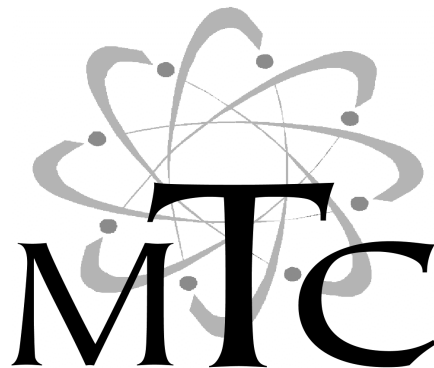


**TECHNOLOGY TRANSFER
AND ITS ROLE IN THE
COMMERCIALIZATION PROCESS**

A CASE STUDY: THE UNIVERSITY OF MISSOURI

**PREPARED FOR THE
MISSOURI TECHNOLOGY CORPORATION**



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OVERVIEW

Governor Holden has stated one of the primary goals of his administration is to increase the family median income or per capita income. The Public Policy Institute, an organization that puts out the annual States' New Economy Index, states that two-thirds of per capita economic growth stems from technological innovation. Whereas innovation can be defined as the transformation of knowledge into new products, processes and services, innovative capacity is increasingly what drives competitive success in the new economy. The Association of University Technology Managers (AUTM) states in their annual survey that responses from member institutions estimate that the licensing of innovations made at academic institutions contributed billions of dollars to the national economy each year.ⁱ

Our research universities clearly are drivers of knowledge creation in our state. Each year there are new discoveries from university research that have the potential to greatly impact and improve our lives. The transfer of scientific discoveries and new technology out of the university and into the commercial sector can create new products, processes and services that drive the economy today. It is therefore critically important that we understand clearly the role of research universities in economic development and that we act to maximize the economic impact of Missouri's university resources.

Technology commercialization at universities is a formal process that includes several critical steps to achieve its maximum impact. In a sense, there is a commercialization pipeline that these discoveries must flow through to make it to the end product. The formal steps of the technology transfer process can be considered different segments of the pipeline, and if there is a "clog" in any step along the way, it will greatly impede the flow of products that come out the other end.

One of the core missions of the Missouri Technology Corporation (MTC), the Governor's advisory board on issues related to technology and its impact on society, is to raise awareness of the existence of this commercialization pipeline, how it works, and opportunities that exist to make it better. In this instance, there is considerable overlap of interest between education and economic development issues, and therefore desirable for the MTC to partner with the University to become a champion for this commercialization pipeline.

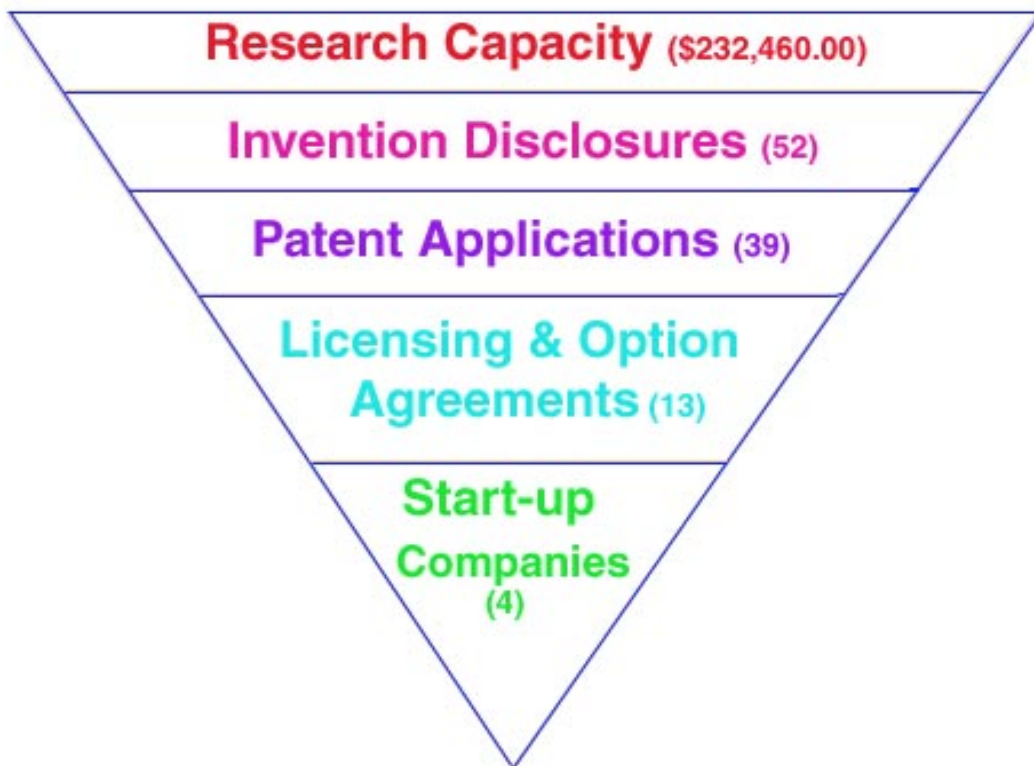
This report attempts take an in-depth look at how well positioned the University of Missouri system is to play an important role in economic development in the coming years. The reader should come away with a solid understanding of the commercialization process at the University of Missouri, how it performs compared to its peers around the country, and suggestions for how the University can continue to improve its performance. The critical steps or influencing factors of the commercialization process that this report analyzes includes: research capacity, invention disclosures, patent applications, licensing and the environment for start-up companies.

The Southern Growth Policies Board recently published a comprehensive study commissioned by the National Science Foundation titled, "Innovation U.: New University Roles

in a Knowledge Economy.”ⁱⁱ This report outlines the significant roles that universities play in promoting economic development in today’s economy. The operations of twelve leading universities are examined in the following areas to highlight best practices: industry research partnerships, technology transfer, industrial extension and technical assistance, entrepreneurial development, industry education/training partnerships, career services and placement, culture and rewards, formal partnerships with economic development organizations, and industry/university advisory boards and councils. While our report only focuses on the specific aspects related to the commercialization process, it will draw from many of the benchmark examples highlighted in the Southern Growth study.

The chart below diagrams the commercialization pipeline that a new discovery follows to get from basic research into the marketplace. As the diagram illustrates, the flow of volume through the pipeline naturally narrows through the process of commercialization. This reflects the reality of difficulty in bringing an innovation to the marketplace. The last step, licensing to a start-up company, is the most difficult to achieve because, in addition to the process, there must be a nourishing environment present for this kind of entrepreneurship to flourish. It should be noted that this is not a closed system and that not all potential results are represented in the chart. For example, the “Licensing and Option Agreements” will not always be with Missouri-based start-up companies. The direct result of such agreements may be revenue to support additional research and research capacity for the University. While this outcome may not contribute as directly to economic growth in Missouri, it is nevertheless another desirable outcome that can enhance the overall mission.

Commercialization Pipeline: University of Missouri FY01



1. EXECUTIVE SUMMARY

Technology transfer out of any university is a difficult process, and relatively few research ideas ever get commercialized into the marketplace. This is evidenced by the fact that, according to AUTM averages at 142 universities surveyed in 2001, it typically takes \$10 million in research expenditures to produce four invention disclosures, three patent applications, one patent issued and one signed license agreement.ⁱⁱⁱ As the numbers in this report illustrate, it takes even more money at the UM System to produce the same results. Technologies that result in a start-up company are even less likely; it takes hundreds of millions of dollars in research expenditures to produce even a handful of university start-up companies.

