently the University of Kentucky does not provide a clear procedure for commercialization. The only way to determine the necessary steps to take is to locate and email or phone the contact listed on the OCED website ("About CED"). However, just getting basic information about the process using this method can be difficult. In some cases, efforts to contact members of the OCED staff via email were unsuccessful. To reduce the need for excessive interaction
with the OCED staff, an in-depth assessment of the process was developed. Based on an overview of current methodologies, a commercialization “roadmap” was developed, which seeks to address two key issues facing inventors. First, it provides a start-to-finish methodology that focuses on how to bring technology to market, license to an existing company or form a start-up company. Second, the “roadmap” includes information and procedures that can aid in procuring funding for a small business or start-up, one of the critical components of commercialization. The completed commercialization “roadmap” provides a direction to commercialization throughout the CVVE and serves to expedite the process by eliminating guess work and having to seek unnecessary OCED assistance.

**Figure 4.2 General Technology Transfer Roadmap for CVVE**
4.2 Goals of Proposed Methodology

The goals of the proposed new methodology were broken down into two categories based on their qualitative and quantitative outcomes, which focus on improving efficiency and minimizing imperfect information in the technology transfer process.

4.2.1 Qualitative Goals

1) **Alleviate time and capital burden on staff and faculty in commercialization process.**
   Faculty’s main responsibilities are educating students and performing research. Commercial endeavors can potentially distract from a faculty member’s main job description. By having dedicated staff and processes in place, the logistical burden placed on an inventor with entrepreneurial ambitions could be minimized.

2) **Manage IP and ensure timely responses from OCED office.**
   The engineering and commercialization group will also be charged with the day-to-day bookkeeping and prioritizing of intellectual property. This entails the allocation of Center resources to develop proof-of-concept models for a technology. Furthermore, the engineering and commercialization group will act as a liaison between the inventor and the OCED office and as an advocate for the inventor’s technology.

3) **Identify and contact potential licensees.**
   In order to increase the through-put of technology in the Center, there needs to be “buyers” for the intellectual property. Establishing relationships with existing businesses would greatly increase the probability and speed at which a technology could be licensed. To attract technology companies and build a reputation for quality products, methods need to be incorporated to showcase the Center’s technologies. Currently,
technology “open houses” provide excellent forums to generate interest, with several technologies receiving “grants” from companies and government agencies in exchange for a product. However, in these instances the CVVE is acting as the technologies provider which is not the end-goal of commercializing the technologies. The focus needs to shift to “selling” the center’s technologies to companies that can further develop and productize the IP. Technology open houses should be geared towards companies with prior success in commercialization. Furthermore, the CVVE should be providing a technology “brochure” to potential licensing companies and establishing working relationships with those companies.

4) **Help facilitate spin-off creation by providing facilities and helping to procure financing.** (SBIR/STTR KSTC grants)

Currently, UK provides business incubator space in the Advanced Science and Technology Commercialization Center (ASTeCC) facility to faculty and staff or companies that are licensing a UK technology. However, space in the ASTeCC building is limited, with around 50% of the space allocated to supporting facilities, such as a Mass Spectrometry Lab. In addition to the limits on space, costs are also significant. An alternative approach would allow a CVVE inventor to lease a “virtual” incubator space within the Center itself. Allowing for “in house” company incubation has many benefits from on-site consultants to potential cost savings.

To further facilitate the creation of spin-off companies, the engineering and commercialization group will consistently keep abreast of potential sources of financing for CVVE technologies. Theses sources for start-up funding include KSTC, SBIR and STTR grants.

5) **Enact new initiatives to encourage invention disclosures.**

As a way to encourage faculty, staff and students to participate in the commercialization process, new methods will be needed to recognize and reward inventors. The recognition program could potentially yield the “copy-cat” phenomenon discussed in Chapter 1.
4.2.2 Qualitative Goals

1) Increase Invention Disclosures
The University of Kentucky performs very well in regards to invention disclosures per ten million dollars spent in research. The goal of the CVVE should be to build on that success.

2) Successfully license greater than 50% of CVVE intellectual property
The average licensing rate across the University of Kentucky is around 33%. The CVVE goal is to reach and sustain a level of 50% with in a 5 year period.

3) At least 33% of licenses to regionally based companies
To attain the goal of regional economic development, the CVVE will attempt to have one-third of its transferred technologies licensed to regional companies. This poses a significant challenge due to the dearth of high tech companies in the region. However, this goal could potentially be met with increased start-up activity within the CVVE. Mersive LLC is a start-up formed out of the CVVE and currently licenses four technologies from the center. This is an excellent example of how a start-up company can help meet the goals of regional licensing.

4) Increase SBIR/STTR participation
The ECG group will assist in the development of SBIR/STTR proposals and monitor open solicitations to match against CVVE research and intellectual property. The ECG group also has resources to aid in the development of proposals and contact information for consultants that can assist in the submission process.

5) CEG self-sufficiency
Tangible results should be expected to justify the existence of a designated commercialization team within the CVVE. Ideally, incoming revenues from licensing royalties should match or exceed the human and financial capital expended on commercial endeavors. The CEG does not need to be directly funded from licensing revenues due to the multiple
responsibilities of the group. However, a pay for performance model could serve to ensure that commercialization efforts remain a priority.