This is not an easy exercise with a quick turnaround on investment. Of 3,200 universities, perhaps six have made significant amounts of money from their intellectual property rights.^{iv} The overall long-term sustainability of these programs is put at risk when expectations are unrealistic or inflated. This being said, in this knowledge-based economy innovation will be research intensive and, as a result, universities are playing an increasingly leading role in economic development. For this reason, it is essential that universities have active technology transfer operations that help bring ideas to the marketplace and benefit society. Moreover, all universities must constantly balance the impact of licensing decisions. For example, it is not uncommon for a university to have to choose between a straightforward and relatively secure licensing agreement with an existing and successful company located outside the state and a less-secure, less-experienced startup or early stage company within the state. The former may well guarantee an earlier and better direct financial return to the university while the latter may hold the potential of greater economic impact for the state. Such decisions should not be taken lightly nor should they be taken without a clear understanding of the expectations placed on the university.

Missouri Improves Performance

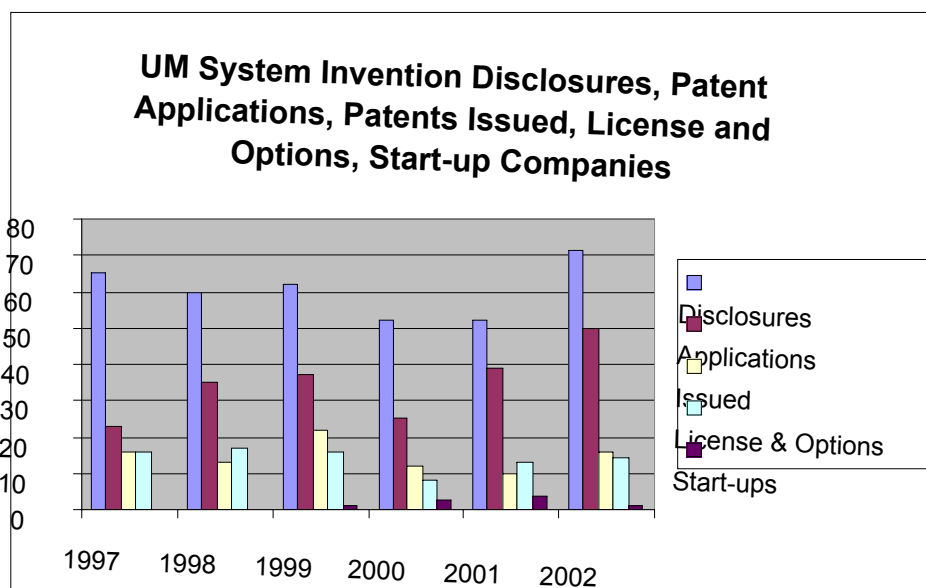
The University of Missouri has made dramatic gains in its commercialization process since the overhaul of the Patents & Licensing Office in 1999 and the subsequent creation of the Office of Technology & Special Projects (OTSP).^v The research enterprise of the University system has increased its federal research expenditures by 91 percent between 1995 and 2000, compared with only 28 percent for the AAU average.^{vi} The Columbia campus, which accounts for about three-fourths of federal research expenditures for the University, is first in the nation for its rate of growth in federal research dollars in FY01.^{vii}

Since the establishment of the OTSP, the percentage of license agreements signed with small companies has increased dramatically to over 75 percent of all signed license agreements. Over 85 percent of all licenses are exclusive, a very desirable ratio for companies wanting to do business with the University and well above the 50 percent AUTM average. Royalty income from license and option agreements is now more than double previous years, putting more money into the pockets of inventors as well as money reinvested into the patent prosecution budget and the license and patenting process. The University has also produced four start-up companies in FY01, up from zero just two years ago when start-up companies were not part of the mission of the Patents & Licensing.

Much of the recent success of the University's performance can be directly attributed to changes in policies and processes implemented by the OTSP. For example, the OTSP has

doubled the number of people and tripled the number of professional staff with technical expertise, enabling the office to bring many of its activities in-house. As a result, the OTSP has been empowered to make many more direct decisions regarding implementation of the university's patent policy, making the process more efficient.

The annual patent prosecution budget for the University now exceeds \$400K, an increase of greater than 400 percent from only three years ago. This has allowed the OTSP to be less dependent on licensees when pursuing patents, and now over 50 percent of invention disclosures are pursued for patenting, up from only 10 percent three years ago. At the end of FY01, there were more than 91 patents pending, up from only 33 a year before. The creation of start-ups at the University is more active now in part because the University can now also take equity in companies.



Challenges Remain

The University has clearly made inroads the last couple of years to improve the commercialization process. However, despite this improvement in the University of Missouri's performance, challenges remain for the system to be truly competitive with the "best in class."

While the University of Missouri has moved up to a 28th ranking in attracting federal research dollars out of AAU institutions, the system is still at the bottom with a market share of only 1.57 percent of federal research expenditures in science and engineering. In addition, the UM System does not have a market share of at least 3 percent in any one discipline area, while some universities exceed 15 percent market share in certain disciplines. Although it is an emerging priority for the UM System, Missouri has consistently ranked around 30 out of 50 in SBIR awards, and has been very inconsistent in its performance with STTR awards (ranking dead last only a couple of years ago). Industry research accounts for only 3 percent of total research expenditures, below the 7 percent AAU average.

An area of serious concern is that invention disclosures are actually in decline in the face of significant growth in research expenditures, and remain well below universities with

comparable research expenditures. [Note: Since the writing of this first draft, this is no longer true; the numbers are no longer flat.] The number of patents issued has also remained the same at around 10 over the past several years, about half of the AUTM mean.

The number of licenses signed have remained the same or decreased, and account for about half of the AUTM mean. Licensing to out-of-state companies continues to remain high, at around 75 percent of all licensing deals. The state-sponsored innovation centers adjacent to each campus were created in part to work with start-up companies and entrepreneurs coming out of the universities. However, up to this point, there has been very little deal flow coming out of the universities and the innovation centers have had to work with clients from other sources.

Suggested Recommendations for Action

Regions that are successful in wealth creation and economic growth contain high quality research universities actively engaged with industry and skilled at transferring technology, according to benchmarking work done by the Battelle Memorial Institute. It's fortunate that the University of Missouri's leadership has committed the University, as part of its mission, to supporting the growth of economic development in this state. The Missouri Technology Corporation, in partnership with the University, has identified three broad areas where the University can make an especially valuable contribution:

- I. Increase Market Share in Research**
- II. Speed the Commercialization of Technology Arising from University Research**
- III. Promote Local Entrepreneurship**

There are specific recommendations to change the process and procedures at the University of Missouri to achieve the desired outcome categories and goals.

The leadership of the University of Missouri in recent years has allowed the system to make many changes needed for the UM System to become competitive in positioning itself to be a world class institution in the coming years. The implementation of these changes over the past couple of years is already showing positive results. Other comparison numbers show that there is still room for improvement. Other successful research institutions have examples of "best practices" in their processes and policies included in this report that should be considered at the University of Missouri. University leadership can make the biggest difference in nourishing the commercialization process by promoting policies that actively foster a faculty culture that supports entrepreneurial activities. Once this environment exists, innovation and technology transfer will flourish.

There are many influencing factors that can affect the technology transfer process at a university. While the University has taken many steps over the last couple of years to change the process in the technology transfer operations, there are also additional initiatives that should be considered to further make the University of Missouri even more competitive. Since the initial draft of this report in April 2002, several of these recommendations are well under way. It is the hope of the Missouri Technology Corporation that these recommendations below will be embraced and quickly implemented to fulfill the newly created fourth mission of the University of Missouri: Promote Economic Development.

The following recommendations are from the Missouri Technology Corporation Commercialization Report. They are compiled with input from benchmarking examples of successful programs around the country, various reports, and knowledgeable people within the

University of Missouri system. These recommendations are centered around policies and procedures that can influence the pressure points of the commercialization pipeline: research capacity, invention disclosures, patent applications, licensing and option agreements, and the environment for start-up companies.

I. Increase Market Share in Research

I.1: Market Share

Recommendation: Each campus should set explicit and measurable goals to raise its market share of federal research dollars in priority discipline areas. These goals should be met by setting and achieving target levels of research expenditures per faculty member in appropriate departments.

I.2: Federal Research Agenda

Recommendation: Aggressively seek more influential roles and positions in Washington, D.C. and the scientific community to influence policy decisions in programmatic priority areas of research

I.3: Federally Sponsored Research Centers

Recommendation: The University campuses should make it a priority to establish federally funded centers, such as NSF Industry-University Cooperative Research Centers, Engineering Research Centers, and Materials Research Science & Engineering Centers.

I.4: Accountability Guidelines for Research Centers

Recommendation: The University campuses should implement a rigorous assessment program and phase out research centers that are not productive and consume more funds than they bring in external research dollars.

I.5: Industry-Sponsored Research

Recommendation: Increase industry-sponsored research on each campus by 10% each year.

I.6: Outreach with Industry

Recommendation: Set definitive timeline and objectives for creating a clearinghouse or portal site to permit sharing of research capabilities and interests (through Peoplesoft and/or COS) of faculty system wide.

I.7: University Research Coordination

Recommendation: Establish a Research Alliance of Missouri (RAM) made up of chief research officers from universities and research institutions around the state charged with coordinating joint research initiatives and technology commercialization.

I.8: Faculty National Honors

Recommendation: The University campuses should make it a priority to set goals to recruit new faculty and promote existing faculty for nationally recognized awards and prestigious titles, such as the National Academy of Engineering or Science fellows.

I.9: Faculty Productivity Incentives

Recommendation: Implement a research grant/salary incentive program to promote extra compensation that can serve to recruit and retain highly productive faculty.

I.10: Endowed Chair Program

Recommendation: The state government and University of Missouri should launch a second endowed chairs and professorship program that is programmatically focused on building capacity in priority areas of research.

I.11: Collaboration and Interdisciplinary Research

Recommendation: Metrics to promote interdisciplinary research should be built into campus and departmental promotion and tenure policies.

Recommendation: Each campus should track expenditures of grants/contracts involving Principal Investigators from multiple departments.

II. Speed the Commercialization of Technology Arising from University Research

II.1: The University of Missouri Office of Technology & Special Projects

Recommendation: Develop and implement a plan to increase face time and market services, benefits and successes of the OTSP to the faculty on each campus.

II.2: Invention Disclosures

Recommendation: The OTSP should overhaul the invention disclosure forms to clarify not only what is needed, but explain why every question on the disclosure form needs to be fully completed

II.3: Patent Policy

Recommendation: The University should revise the patent policy to encourage commercialization of UM technology and entrepreneurial activities.

II.4: External Board of Advisors

Recommendation: Establish an OTSP Board of Advisors composed of members from the private sector

II.5: Patent Applications

Recommendation: Set goals and track invention disclosures and patents filed in relation to the amount of research expenditures by campus.

II.6: Process Communication

Recommendation: Communicate more regularly with faculty about the status of disclosures, patent applications, and license agreements.

II.7: Licensing Agreement Templates

Recommendation: The University should revise the University “template” license agreement with additional approved standard clauses that can be inserted and removed, as well as create additional boilerplate agreements for simple transactions.

II.8: Licensing Royalty Income

Recommendation: The University should develop a royalty disbursement policy that includes an appropriate incentive for faculty to disclose inventions and participate in the filing of patent applications.

III. Promote Local Entrepreneurship

III.1: Licensing to Missouri companies

Recommendation: Develop and implement a marketing plan to aggressively promote university invention disclosures to Missouri industry.

III.2: Economic Development as an Institutional Mission or Goal

Recommendation: The University should work in partnership with state government and the business sector in developing strategic plans for Missouri economic development.

III.3: Personnel Policies and Practices

Recommendation: Explicitly include in the faculty leave policy that the University will allow flexible sabbatical or development leaves of absence not only for professional development related to research, but for a faculty researcher to launch a start-up company.

III.4: SBIR/STTR Programs

Recommendation: The OTSP should prepare a standard intellectual property agreement and working document for faculty participating in the SBIR/STTR program.

III.5: Conflict-of-Interest

Recommendation: Develop an education program for faculty and staff and an efficient but credible process for identifying and managing potential conflicts of interest.

III.6: Technology Transfer Showcase and Faculty Entrepreneur of the Year

Recommendation: The University should expand the evening Technology Transfer Showcase to hold in conjunction with other related and supporting activities and events.

III.7: Tenure Policies

Recommendation: The University should outline a process that appropriately recognizes the preparation and the successful completion of patent applications in the tenure and promotion process.

III.8: Research Foundation

Recommendation: The University should commission an independent study to look at the specific advantages and disadvantages in placing the OTSP in a closely related research foundation.

III.9: Encourage Faculty Entrepreneurship

Recommendation: If the UM System does not commit to patent application or licensing of an invention disclosure within a set amount of time, it will either provide a detailed plan for development of the invention disclosure or make the invention disclosure available for development by a campus-related organization and/or the originator of the invention disclosure.

Recommendation: Each campus should make arrangements with a campus-related organization to assist faculty in the entrepreneurial development of their own disclosures.

III.10: Facilities and Physical Infrastructure

Recommendation: The University should consider making research facilities available to start-ups for doing prototype development or applied research in exchange for a more favorable royalty rate as payment for use of the facilities.

III.11: Business Support Systems

Recommendation: The University of Missouri – Columbia should promptly complete the new incubator and research park in Columbia. This will provide needed wet lab space while utilizing experienced technology business managers and entrepreneurs who can provide advice, mentoring and guidance in launching a technology company with faculty researchers.

III.12: Capital and Finance

Recommendation: The University should identify resources to support an internal technology development fund for the university to help the faculty researcher reduce the invention to practice and support proof of concept activity. This could be used as match to also help augment other sources of funding.

Next Steps

Timeline

The next step is to prioritize and place timelines for each recommendation to be completed.

University of Missouri will report to the Missouri Technology Corporation at least every six months to inform the Board which recommendations have been completed.

Outcome I: Increase Market Share in Research

The amount of research a university does each year directly impacts the amount of technology that can be transferred and later commercialized. The larger the research capacity of a university, the larger the commercialization capacity of a university.

Before a university can spin out products, or file patents, or even have invention disclosures, there must first be a critical mass of basic research by which innovation can flow. It is a moot point to analyze the effectiveness of later steps of technology transfer if the research base is not sufficient to support new discoveries.

All information in this following section on research expenditures uses data provided by the National Science Foundation (NSF), and is taken directly from the report "Status on FY2000 Research Funding at the University of Missouri." D. Lanette Vaughn in the Office of Planning and Budget at the University of Missouri System compiled this report. To see the complete numbers and rankings of other AAU institutions, the entire report can be found at <http://www.system.missouri.edu/planning>

I.1: Market Share

A useful way to measure our competitiveness in obtaining federal research dollars is by showing the size of the piece of the pie for the University of Missouri. From 1995 to 2000, the University's market share in federal research expenditures among the public AAU institutions increased from 1.06 percent to 1.57 percent. In terms of federal research expenditures, the **University of Missouri ranked 28th among the 34 public AAU institutions in 2000, up from a rank of 31st in 1990.**

Market Share Gain or Loss in Federal Expenditures for Science and Engineering R&D, 1995 to 2000					
	<u>1995</u>		<u>2000</u>		MS +/- Since 1995
	\$	Market Share	\$	Market Share	
University of Missouri Total	45,600	1.06	87,237	1.57	.52

*Dollar amount per 1,000

In 2000 the majority of federal research funds expended by the public AAU institutions were in the life sciences (53%) followed by engineering (16%), the physical sciences (13%) and environmental sciences (8%). Columbia and Kansas City secured 70% and 79% of their federal expenditures from life sciences, respectively, and Rolla garnered 73% of its federal funds in engineering. St. Louis received federal funds in more evenly dispersed percentages with 26% being in the physical sciences, 42% of its federal funding in life sciences, 15% in psychology and 14% in the social sciences.