4.3 Proposed Methodology

The first step in developing this methodology was to identify and outline the specific routes in the commercialization process. There are mainly three types of potential commercialization routes that require more detailed methods to pursue them.

- An existing business with experience in commercialization;
- A start-up/internal company with accessible funding;
- A start-up/internal company without current capital.

The plans themselves provide a theoretical view of the feasibility of commercial success, which is measured with metrics such as finances, prior commercialization success, and competency of the team that is developing the technology. Commercialization plans differ from business plans, because commercialization plans focus on how the technology is going to be developed into a viable product. However, a commercialization plan alone may not be sufficient for successful licensing of a university technology. For instance, the AUTM recommends that university procure a full business plan in order to determine royalty rates (Valuate Manual). The need for the full business plan is arguable because many aspects of a potential business are proprietary. As long as the commercialization plan includes estimates of sales and revenue, it should be valid to estimate economic returns to the university based on royalty and fee agreements.

4.3.1 Commercialization Process for Licensing to an External Company

In the case in which the CVVE is approached by an external company to license a technology, the CVVE is limited to only referring the company on the OCED office. Alternatively, the CVVE should be equipped to respond to requests for
information to expedite the licensing process. The company would be informed by the CVVE that a commercialization plan should be worked out in detail before meeting with the OCED. The process is outlined in Figure 4.3.

**Figure 4.3 Process flow for Licensing to External Company**
An example of a commercialization workbook that is being developed at the CVVE can be viewed in Figure 4.4. It can be given to potential licensing companies as a template to begin the commercialization process. This plan is derived from a plans being developed by the navy and an outline proposed by Lisa Kurek during a SBIR/STTR workshop ("Commercialization Plan Guidelines (Draft)"; "SBIR-STTR").

Figure 4.4 Sample template for CVVE Commercialization Workbook

| Center for Visualization and Virtual Environments  |
| Commercialization Plan Workbook                  |

Commercialization Plan Executive Summary (2 pages max.)

Background and Development Strategy
The background and development strategy section should include a brief but concise description of the following: The goals of the commercialization project, a development plan to achieve the project goals, measurable benchmarks and milestones to gauge performance, contingency plans to overcome project setbacks.

Management
The management approach section should focus on transferring the technology into the marketplace. This section should also include details about the management team and the qualification of participants. Furthermore, a detailed description of how the end results of the commercialization effort will translate into a commercial product or service. This section should also be used to outline risks and plans for dealing with the realization of those risks.

Commercial Viability
The commercial viability section should include a SWOT (strengths, weaknesses, opportunities and threats) assessment of the technology in regards to the marketplace. Include estimates for time to market, market size, competitive advantages, and additional applications for product differentiation.
**Commercialization Planning (15 pages max.)**

### Company Information
- Description of company, market focus, future vision.
- Commercialization successes (for non-start-up)
- Company resources for research and development, manufacturing, and marketing.
- Company designation i.e. start-up, small business (< 500 employees) or large business (> 500 employees)

### Management Information
- List key members of the development team: principle investigator, management, consultants, etc.
- Detail development team expertise and prior collaborative experience
- Discuss team leadership and level of commitment to the project.

### Technology Development
(A revise SBIR/STTR technology development can be inserted here. See section 4.3.3)
- Description of the technology and current state in regards to commercialization.
- List primary CVVE contact for this technology, and describe the relationship between company and the CVVE contact.
- Assistance required from university and technology inventors.
- Estimated time to market.
- Provide commercialization timeline with milestones and criteria for determining success.
- Define the financial and human capital needed to develop the technology.
- List potential risks and roadblocks and contingency plans.

### Market Characterization
- Define the field of use sought in the licensing agreement.
- Discuss company plans for placing product in market and any derivative products.
- Who are the customers for the technology?
- Estimate market penetration and market dynamics.
- Explain why this technology provides a competitive advantage over industry competitors.
The commercialization workbook can assist a company in proving its case that it is a viable candidate for commercializing a university technology. The inventor of the technology should also be prepared to assist the OCED office with estimating the potential value of the intellectual property. In order to make an initial assessment the ECG can assist with determining an initial value of the technology. ECG group can complete a “market method” assessment by research SEC filings or third party fee based services in order to determine industry rates of similar technologies. However, for some cases finding industry rates may be difficult in which case a university average rate could be sufficient. In an AUTM Economic Impact Survey as sited in a brochure from Technology Transfer and Research Ethics Committee of the Council on Governmental Relations stated that a royalty rate of around 2.3% was the average of the universities they surveyed (Technology Transfer in U.S research universities). Once a normal industry rate is agreed upon, the value of the specific technology can be approximated by using a royalty rate calculator. The royalty rate estimation can be determined using a rate calculator that was developed by Dr. Phyllis Speser and used by her company Foresight (Speser 358).
Table 4.1 Royalty Rate Calculation

<table>
<thead>
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<td>Foreign rights (yes add, no subtract)</td>
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<td>2</td>
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Total: 37 0
The steps taken upfront to ensure that an acceptable commercialization plan and initial royalty assessment are completed should facilitate a more efficient process once the OCED office takes over to the licensing process. The OCED office will only have to approve or deny the company based on the case it makes for being an adequate partner in the development of the intellectual property. Also, by having a fair assessment of a technology's value will help to alleviate many of the difficulties that manifest during the negotiations of royalty rates.