2000 Federal R&D Expenditures by Science and Engineering Field Row Percentages								
	Engineer- ing	Physical	Environ- Mental	Math & Computer	Life Sciences	Psych- ology	Social Sciences	Other Sciences
Columbia	13	4	1	1	70	4	7	0
Rolla	73	24	3	0	0	0	0	0
KC	0	5	0	10	79	1	4	0
St. Louis	0	26	0	2	42	15	14	0
UM Total	18	7	1	1	61	4	6	0

Despite the focused efforts of Columbia, Kansas City and Rolla in going after federal research dollars, in the life sciences and engineering, **our market share remains relatively low**, with 1.8 percent in both discipline areas. The discipline areas where the University of Missouri secured the most significant market share were in psychology (2.9%) and social sciences (2.6%), discipline areas that did not receive a primary focus from any one campus. New initiatives such as the new \$60 million life sciences center will help raise the market share in these priority disciplines.

2000 Market Share in Federal R&D Expenditures by Discipline Area								
	Engineer- ing	Physical	Environ- Mental	Math & Computer	Life Sciences	Psych- ology	Social Sciences	Other Sciences
UM Total	1.8	.9	.2	.6	1.8	2.9	2.6	0
Market Share of top University in each discipline	11.2	9.3	17.6	16.5	9.1	13.9	19.8	

Market share leaders in each discipline area were: Pennsylvania State University in engineering (11.2%), the University of Colorado in the physical sciences (9.3%), the University of California, San Diego in environmental sciences (17.6%), and the University of Illinois in math and computer science (16.5%). In addition, other leaders by discipline area included the University of Washington in life sciences (9.1%), University Wisconsin-Madison in psychology (13.9%), and the University of Michigan in the social sciences (19.8%).

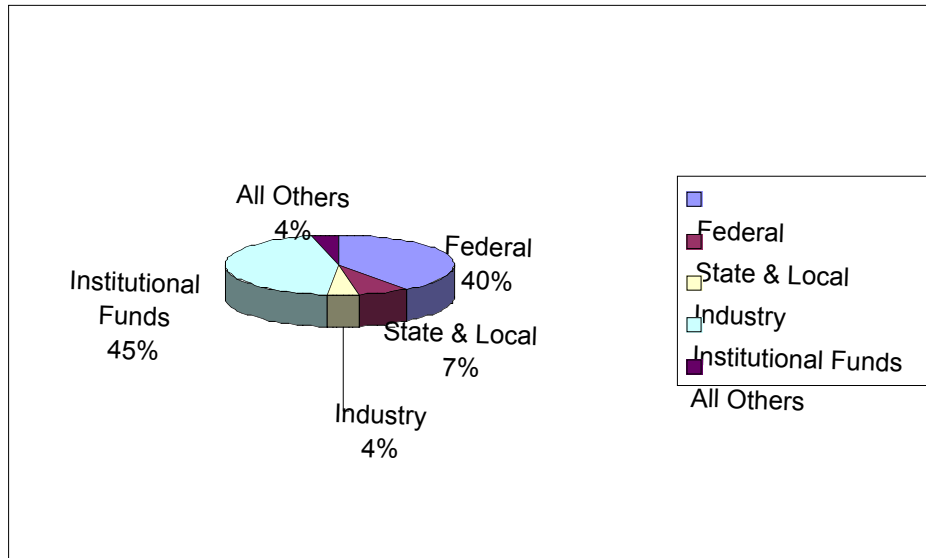
Those universities with large market shares in certain disciplines have made a strategic decision to focus the university's efforts in these one or two areas where it feels there exists an expertise that can give it a competitive edge to build a critical mass.

The following table shows Missouri's breakdown of research expenditures between FY1997 and FY2001.

Trends in Research Expenditures for Science and Engineering R&D at the University of Missouri, 1997-2002							
	(in thousands of dollars)						% Change +/-
	FY1997	FY1998	FY1999	FY2000	FY2001	FY2002	since 1997
UM-Columbia							
Federal	43,335	45,448	53,875	65,420	68,435	77,742	79%
State & Local	15,631	16,978	17,031	17,361	16,154	17,048	9%
Industry	3,777	4,348	3,832	4,007	4,654	5,042	33%
Institutional Funds	61,397	63,165	67,631	62,769	78,842	71,132	16%
All Others	4,039	6,122	6,633	9,304	6,697	6,047	50%
Total	128,179	136,061	149,002	158,861	174,782	177,011	38%
UM-Kansas City							
Federal	5,380	6,199	7,206	7,490	8,176	10,796	101%
State & Local	115	108	61	75	287	210	83%
Industry	348	505	426	660	1,665	1,371	294%
Institutional Funds	5,327	5,438	5,571	10,376	8,268	10,785	102%
All Others	564	625	803	1,046	399	899	59%
Total	11,734	12,875	14,067	19,647	18,795	24,061	105%
UM-Rolla							
Federal	8,080	7,934	8,731	9,804	11,929	15,749	95%
State & Local	795	182	446	322	481	120	-85%
Industry	1,575	1,361	2,079	2,543	3,088	4,282	172%
Institutional Funds	9,845	10,838	12,996	10,892	11,530	11,577	18%
All Others	600	1,425	1,641	2,407	1,771	493	-18%
Total	20,895	21,740	25,893	25,968	28,799	32,221	54%
UM-St Louis							
Federal	3,650	3,975	4,841	4,523	4,321	4,755	30%
State & Local	236	279	209	428	238	199	-16%
Industry	274	273	386	461	395	205	-25%
Institutional Funds	3,767	4,656	4,583	4,053	4,722	6,047	61%
All Others	223	279	275	433	408	313	40%
Total	8,150	9,462	10,294	9,898	10,084	11,519	41%
UM Total							
Federal	60,445	63,556	74,653	87,237	92,861	109,042	80%
State & Local	16,777	17,547	17,747	18,186	17,160	17,577	5%
Industry	5,974	6,487	6,723	7,671	9,802	10,900	82%
Institutional Funds	80,336	84,097	90,781	88,090	103,362	99,541	24%
All Others	5,426	8,451	9,352	13,190	9,275	7,752	43%
Total	168,958	180,138	199,256	214,374	232,460	244,812	45%

*Adjustments for federal flow-through expenditures have been made for all fiscal years. Thus, the revised figures for 1997-1998 in these tables are different from expenditures reported previously.

Source: Office of Sponsored Programs and Planning and Budget, 11/02



The above pie chart shows the breakdown of research expenditures at the University of Missouri. Based on total research dollars (including federal, state & local, industry, institutional funds and other), research expenditures per professor at each campus is as follows:

FY2000 RESEARCH EXPENDITURES PER FACULTY MEMBER			
	Total Research Expenditures	Full-time regular and non-regular Faculty	Research Expenditures per Faculty Member
Columbia	\$158,861,000	2,480	\$64,057
Rolla	\$25,968,000	347	\$74,836
Kansas City	\$19,647,000	826	\$23,786
St. Louis	\$9,898,000	505	\$19,600
UM System Totals	\$214,374,000	4,158	\$51,557

While Missouri continues to increase its research expenditures each year, the above numbers illustrate that when broken down to the level of the individual faculty researcher, our numbers are low. For example, the Rolla campus has a goal to get research expenditures per faculty member increased to the minimum amount of \$160K in order for it to be considered competitive with other U.S. News and World Report Tier 1 engineering institutions.