4.3.2 Commercialization Process for Internal Company

An internal company that desires to license a CVVE technology would follow similar steps as outlined in Section 4.3.1. The company would need to complete a commercialization workbook and prepare an initial assessment of royalty rates. However, if the internal company is a faculty start-up for example there are in many cases significant gaps in the management teams i.e. marketing, sales, etc. The University of Kentucky and other state entities, such as KSTC, can provide assistance in these areas. Furthermore, in the commercialization plan more focus should be given to development of the company, financial support and business strategy (Carlsson and Fridh 209).

The ECG can assist an internal company with finding resources, such as facilities, and keep companies informed of funding opportunities such as grants offered by KSTC. Furthermore, by incorporating the strategy regarding CVVE technology development much of the initial commercialization planning should be completed thus elevating much of the upfront work required by the company. The ECG group ideally would have completed a technology development plan and identified key players in the industry. If a new application is developed that falls out of the scope of the ECG technology development plan the ECG group can still assist with developing the plan if needed.

If the streamlined methodology is successful the only steps left in the process are licensing and implementing the commercialization plan as shown in Figure
4.5. Also, an initial assessment of royalty rate should be made before beginning the process of procuring and negotiating a licensing agreement. The University of Kentucky does not have set licensing fees therefore royalty rate agreements are made on a case by case basis. The framework used in evaluating the technology in previous section for licensing to an external company can also be used in this case.

**Figure 4.5 Process Flow for Licensing to Internal Company**

It should be noted that initial licensing cost can be offset by granting company equity to the university. In some instances equity agreements have proven very profitable to universities. However, the managing of company equity adds an additional level of complexity for the technology transfer offices. For the
case of procuring a license from the University of Kentucky, granting company equity in exchange for reduced licensing fees is not likely. From 1996 to 2005 the University of Kentucky executed ninety-eight licenses and only took equity seven times, a rate of around 7% (AUTM 1996-2005). Therefore the prospect of offsetting licensing cost by granting equity is not impossible just not likely given the university’s history.

4.3.3 Commercialization Process for SBIR/STTR funded Internal Company

The SBIR (Small Business Innovation Research) and STTR (Small Business Technology Transfer) are programs administered by the U.S. Small Business Administration geared towards helping small high-tech companies with commercialization efforts. The programs are highly competitive and targeted only to for-profit small businesses with less than 500 employees that are based and planning to develop their technology in the U.S. SBIR and STTR grants differ in that STTR grants involve partnering with a U.S. non-profit research institution, such as a university ("SBIR-STTR"). The grants are structured into three phases:

**Phase I:** Phase I grants are usually $100,000 for six months of work and facilitate the proof-of-concept stage of technology development. The grants are highly competitive, with about 10% of proposals receiving funding. However, soliciting the help of an SBIR/STTR consultant can potentially increase odds of receiving an award. Lisa Kurek of Biotechnology Business Consultants states that clients of her firm are granted SBIR/STTR awards at rates of around 50% ("SBIR/STTR Conference").

**Phase II:** Phase II grants are usually $750,000 for up to 2 years of work. A Phase II grant is aimed towards further research and development and transitioning proof-of-concept model to a commercially viable product. Phase II solicitations are by invitation only, and a company must have
received a Phase I award to participate. The probability of receiving a Phase II award is around 50%. Once again, consultants claim to significantly improve the odds of receiving an award. The Phase II solicitation also requires a commercialization plan that can be based on the CVVE’s proposed plan, which is outlined in “Section 4.3.1.” ("SBIR/STTR Conference")

**Phase III:** The Phase III portion of the SBIR/STTR process receives no funding. At the Phase III stage, the company is expected to have a product and the means to move its product onto the market. For some SBIR/STTR grants, the granting agency contracts to purchase the final product, with the expectation there will be other buyers as well. Therefore, the commercial application needs to have broader market potential ("SBIR/STTR Conference").

To aid internal and start-up companies with their commercialization efforts, the ECG group will facilitate procuring SBIR and STTR grants. A word of caution—SBIR/STTR awards for commercialization cannot be used to pay licensing fees. Kentucky Science and Technology Corporation (KSTC) lists funds can be used towards initial licensing fees, which helps a company minimize financial risk associated with licensing. The Innovation and Commercialization Center (ICC) offers concept pool funds of $25,000 that also can be used for this purpose ("Kentucky Enterprise Fund"). However, the ICC concept pool funds are only offered two times a year and might not coincide with the SBIR/STTR grants. Initial Phase I grants are usually $100,000, yet initial licensing fees alone can exceed that amount. Even if a licensing fee was only $25,000, a granting agency would be skeptical that a company could complete the proof-of-concept effort with such high initial cost.

To expedite the process, the ECG will provide an SBIR/STTR checklist, which should be completed before proposal submission. The checklist will contain all of the initial preparatory paperwork that is necessary in order to submit
a proposal for a SBIR/STTR solicitation. These steps include establishing a company (i.e. limited liability corporation or incorporation), obtaining a tax identification number, establishing a company checking account, registering the company at the Grants.gov website, registering the primary investigator, and other administrative tasks. Figures 4.6 and 4.7 outline the commercialization process that incorporate procuring SBIR/STTR funds.