Recommendation: Each campus should set explicit and measurable goals to raise its market share of federal research dollars in priority discipline areas. These goals should be met by setting and achieving target levels of research expenditures per faculty member in appropriate departments.

I.2: Federal Research Agenda

Many universities with a larger research base, like the University of Colorado and the University of Pittsburgh, received over 80% of their research expenditures from the federal government, while the University of Missouri – Columbia receives only 41% of its research funds from the federal government. In addition, the University of Missouri funds a higher percentage of its research program (40%-53%, depending on campus) with institutional funds than all but four other public AAU institutions.

For this reason, it is imperative that Missouri universities increase the amount of federal research dollars that flow into the state. Increasing our market share of federal funding of research is the most significant way our research institutions can build their critical mass to promote innovation. Another reason to pursue federal dollars is that the Bayh-Dole Act allows universities to retain intellectual property derived from federally sponsored research. This allows a university a greater level of ownership than contract or industry-sponsored research when forming a strategy to commercialize an invention.

The University of Missouri System has made a conscious effort to place a greater emphasis on the importance of faculty submitting proposals for federally funded research. **On average, federal research expenditures at the University of Missouri have increased 91 percent between 1995 and 2000, compared to 28 percent at the public AAU institutions. The rate of growth in federal funding at the Columbia campus was first in the nation in FY01.** The following chart shows Missouri's performance by campus for a slightly different time period since FY1997.

Federal Expenditures for Science and Engineering R&D at University of Missouri						
	FY1997	FY1998	FY1999	FY2000	FY2001	% Increase since 1997
Columbia	43,335	45,448	53,875	65,420	68,435	58%
Kansas City	5,380	6,199	7,206	7,490	8,176	52%
Rolla	8,080	7,934	8,731	9,804	11,929	48%
St. Louis	3,650	3,975	4,841	4,523	4,321	18%
Total	60,445	63,556	74,653	87,237	92,861	54%

*Dollar amount per 1,000

The University has increased its federal funding by more than half since 1997. Three of the four campuses have increased their respective federal funds by between 48 and 58 percent and increased the amount each year between 1997 and 2001.

The lion's share of federal research within the University of Missouri System is done at the Columbia campus. Among the four campuses in FY2001, Columbia accounts for 73.7 percent of all federal research dollars, followed by Rolla at 12.8 percent, Kansas City at 8.8 percent, and St. Louis at 4.6 percent.

We are moving in the right direction, but our share of the federal research dollars remains at the bottom. The old method of obtaining federal research dollars was through chasing after individual earmarks. However, this method was unmanageable and impractical and the track record shows that this did not work effectively. Several years ago the University of Missouri

system took a new direction where it focuses on strategic positioning in influential roles and positions to influence policy. These kinds of positions can influence programmatic priority areas and funding decisions. The numbers in the last couple of years show that this strategy is working:

Recommendation: Aggressively seek more influential roles and positions in Washington, D.C. and the scientific community to influence policy decisions in programmatic priority areas of research

I.3: Federally Sponsored Research Centers

The leading AAU research universities all have strong ties to industry consortia and/or research centers with focused research in a particular area. These centers are often drivers of interdisciplinary research among universities. N.C. State, for example, hosts approximately 40 industrially focused centers that are home to more than 300 firms.^{viii} The University of Wisconsin at Madison (UW-M) is home to 21 research consortia.^{ix} These examples show successful focused efforts by universities where these research centers bring in millions of dollars each year in outside research funding. Many of these centers are designated as NSF Industry-University Cooperative Research Centers. Centers with this designation have basically received a stamp of approval for the quality of research done at the center. These tend to bring in more external funding to a university as well because NSF allocates \$100,000 along with at least a \$250,000 match from industry. The University of Missouri currently has only three of these centers.

Recommendation: The University campuses should make it a priority to establish federally funded centers, such as NSF Industry-University Cooperative Research Centers, Engineering Research Centers, and Materials Research Science & Engineering Centers.

I.4: Accountability Guidelines for Research Centers

The University of Missouri System shows over 191 research centers, labs or institutes among its four campuses. While this is a relatively large number of research centers with a specific focus, the real indicator of performance is quality over quantity. That is, it is not as important how many research centers are at a university, but rather how much research is produced from each center.

At the University of Missouri System, there is a process to establish a research center, a process to review the performance of a research center, but no process to phase out research centers that are not productive is enforced. The return on investment to the University needs to be considered when making decisions for support of these centers. This lack of accountability should be addressed to assure that critical and limited research dollars are being funneled in the direction that can make the most “bang for the buck” instead of supporting research centers that consume more research dollars than they bring in to the University. The University is currently revising its processes for reviews and decisions concerning the continuance of research centers. This may include five-year plans with a decision to continue or eliminate support at the end of five years.

Recommendation: The University campuses should implement a rigorous assessment program to phase out research centers that are not productive and do not bring in more research dollars than they consume.

I.5: Industry-Sponsored Research

Firms that collaborate with universities report that more than 10 percent of their products resulted from the collaboration.^x While securing federal funding offers the greatest potential for building a critical mass of basic research, industry-sponsored research is a step closer to the application of technologies in the marketplace. In FY2000, the institutions that led the public AAU group in terms of industry-sponsored research were Pennsylvania State University (\$64.4 million), University of Washington (\$57.4 million) and Ohio State University (\$57.1 million).

The University of Missouri secured \$7.7 million in industry-sponsored research expenditures in 2000 and \$9.8 million 2001, accounting for about 4 percent of total R&D expenditures. As Missouri works to decrease the percent of its R&D funded through institutional funds, there is room for a greater interaction with industry to support research initiatives for Missouri to increase its industry sponsored research to the AAU average of 7 percent. It is the goal of the OTSP to increase the number of and revenues from research and development agreements with the corporate sector by 10 percent in FY03.

Recommendation: Increase industry-sponsored research on each campus by 10% each year.

I.6: Outreach with Industry

Another method employed by many universities is to create and keep an online research directory. These typically describe the faculty member's vitae, interests and expertise, as well as the foci and capacities of centers, institutes, and laboratories. Any industry representative that has an interest to collaborate with a university can type in the area of interest and the portal will draw down all relevant researchers and institutes that may be of interest. Most of the universities have an extensive system similar to this that serves as an important outreach tool to industry. Penn State and University of Wisconsin are just two examples, which over 80 percent of the faculty participating at UW-M.^{xi} At Purdue, the expertise information is gathered from Community of Science (COS), a private company that provides and updates information through this service to universities.

Currently three of the four campuses use the COS services. The Columbia and Rolla campuses have used COS for quite some time, and the St. Louis campus recently began using COS. Earlier, the faculty had been slow to accept use of this new system because it is seen as another way to take up valuable time and not all see how it can directly benefit their needs. It is now integrated with the Faculty Accomplishment System (FAS), so incorporation into COS can be accomplished automatically. With this change, more than 80% of faculty on the Columbia campus are incorporated into COS. The integrated database that undergirds the Peoplesoft modules will support a portal that will provide a much richer knowledge management system that currently or ever could be provided by COS. There is planning to build a portal that will support connections between faculty and research agencies, links between and among faculty with related interests, and inventory of faculty expertise to establish connections with industry, self-service for invention disclosures, etc.

In addition, the university leadership can promote the use of this system is by using data derived from it in public forums (such as facts and figures about research at the university). Deans and department heads can push that faculty activity reports and information from faculty review will come from this system as well. Such a change in policy would ensure the needed incentive to increase faculty participation. This kind of searchable portal is important to market university capabilities and connect to likeminded researchers in the private sector.

Recommendation: Set definitive timeline and objectives for creating a clearinghouse or portal site to permit sharing of research capabilities and interests (through Peoplesoft and/or COS) of faculty system wide.