Figure 4.6 Process Flow for Utilizing SBIR/STTR Phase I Grants for Commercialization

46
Once an award has been made, Kentucky-based companies can also apply for matching grants from the State. For Phase I awards, an additional $100,000 is available; $500,000 is offered for Phase II awards ("Matching Funds"). SBIR/STTR grants and State matched funds provide an excellent resource for entrepreneurs and small businesses that need additional money for
research and development. Successful grant applicants who receive the standard grant amounts could add nearly a one and a half million dollars to their R&D efforts. This significantly reduces the financial risks associated with starting new ventures, because these grants do not have to be paid back. According to Dr. Robert Berger, a former SBIR manager, the amount of grant awards may increase in the near future. Phase I awards could potentially double to $200,000 with Phase II increasing as well (Berger).

To aid in the creation of the technology development plan, the CVVE plans to adopt a standard format that was developed by Dr. Robert Berger (see Figure 4.8), which was presented at an SBIR/STTR workshop (Berger). The strength of using this format is that it is easily adaptable to the varying requirements of the soliciting agencies.

**Figure 4.8 SBIR/STTR Technology Development Plan**

The sequence for writing the proposal based on Dr. Robert Berger’s *How to Prepare Winning Proposals for SBIR and STTR Workshop Handbook*

1. The general problem, and the benefits of solving it
   a. There is a big problem that needs solving
   b. Solving the problem leads to big benefits, economic/societal and technical
2. The specific technical problem and proposed solution
   - We have identified the key technical issue
   - The idea for solving the problem
   - Components of the solution
   - Why the idea is innovative
3. What you must learn to determine whether the proposed solution works
   - The research questions
4. Your approach to solving the specific technical problem
   - How we will find what we don’t know
   - Why the approach is better than others that have been tried
   - What might go wrong and how we will address it
   - Why the work is challenging
5. The Phase I technical objectives
6. The Work Plan and the Budget
   a. Link tasks to objectives
   b. Criteria to determine when objectives and feasibility are accomplished
   c. Details of what will be done
   d. Budget: Link to tasks, use budget explanation page if appropriate
When the CVVE has commercializable intellectual property or research, it can create technology development plans, which will allow the ECG to solicit SBIR/STTR granting agencies. According to SBIR/STTR project managers, the granting agencies are open to new ideas from outside interests. Solicitation topics that are inline with the CVVE research could improve the likelihood of receiving grants. Furthermore, if the solicitation is from an agency that awards contracts, the company awarded the grant already has a customer for their product (“SBIR/STTR Conference”).

4.3.4 Plan for Web Based Management

The next step in the process of streamlining the commercialization process is to make the information presented in the proceeding sections easily accessible to individuals undertaking commercialization. The director of the CVVE has stated his desire to have commercialization information available on the CVVE’s website by the Spring 2008 semester. A derivation of the preceding information is part of that plan.

The need for a streamlined methodology is not a new concept. Due to lack of financial and human resources available to technology transfer organization better methodologies are needed. A recent patent application highlights this growing problem. Patent application number 20070203737 for a Virtual Technology Transfer Office details a methodology for managing intellectual property (Tanana-Boozer). The application mainly deals with a centralized web based service to rank the importance of IP and identify and solicit services from an entity to develop the IP. The claims of the applications are weak; many large
corporations already perform web based IP rankings. Furthermore, a web based keyword search that is proposed to identify similar IP and potential licensees is not a novel concept either. The most impressive aspect of the application is the application itself. Knowing that someone has risked significant financial capital to attempt to protect this idea shows the need for a better methodology for intellectual property management in the marketplace.

The University of Arizona is an example of current efforts to improve technology management practices and improve the commercialization process. The main impetus of their actions was to address lack of information sharing, one of the main complaints associated with technology transfer offices. The university implemented a web based portal that keeps records of technologies, disclosure dates, the current status of the disclosure and who is managing the IP. The new system has been met with very positive feedback from university administrators but is mainly serves to aid in transparency to technology transfer office activity ("Department web pages" 26-7).

To further facilitate the commercialization process in the CVVE, a new web based shared resource is proposed. The goal is to create a centralized source that includes inventors, research, commercialization efforts, and status of those efforts. As a shared resource, other inventors at the CVVE, and potentially the university, can have visibility to potential licensee and other aspects that could assist with their own commercial endeavors.

The first step in the process is to create a centralized database of all of the CVVE intellectual property based on the inventors. Each inventor will have a profile created that details the areas of research, patents granted, and patents pending. Each patent and patent pending is tasked with the creation of a technology development plan. A potential commercial application should already be envisioned if intellectual property protection has been pursued. The commercialization plans will to include Gantt charts detailing milestones and goals. Furthermore, each plan needs to include a list of potential licensee and ideally additional applications for the technology. The following is an example of the layout of the proposed CVVE commercialization database (Figure 4.9–4.10).
Database of CVVE Technologies