I.7: University Research Coordination

Several states around the country have a statewide system of research alliances or networks that serve to create a better dialogue among chief research officers of research capabilities across institutions within a state. Depending on the state, these range from more formal groups (such as the Georgia Research Alliance) to other less formal networking opportunities.

Missouri needs to create such an advisory group of chief research officers that can serve several purposes. First, this group can serve to advise the Governor on important research underway and core capabilities that the Governor can use in creating a research agenda to promote within the state and in Washington, D.C. This group can explore ways to increase communication between research labs across the state to leverage our expertise.

Recommendation: Establish a Research Alliance of Missouri (RAM) made up of chief research officers from universities and research institutions around the state charged with coordinating joint research initiatives and technology commercialization.

I.8: Faculty National Honors

One benchmark to ascertain the quality of a university's research program is whether the faculty contains any prestigious titles and awards such as the National Academy of Engineering or Science fellows. The Columbia campus has recently attracted a couple of these members to its faculty. In addition, the University of Missouri System has recently set goals with annual benchmarks and a five-year target for increasing the number of faculty who have been awarded prestigious titles.

Recommendation: The University campuses should make it a priority to set goals to aggressively recruit new faculty and promote existing faculty for nationally recognized awards and prestigious titles, such as the National Academy of Engineering or Science fellows.

I.9: Faculty Productivity Incentives

A select portion of faculty will consistently be more aggressive and entrepreneurial in nature when it comes to pursuing research and development collaborations. These entrepreneurs are more prone to risk taking, and several universities, such as the University of North Dakota, have taken advantage of this. The University of North Dakota has a novel hiring practice where certain research faculty that are hired have no set salary or cap. Instead, their salary is directly tied to the amount of external research dollars they bring into the university. This approach has been effective in luring several entrepreneurial faculty members to North Dakota who are now bringing in millions of external research dollars to the university every year.

At times it can be a challenge to encourage faculty to aggressively go after external research contracts. At Stanford, “faculty members are expected to support themselves and their research activities with little help from the institution beyond start-up support for new faculty members. In a word, the Stanford culture rewards the academic entrepreneur. As a result, there has been an open environment in which doing research with a company or a new venture is not considered in a negative light, provided it enhances the education of students and provides or contributes to opportunities to conduct important, nationally visible research.”^{xii}

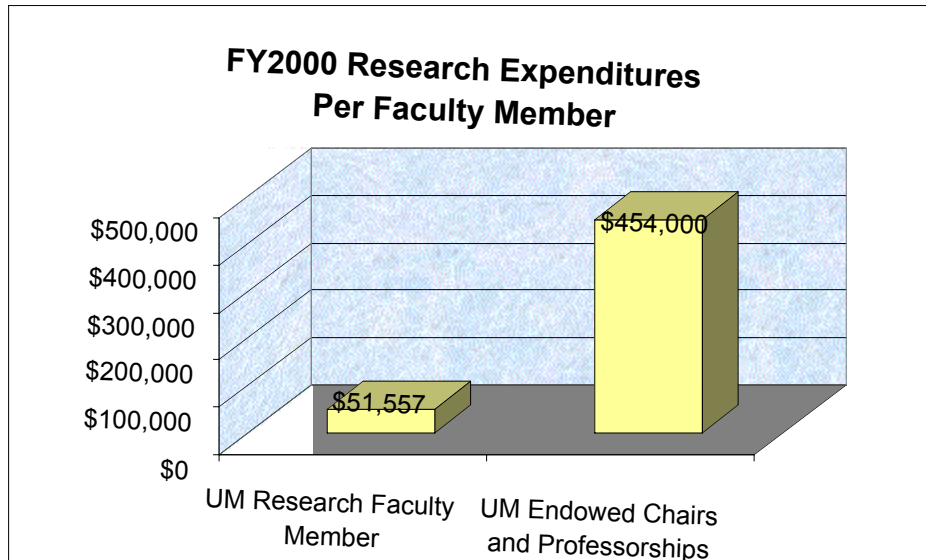
This approach can also free up dollars for the university as well. Currently about nine percent of the faculty salary is covered by grants. If this number was increased by five percent, it would create an additional \$7.8 million to be used in other areas. The University is now looking at grant incentives and exploring ways to employ its innovative Faculty Performance Shares Program to provide one-time incentive funds that are linked with the generation of salary support and direct cost recovery from outside support. This is an important step

Recommendation: Set goals and aggressively promote the hiring of selected research faculty who have salaries or caps set by their own productivity.

I.10: Endowed Chair Program

Endowed chairs are also important indicators of the breadth of support for a research program. At Georgia Tech for example, 37 Georgia Research Alliance Eminent Scholar Chairs have been endowed across the six member universities of the Alliance.^{xiii} These type of faculty are what give leading research universities much of their prestige, and they should be sought out. It is not atypical to find that the top 20 percent of faculty account for over 80 percent of the research expenditures at a university.

Although state funding has now run out, the University of Missouri has had an endowed chair program where it has leveraged the state’s investment of \$4 million to raise over \$80 million dollars to support 121 chairs and professorships across the four campuses. Columbia has 38 endowed chairs or professorships, Kansas City has 45, Rolla has 11 and St. Louis has 27. Eighty-nine of the chairs and professorships have been filled, and searches are underway to fill the remaining 32 positions. Forty-three (36%) of the endowed positions are in the Life Sciences areas. The fifty endowed chairs and professors who have been with the University for more than two years have been awarded \$22.7 million in grants and contracts.^{xiv} That means **each of these professors have, on average, brought in \$454,000 – roughly five times the amount of the average faculty researcher!**



This program is clearly an excellent way to leverage investments while generating a large return to the University in terms of research productivity. Based on the success of the first endowed chairs program, the state and the University should participate in a second endowed chairs and professorship program. The second program should be much more programmatically focused than the first one to build capacity in priority areas of research.

Recommendation: The state government and University of Missouri should launch a second endowed chairs and professorship program that is programmatically focused to build capacity in priority areas of research.

I.11: Collaboration and Interdisciplinary Research

If the University of Missouri is going to become a major competitor for federal research dollars, the four campuses must put behind historical differences and individual departments must look beyond their traditional disciplines. Collaboration is key. In fact, several federal agencies demand it as proposal requirements. Individual campuses need to leverage the research potential of their combined intellectual capacity to compete against larger programs in other states. For example, the combined engineering schools at both Rolla and Columbia are still smaller than the engineering school at the University of Illinois.

Departments need to also promote interdisciplinary research whenever possible and develop metrics to show this progress. The most productive science is occurring at the borders between different disciplines. Although detractors feel this may lessen the prestige of an individual department, successful interdisciplinary research can still show appropriate recognition and rewards to individual departments.

Recent progress was shown in promoting these collaborations through the formation of the UM Bioinformatics Consortium and the Governor's Life Sciences Research Account. Of the sixteen proposals submitted around the state, all contained aspects of interdisciplinary research and cross-collaboration across campuses and universities. The creation of the new life sciences building at UM-Columbia will also be an excellent way to promote interdisciplinary efforts.

Recommendation: Metrics to promote interdisciplinary research should be built into departmental promotion and tenure policies, and should be measured by tracking expenditures of grants/contracts with multiple PI's from other departments.

Outcome II: Commercialize Technology through Increased Licensing Income

II.1 The University of Missouri Office of Technology & Special Projects

A vibrant technology transfer office is a critical element in the success of a university's ability to move an invention through the commercialization pipeline. This office provides an interface and link between faculty researchers and industry. Core responsibilities of any technology transfer office include facilitating invention disclosures among faculty researchers, investing in and promoting patent applications, and developing a commercialization strategy for the invention either through licensing to an existing company or starting a new business.

OTSP Organization Chart

The Office of Technology and Special Projects (OTSP) was created in September 1999, replacing the former University Patents and Licensing Office. This change resulted largely out of recommendations from the 1999 Battelle Report ("Assessment of University of Missouri Research and Technology Plans and Strategies") and by the Chief Research Officers of the four campuses.

The OTSP Executive Director (Dr. Tom Sharpe) reports both to the Vice President for Academic Affairs (Dr. Steve Lehmkuhle) at the University of Missouri System level and on a day-to-day basis to the Vice Provost for Research at the University of Missouri-Columbia (Dr. Rob Hall is Interim Vice Provost for Research). The research enterprise is at the campus level, and the OTSP must be tightly linked to the research enterprise. Because the Columbia campus accounts for about 75 percent of all research at the University of Missouri, the University decided to base the OTSP in Columbia. This is a change from the previous Patents and Licensing Office, where the director reported only to the system level. One reason for this change was because the system level was not seen as being as responsive to the campuses. However, there are still some complaints now that the OTSP reports to the Columbia campus from the other three campuses. Clearly, there is not a perfect system where all parties will always be in agreement over perceptions.

The OTSP also meets monthly with the Chief Research Officers of the four University of Missouri campuses. The OTSP does not report directly to the Office of General Counsel, but works closely with the office in preparing and negotiating various agreements. The Office of General Counsel approves all agreements as to legal form that are negotiated by the OTSP.

Any university patenting and licensing office needs a great deal of autonomy and flexibility in its operations. Each extra layer of bureaucratic review renders the process less efficient. Since its creation, the OTSP has been empowered to operate more freely within the patent policy of the University of Missouri.

OTSP Budget

The budget of a patenting and licensing office is directly tied to its ability to generate outcomes and file patent applications. Since its inception, the OTSP has more than quadrupled its total budget for the office. The OTSP budget is broken down into two basic categories, budget for personnel & office operations and the patent prosecution budget. The personnel and office operations budget is covered by institutional funds. The patent prosecution budget is covered largely by institutional funds of \$90K, with royalty income through licensing deals of the OTSP covering the rest. The patent prosecution budget will be addressed later in the report.

Currently, the Columbia campus covers about 80% of the increase in the personnel and office operations budget from which the OTSP operations were expanded. Based on the University of Missouri's current amount of invention disclosures and current scope of activities, the OTSP now believes that it is well on the way to having the quantity and quality of personnel needed to fulfill its mission.

Employees

In their 2000 report "Assessing the Effectiveness of Technology Transfer Offices at U.S. Research Universities," Rogers, Yin and Hoffman discuss that a large staff for technology licensing is a strong characterization of universities that are more effective in technology transfer. Their report states that the number of support staff for technology transfer is an important predictor of a university's technology transfer effectiveness, accounting for 36.4 percent of the variance in technology transfer effectiveness scores of those surveyed.^{xv}

At one point the University of Missouri System consisted of only one director and one junior licensing person who focused on technology transfer. However, in 1999 the University of Missouri recognized a need to put more focus on commercialization of technologies. Today, only three years after its conception, the OTSP has doubled the number of total staff and tripled the number of professional staff.

The OTSP has six professional people:

1. Executive Director (Dr. Tom Sharpe)
 2. Associate Director, who deals with entrepreneurial activities (Terry Nixon)
 3. Licensing and Business Development Manager, who focuses on software licensing, and complicated license agreements and reviews research agreements with companies for intellectual property language (Scott Uhlmann)
 4. Senior Licensing & Business Development Associate for Physical Science and Engineering (Wayne McDaniel)
 5. Senior Licensing & Business Development Associate for Life Sciences (Charlene Boyes)
 6. Senior Licensing & Business Development Associate for Life Sciences (Chris Fender)
- The OTSP also has 4.5 people for support staff:
 1. Administrative Associate for record keeping, license and patent database, correspondence with patent attorneys
 2. Executive Assistant for Dr. Sharpe
 3. Administrative Assistant
 4. Senior Secretary (part time)
 5. Office Support Staff III

Clearly, the OTSP has made great strides in developing the staff for the office. With greater number of staff people the OTSP will have the capability to have a greater amount of contact with the faculty and increase the efficiency of the patenting and licensing process of the university. Even with the additional staff, the OTSP recognizes it could still use a full-time person on software licensing (this is a future growth area) and a person who specializes in material transfer agreements to make the office operations even more effective.

The OTSP can play a critical role in making faculty aware of its services. This can be done through a variety of ways, including seminars, technology transfer conferences and one-on-one meetings with researchers.

The UM System has four separate campuses, with the OTSP located only on the campus of MU in Columbia. In addition, the administration of the office was moved from the system level to the campus level in 1999 to be tightly linked to the research enterprise. The OTSP travels to the other three campuses once or twice a month. This current policy is also justified in part because of the ratio of disclosures:

- About 75% of disclosures are made by the Columbia campus
- About 15% of disclosures are made by the Rolla campus
- About 10% of disclosures are made by the St. Louis and Kansas City campuses combined

Not surprisingly, this breakdown of invention disclosures is also consistent with the percentage breakdown of federal research dollars each campus receives.

In addition to the amount of invention disclosures, the Columbia campus currently covers about 80 percent of increases in the OTSP budget. As we look to increase the OTSP presence at the other three campuses, the other campuses may want to cover a larger percentage of the OTSP institutional budget. This will enable the OTSP to expand its services to offer more face time with faculty at the other three campuses.

About 70 percent of invention disclosures are in the area of life sciences; about 20 percent are in engineering. As a general rule, physical science companies license in less new technology and pay lower royalties than life science companies. The OTSP expects an increase in every area on all four campuses where it has any research strengths.

There are ways in which the OTSP can still take a more active role at interacting with the faculty at the other three campuses. Beginning this year, the OTSP plans to visit each campus at least once per month. The mere fact of increased face time of researchers with the OTSP will make the faculty member more knowledgeable and comfortable with the system and more likely to disclose invention discoveries to the university to pursue for commercialization. This is already paying off where invention disclosures increased 35 percent in FY02 compared to FY01, yielding a record 71 invention disclosures.

Recommendation: Develop and implement a plan to increase face time and market services, benefits and successes of the OTSP to the faculty on each campus.

II.2: Invention Disclosures

Once a university researcher has made a new discovery, the first step in the commercialization process is to disclose this discovery to the university. Simply put, without disclosure that a researcher has made a discovery or invention, the university has nothing to work with towards developing a marketable product. There are 2,800 members in the Association of University Technology Managers (AUTM). 190 institutions (142 universities) participated in their annual survey. The AUTM reports that, out of 142 U.S. universities surveyed, there were 10,802 invention disclosures received in FY2000, up from 10,062 the year before.