Figure 4.9 CVVE Technologies Home Page

CVVE Technologies Home Page
CVVE Inventors
Faculty
- Dr. Hank Dietz
- Dr. Kevin Donohue
- Dr. Laurence Hassebrook
- Dr. Daniel Lau
- Dr. Greg Luhan
- Dr. Doreen Maloney
- Dr. Joan Mazur
- Dr. Brent Seales
- Dr. Dimtry Strakovsky
- Dr. Ruigang Yang
Staff
- Steve Bailey
- Danny Castro
- Bill Gregory
- Matt Fields
- Etc
Students
- Aaron Crooker
- Steve Dominick
- Michael Schmidt
- Etc

From the home page of the web based database, each inventor name is linked to a password protected page that includes the details of the inventor research, intellectual property, and additional information such as grant opportunities and status of licensing efforts. For an example, Dr. Ruigang Yang's work was used as a model (Figure 4.10).
Dr. Ruigang Yang
Assistant Professor
Ph.D., University of North Carolina at Chapel Hill
Phone: 859.257.1257
Ext: 81282
Room: 829
email: Hryang@cs.uky.edu

Research Examples:

HEye-Gaze Correction
Intellectual Property Pending: status
Intellectual Property:
Video-Teleconferencing System with Eye-gaze Correction, with Zhengyou Zhang (Microsoft Research), US patent 6771303.

Commercialization Efforts:
Technology Development Plan (Based on SBIR/STTR proposal)
Licensing status: Yes/No/Pending, Company, Field of Use
SBIR/STTR status: STTR awarded, Company Information

Potential Licensee(s):
HP – Halo Collaboration Studio
Contact Information – use Jigsaw service to identify key contacts

Large Format Display
Intellectual Property Pending: status
Intellectual Property:
2) High-definition home theater with multiple projectors. (2006)

Commercialization Efforts:
Technology Development Plan (Based on SBIR/STTR proposal)
Licensing status: Yes/No/Pending, Company, Field of Use
SBIR/STTR status:

Potential Licensee(s):
Display Solutions, Inc.
43 Broad Street, A404
Hudson, MA 01749
The strength of this approach addresses one of the key elements of the thesis which is to eliminate imperfect information. Commercialization efforts can be focused on specific tasks, reduce any redundancy and identify roadblocks. This information can be shared easily among administrators and inventors. For administrators this tool will provide detailed information about commercialization efforts. The transparency will aid in technology transfer oversight and accountability. For the inventors this tool will provide information to aid the commercialization process.

The information given in Figure 4.10 provides an overview of the commercialization status of intellectual property and research. Specific web pages outlining commercialization task can further facilitate the technology transfer process. Figure 4.11 gives a generalized list of information that focuses on specific needs in the commercial development process. The generalized list of task can eliminate inventors having to locate and retain services to help with commercialization. The inventor’s commercialization needs can be documented and prioritized. This gives a clear framework and timeline for developing intellectual property.
Figure 4.11 Generalized Task List for Developing IP

Technology Development Task List

Identify and Solicit Potential Licensees
 If a potential licensee is known to the inventor the next steps are referred to the CED office. The ECG is not charge with negotiations of royalties or fields of use. The ECG requires notification of the field of use in order to guide any further commercial efforts surrounding a licensed intellectual property.

In the case the inventor can not provide any lead on potential licensee. The ECG will attempt to identify and solicit companies that could have potential interest in licensing the CVVE technology.

SBIR/STTR grant solicitations
 In the case that licensing is not successful SBIR/STTR will be explored as another avenue to commercialization. CVVE intellectual property will be assessed against open solicitation in order to find related topic. Solicitations can be found at [http://www.sba.gov/SBIR](http://www.sba.gov/SBIR). ECG group can provide assistance with grant writing and finding resources and consultant to help further develop proposals.

Proof of concept modeling
 When applicable provide assistance with developing technology in to a commercially viable product.

Spin-off into New Technology Based Firm (NTBF)
 If the intellectual property is developed into a potentially viable commercial product efforts will be made to spin the technology off into a NTBF. The ECG in conjunction with the CED office can aid with finding initial funds to help start a new venture. The source of funding range from state grants to venture capital opportunities.
4.4 Commercialization Obstacles

The proposed methodology seeks to address inefficiencies at the lowest level of the process. However, obstacles still remain even with an improved methodology and clear procedures. A recent study showed that technology transfer success can be affected by the organizational structure of the university. The University of Kentucky has move towards a multidivisional organizational structure which research shows as effective but not without challenges (Bercovitz et al.). The interactions between administration and licensing staff are beyond the scope of this thesis. The proposed methodology can not address organizational inefficiency, only willing university officials.

A recent study by the Ewing Marion Kaufmann Foundation highlights another significant obstacle in university technology transfer. The study stated “The temptation to chase big profits rather than less lucrative, more practical innovations is stunting efforts to transfer technology from the university labs to the U.S. marketplace” (Simmons). Licensing negotiations are often sighted as very difficult processes. The commercialization example in “Chapter 5" highlights challenges faced when attempt to license a technology from the University of Kentucky. University ownership of intellectual property could be in jeopardy with rising concerns regarding licensing practices.
Chapter 5: Example of an Internal Company’s Commercialization Process

5.1 Introduction

To better understand UK’s commercialization process, this chapter outlines an internal company’s attempt to license a UK intellectual property. I served as a consultant/observer during this effort. Bill Gregory, the manager of the ECG at the CVVE, headed the licensing effort, which would develop the licensed technology in his existing business. This commercialization example helped to identify challenges, which aided in the development of the improved methodology that was proposed in “Chapter 4.”

5.2 Application and Intellectual Property

The first step in the process of technology transfer was to identify a commercial application for a university technology. An image recognition technology was chosen as the base technology to develop our commercial application. This technology was chosen for several reasons. First, the technology was software based so any proof-of-concept work would mainly involve only human capital, thus keeping cost to a minimum. Second, the inventors of the technology were leaving the university and our efforts would keep a promising technology from falling into obscurity. Third, the application that was chosen for the technology was viewed as novel and beneficial to society.

Dr. David Nister and Dr. Henrik Stewenius developed the IP used for the image recognition technology at the University of Kentucky’s Center for Visualization and Virtual Environment (CVVE). The technology was covered by patent application number 20070214172 *Scalable object recognition using hierarchical quantization with a vocabulary tree* and software copyrights (2006). The intellectual property had been developed into an application that could easily
create deployable image recognition systems. Any database of images could be compiled and linked to corresponding sound files.

The image recognition software we sought to license would be used to develop a product that could recognize currency for blind or visually impaired individuals. The inspiration for such a device stemmed from a November, 2006 ruling against the treasury department which deemed U.S. currency unconstitutional because it could not be recognized by the visually impaired (Apuzzo). The ruling is currently in appeal, the basis for which is that technology already exists to aid visual impaired individuals to identify currency (Apuzzo). The application was documented and sent to the University of Kentucky’s Intellectual property office to explore patent protection. A proof-of-concept product was created for demonstration purposes and to test for reliability in recognizing the different denominations of currency.

5.3 Licensing Process

A company was needed to license the technology from the University of Kentucky and proceed with commercializing the image recognition application. Bill Gregory was already the founder of a sole proprietorship, which was chosen as the entity to exploit the technology. Furthermore, a preliminary commercialization plan was started and the services of a computer scientist were retained to further develop the technology.

Meeting 1:
The next step in the commercialization effort was to approach the University of Kentucky about securing a license for the image recognition software. The technology transfer office was contacted and setup a meeting between Bill Gregory and key members of the OCED on June 20, 2007 at 1:30pm. The application for the technology was well received and an initial offer was made by OCED that UK would receive $25,000 upfront and 25% of pre-tax net revenues. The initial licensing fee that UK was seeking was based on premise of receiving an Innovation and Commercialization Center (IIC) concept pool grant. The 25%
revenue was somewhat concerning, 25% of pre-tax net revenue has become a *de facto* standard among universities. The rate does not consider risks and other circumstances surrounding a particular intellectual property. Further research showed sources stating that a royalty rate of around 5% of the product sale price is normal. Whereas, the AUTM sited in an Economic Impact Survey that a royalty rate of around 2.3% of product sale price was the average of the universities they surveyed (*Common Myths*). What became evident was how ill prepared we were to approach the OCED to discuss licensing the technology. A full commercialization plan and assessment of the royalty rates would have strengthened our position as a licensee.

We sought the help of Dr. Phyllis Speser and her company Foresight to develop a strategy concerning the royalty rates. Although we were unable to retain her services, we were able to take advantage of a methodology she outlines in her book *The Art and Science of Technology Transfer*. The royalty rate calculator that she provides in her book is based on major sticking points in the licensing negotiation process. However, these are not the only issues to consider and some items that are included might not apply to every licensing situation. This methodology does give a better feel to the parties involved of issues that could affect revenues, initial cost and potential risk. (Speser 358). The following tables provide a range of potential royalty rates base on 5% and 2.3% industry rates.
Table 5.1 Royalty Rate Calculation Based on 5% Industry Norm

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Table 5.2 Royalty Rate Calculation Based on 2.3% Industry Norm

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<td>Competition exists which will inhibit ability to exploit (yes add, no subtract)</td>
<td>-1</td>
<td>1</td>
<td>-1.0%</td>
</tr>
<tr>
<td>Foreign rights (yes add, no subtract)</td>
<td>-1</td>
<td>3</td>
<td>-3.0%</td>
</tr>
<tr>
<td>Sales Conveyed or highly likely (yes add, no subtract)</td>
<td>1</td>
<td>2</td>
<td>2.0%</td>
</tr>
<tr>
<td>Duration (over ten years add, under three years subtract)</td>
<td>1</td>
<td>2</td>
<td>2.0%</td>
</tr>
<tr>
<td>Upfront payment required (yes subtract, no or conditional add, standard neutral)</td>
<td>-1</td>
<td>2</td>
<td>-2.0%</td>
</tr>
<tr>
<td>Minimum royalties (yes subtract, no add, standard neutral)</td>
<td>1</td>
<td>2</td>
<td>2.0%</td>
</tr>
<tr>
<td>Know-how included in deal (yes add, no subtract, standard neutral)</td>
<td>1</td>
<td>3</td>
<td>3.0%</td>
</tr>
<tr>
<td>Support/training provided after initial transfer (yes add, no subtract, standard neutral)</td>
<td>0</td>
<td>2</td>
<td>0.0%</td>
</tr>
<tr>
<td>Maintenance and enforcement burden (licensee subtract, licensor add, standard neutral)</td>
<td>0</td>
<td>2</td>
<td>0.0%</td>
</tr>
<tr>
<td>Exposure to liability (yes subtract, no add, standard neutral)</td>
<td>0</td>
<td>2</td>
<td>0.0%</td>
</tr>
</tbody>
</table>

| Total                                                                  | 39.6 | 3.3%   |
| Rate                                                                   |      | 3.3%   |
Using the Foresight royalty rate calculator, it was determined that a royalty rate in the range of 3.3% to 6% of the product sale price depending on which rate was to be used as the industry norm. A clear methodology for royalty rate assessment gives a more solid foundation for negotiating a mutually agreeable rate. Another key element that has been pervasive in anecdotal accounts of licensing deals is to approach the negotiations from a win-win perspective and maintain an air of levity to hopefully reach an amenable agreement.

The licensee should be in an excellent position in negotiating a license agreement from a university. Only about one-third of university inventions are ever commercialized and only 22 percent of licensed technologies have more than one interested party (Shane 35, 172). Regardless of who has the “upper had”, the negotiation should not be perceived as a win-lose scenario. The marriage of the university and industrial partner should be seen as a symbiotic partnership benefiting all parties. Having a mediating third party, such as Dr. Phyllis Speser's Foresight, also could be beneficial.

**Meeting 2:**

After the initial meeting with OCED, a second meeting was scheduled the next week between Bill Gregory and key members of the OCED, including members of the Office of Intellectual Property. This meeting was arranged to determine how the vision recognition application fits into the landscape of the intellectual property. The image recognition software had been licensed previously to a company in California for a specific use, according to the inventors and the Director of the Center for Visualization and Virtual Environment. However, due to some confusion or miscommunication between the researchers and those issuing the license, the “field of use” outlined in the licensing contract gave very broad usage to the California based company. OCED lawyers agreed to examine the agreement further and verify that our usage of the technology did not infringe on the “field of use” outlined in the licensing contract. The outcome of the meeting was positive regarding the use of the intellectual property for the currency recognition application. However, due to
the broad “field of use” given to California based company, several other applications that were being explored could no longer be pursued.

**Meeting 3:**

Next, we met with a new member of the OCED. One month had passed since our initial meeting and no progress had been made in our goal of securing a license. Bill Gregory met with members of the OCED and was provided with some marketing results from their own investigation of our currency recognition product. Much of the information and work was redundant, since much of that market research had been performed, prepared and presented at the initial meeting. Also, the OCED had contacted individuals in industry to explore the feasibility of our product. The OCED efforts were somewhat of an enigma, as we were directed during the second meeting not to discuss our technology with outside interests unless they signed non-disclosure agreements. This also raised concerns that UK was marketing the technology to outside parties as an alternative to licensing to Bill’s company. We were then informed that we need a full commercialization plan and that we would need to present this information to the IP committee to inform them of how we intend to use the technology.

The OCED wanted to know if we were going to partner with a software company or a cell phone provider. Either case would be potentially beneficial to the company but that status was unknown at this point because we had been directed not to talk to outside interest. There was also confusion about meeting with the IP committee. The technology was already submitted as a disclosure and the committee does not grant licensing rights. The meeting seemed like an added step that did not get us any closer to our goal of securing a license.

**Meeting 4:**

The meeting was called to discuss the licensing of the IP to our company again. The final decision was based on OCED lawyers not believing that our application infringed upon the “field of use” given in a prior licensing agreement. The OCED members also broached the idea of contacting the previous licensee to determine if they were interested in the application. This, with the fact the OCED had contacted external entities regarding our application, furthered our
concern that the OCED was seeking alternatives licensing routes. The final agreement was that OCED would contact the prior licensee as a courtesy and inform them that IP had been further developed and would be licensed for a non-conflicting field of use. Once this task was completed the licensing process would proceed for our application.

**Current Status:**

To this date no agreement has been made. The task of contacting the prior licensee to the technology has yet to take place. The entire process has taken around five months without entering licensing negotiation. Furthermore, it has been over five months since the application was submitted to the intellectual property office to explore clearance and patentability and we have yet to receive a response.

**5.4 Summary**

The commercialization attempt outlined in this section highlights the difficulties that one faces during the licensing process. The problems are exacerbated for individuals who are unfamiliar with the process. The attempt at securing a license would have been much more efficient had the methodologies outlined in “Chapter 4” had already been in place. First off, if a database containing information regarding the “field of use” had been in place, alternative technologies at the CVVE might have been explored. The intellectual property was chosen is because of the advanced state of its development and that it was assumed to be “fair game” for licensing.

The process also could have been expedited had a preliminary commercialization plan and an initial assessment of royalty rates been completed. As seen in the methodology outline in “Chapter 4”, these are the preliminary steps to any scenario before entering the licensing negotiation process.
Lastly, the improved methodology details means in which funds can be acquired to help facilitate the development of the technology and help pay for upfront licensing fees. For our application we were relying heavily on personal finances and unsecured investment. By pursuing “free” money that is available though a variety of state and federal grants, our personal financial risk would have been significantly mitigated.
Chapter 6: Conclusion and Future Work

6.1 Conclusion

This thesis addresses the imperfect information and lack of clear procedures in the commercialization process by developing an improved methodology. The methodology proposed provides a roadmap for any individual seeking to license and commercialize a technology from the University of Kentucky. Currently most universities only offer terse overviews of the process and leave much of the intricacies to be learned as one goes. The methodology addresses the asymmetric information and facilitates a more streamlined process by providing a step by step guide.

Furthermore, with the implementation of the centralized database the efficiency commercializing university technologies can be improved. As seen in the commercialization example in “Chapter 5”, the challenges, such as the “field of use” would have been addressed up front before licensing the intellectual property was even attempted. This shared resource also could have provided information regarding securing funding, potential licensees, etc. If the database portion of the methodology is adopted university wide it could further aid inventors in finding licensees. For example, recent work at the CVVE has involved helping a medical doctor create commercialization plans for his technologies. In the process a relationship with external pharmaceutical company was fostered as a potential commercial partner. However, the company could have other licensing interests within the university. The only means to share this company’s information is to pass it to the OCED and hope that it makes its way to applicable inventors. For example, inventors in the pharmacy college could have access to this information directly if a shared resource was already in place.

The proposed methodology in “Chapter 3” provides a system that the University of Kentucky can use to assess its progress in its technology transfer practices. The new methodology ranks metrics such as, start-ups, invention disclosures, license revenue and new patent applications per ten million dollars in total research expenditures. The methodology was proposed to the OCED but
even if it is not adopted by the University of Kentucky, it can still be utilized in the CVVE to assess its performance.

With universities becoming stewards of vast amounts of intellectual property, they inherit great opportunity and responsibility. However, great challenges remain. Universities must act to ebb the rising tide of discontent. With the rise in opposition to the practices of university technology transfer as seen in the Kaufmann report, more inventive and improved practices are necessary (Simmons).

6.2 Future Work

To further the research presented in this thesis, the next steps would be to implement the web based strategy and evaluate the results. The evaluation process should only take a semester to ascertain the impact of the methodology. The assessment will require feedback from individuals and administrators at the CVVE and potentially in the OCED office. The questions that should be addressed are: Has the new web based system improved the flow of information? Does the new system have the potential to streamline the technology transfer process? If the consensus is “yes” to both questions then the university wide distributions should be evaluated for the web based system. Furthermore, quantitative results should be measured over a longer durations of time. Has the new methodology increase the number of licensed technologies? Has the system increased SBIR/STTR participation and start-up activity?

An additional area of study that could be a supplement to this research is to assess the development of a technology once it leaves the confines of the Technology Transfer Office. Specifically, how is the commercialization process affected by the transfer of a technology into a commercialization vehicle such as a business incubator? Utilizing a business incubator for technology has many benefits. University business incubators are generally located close to campus and can potentially foster involvement of inventors, who aid in the development
of their intellectual property. The tacit knowledge that is brought to the process in often documented as a critical component of commercialization success (Lowe).

6.3 Need for integrated education

While the University of Kentucky provides the infrastructure and means to commercialize technologies, it however does not sufficiently train students, particularly engineering students, in the commercialization process. Many schools, such as Stanford, MIT, and the University of Colorado – Boulder have developed courses integrating an entrepreneurial education with engineering courses. The main goal of such courses is to “demythify entrepreneurship” and to address the lack of understanding new entrepreneurs often have in bringing and idea from concept to the marketplace (Lewin 6).

The University of Virginia, for example, has created a course on “Invention and Design” that fulfills an upper level communications, humanities and social science requirement. The course objective is to instruct students in developing ideas into patentable inventions. One of the key deliverables of the course is creating a draft of a real patent and pursuing patent protection. The “Invention and Design” course also is structured to meet the required outcomes of ABET Engineering Criteria 2000 (Weilerstein, Ruiz and Gorman).

Integrated engineering and commercialization courses are also being developed outside the United State. The Kochi University of Technology was the first university in Japan to implement an “Entrepreneur Engineering” course in its graduate school curriculum (Tomisawa and Kano 347). The course was designed to be a three-layered structure that addressed fundamental components of business creation (Tomisawa and Kano 347). The lower level of the program focused on topics such as financing, accounting and economic principles (Tomisawa and Kano 347). The middle layer of the program outlines fundamental aspect of business creation, such as business planning, marketing, and management issues (Tomisawa and Kano 347). The top layer of the program is
described as application oriented and focuses on management practices and business collaboration (Tomisawa and Kano 347).

The trend in engineering program has moved towards integrating an engineering education with the fundamental of business creation and development of inventions. The concept is not a new one, and integrated courses are offered at many universities around the world. The University of Kentucky does not currently have entrepreneurial courses a part of its engineering curriculum. The addition of such a course could help to foster more entrepreneurial endeavors at the university and potential create more innovative engineers.
Works Cited


BREITBART.com


"John Ciardi". *ThinkExist.com*.

<http://thinkexist.com/quotation/a_university_is_what_a_college_becomes_when_the/7944.html.


Kurek, Lisa. 2007.


<PERSISTENT_LINK>http://www.kintera.org/atf/cf/%7B4A887362-9129-4A13-9200-7A21527E3A5A%7D/REVISED_SOLICITATION_NOTICE_FINAL.pdf.</PERSISTENT_LINK>


<PERSISTENT_LINK>http://www.sba.gov/aboutsba/sbaprophgs/sbir/sbirstir/sbir_sbir_description.html.</PERSISTENT_LINK>


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