INVENTION DISCLOSURES						
	FY97	FY98*	FY99	FY00	FY01	FY02 to date
Columbia	44	37	36	34	32	40
Rolla	11	16	18	10	12	19
Kansas City	5	3	4	3	7	8
St. Louis	5	1	1	5	1	4
UM System Disclosures	65	60	62	52	52	71
AUTM Mean	69	124.3	72.3	76		
Mean for I.D. within \$50 million**	72.5	104.8	93.3	93.2		
Mean within \$50 million under UM number***	46.8	115.8	84	84.35		
UM System Disclosures/\$10 million in Research Exp. AUTM	4.62	3.12	2.92	2.32		
Disclosures/\$10 million in Research Exp.	4.55	4.89	4.27	4.19		

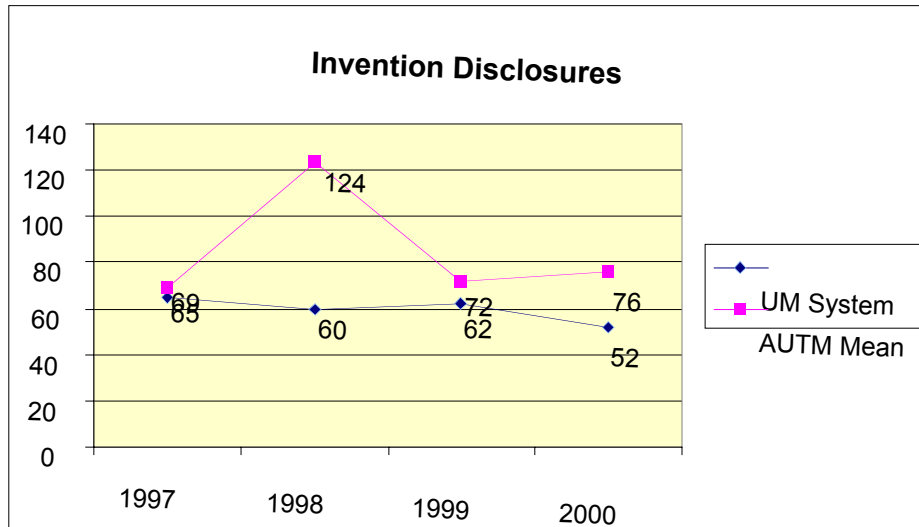
*FY98 only contains AAU universities

**Range of research expenditures covered includes universities with up to \$50 million above the UM System research expenditure number for each year and down to \$50 million below UM System research expenditures

***Universities with research expenditures within \$50 million under the UM System research expenditure number are included

*1998 AUTM number includes AAU universities only

Data shows that the UM System produces about four invention disclosures for every \$10 million in research expenditures. The above table shows that invention disclosures for the UM System are below the mean for the AUTM average, and that the number of invention disclosures actually decreased over the period from FY97 to FY01, despite significant increases in University research expenditures. FY02 saw a reverse of this trend, however.



In an effort to get a better idea on how UM System performs compared to other universities with similar research expenditures, this table also looked at the mean for universities within \$50 million of UM's research expenditures. For example, if UM's research expenditures in FY97 was \$140 million, this table found the mean of invention disclosures for universities with research expenditures between \$90 million and \$190 million. As the numbers show, the UM System fares even worse in the number of invention disclosures when compared to universities with similar research expenditures.

To further illustrate this example, the table also compares the UM System with universities that have equal or up to \$50 million less in research expenditures to the UM System. Even when compared to universities that have a smaller research capacity, invention disclosures for the UM System are still drastically lower.

The OTSP has stated that this is an area of concern, and it is the goal of the OTSP to increase the number of invention disclosures by 10 percent in the coming year.

Publication and effects on Patentability

Faculty are independent people, and this is often the strength, but sometimes the frustration of any patenting and licensing office. It is critical that a university has policies that entice researchers to disclose their discoveries or inventions. Universities cannot make faculty disclose inventions prior to publishing a discovery. One area of constant debate is whether pursuing patents unduly delay publication. The Council on Governmental Relations, in its 1996 Report on University Technology Transfer, reports that some scientists are concerned that the desire to obtain protection may cause publication to be delayed for long periods, slowing the exchange of scientific information and thus scientific progress. While this may be true in industry, it does not appear to occur in academia where publication delays for patent purposes are rare. When they do occur, it is usually for less than three months. In fact, if a faculty member starts the patent filing process at the same time as submitting a manuscript for publications, it is likely that the patent application will be filed (in three months) long before the manuscript is published (in six months).^{xvi}

Furthermore, the Council on Government Relations argues that if the invention has been dedicated to the public through publication, no commercial firm would devote extensive resources to developing the first commercial application. This is because they know any of their competitors can step in and reap the profits of commercial exploitation once the invention has been proven. Patents, and the twenty-year (from the date of filing the patent application) exclusive position they provide to the inventor, or to the inventor's designee, are necessary for successful commercial development of inventions.

Inventors must be aware of certain statutory bars to patenting that are activated by publishing a description of the invention. 35 U.S.C. 102(b) describes bars to patentability. Publication can occur in a variety of forms: an article, thesis, electronic message, brochure, or power point presentation at a conference can all constitute publications under certain circumstances. Once a publication occurs, U.S. patent protection is barred if a patent application is not filed upon the expiration of one year following publication. For foreign patents, publication may constitute an automatic bar to patentability.

It is critically important that a researcher consult with the OTSP before publishing any discoveries. This way, the OTSP can take the necessary steps to protect the researcher's discovery before any aspect of it is disclosed to the public.

Invention Disclosure Form

In order to disclose a new discovery, a researcher must fill out an invention disclosure form. This form asks the inventor(s) to provide information regarding: whether the discovery was sponsored by the government, a company, a foundation, etc.; have the inventors already publicly disclosed the invention in any way; a description of the invention and the known prior art; advantages and disadvantages of the invention; areas of application of the invention; state of development of the invention and additional research and development that would enhance it; when the invention was first conceived; whether there is more than one inventor, and the percentage of contribution by each inventor to the invention; and other information.

The OTSP plans to completely overhaul the invention disclosure forms by the end of FY03. The University Patent Regulations currently state that there are two different invention disclosure forms, Form 16B (which serves as a pre-invention disclosure form to let OTSP know that a faculty is working on something they think may result in an invention) and Form 16C (which is the official invention disclosure form). The OTSP may eliminate Form 16B altogether because faculty often confuse this with the invention disclosure form and will not complete a full disclosure later. Furthermore, Form 16C will also be overhauled to clarify not only what is needed, but will explain why every question on the disclosure form needs to be fully completed. The below recommendation is currently in process by the OTSP and should be completed by June.

Recommendation: The OTSP should overhaul the invention disclosure forms to clarify not only what is needed, but explain why every question on the disclosure form needs to be fully completed

II.3: Patent Policy

The OTSP is currently in the process of evaluating the University of Missouri's policies related to intellectual property, with a look toward recommending an overhaul of the patent policy and modification of related policies. Any change in policy must be approved by the Board of Curators. The current patent policy was written in the 1970's and does not address many of the needs of the university in today's environment. For example, the policy did not anticipate entrepreneurial faculty starting businesses around the technology they developed in the University laboratory, nor did it anticipate the conflict of interest issues that would need to be addressed in relation to such start-ups. As the OTSP moves forward with these recommendations, increased communication and input from all four campuses will improve acceptance of changes and reduce any resistance.

Process

1. Do a Preliminary Patent Search

The first step after receiving an invention disclosure from a faculty member is to look at the technical merit of the disclosure. The OTSP searches scientific and patent literature and identifies existing patents in the same area. Most faculty are not aware of the patent literature. The OTSP also asks the inventors how this invention may be different from a similar looking patent. This process usually takes about two weeks to complete after receiving what the OTSP considers a complete and perfected disclosure from a faculty member.

2. Look at Market Implications for the Invention

This is typically done at the same time as the preliminary patent search. The OTSP looks to see if the uses are very narrow or broad for the invention, and categorizes it either as Hot, Medium, or "Commercially Challenged." Although there is no formal grading system or checklist, the OTSP has guiding principals in assessing the viability of an invention disclosure to ensure the licensing staff has covered all the bases to determine if it should apply for a patent.

The University Patent Policy describes a Patent Policy Committee that reviews invention disclosures and makes recommendations on what to patent. However, in practice, this committee has not functioned in this manner since before the creation of the OTSP. This approach was an extremely inefficient process that took too much time and only made sense when the patenting and licensing office did not have internal technical expertise. Now the OTSP relies on its own staff with technical expertise and makes all decisions internally on which disclosures will be pursued for patenting. In an effort to streamline the process, the Technology Assessment Team, an informal group made up of faculty to review the technical merit of disclosures, also does not meet regularly anymore due to the technical expertise of the OTSP staff. In cases where the OTSP does not have the appropriate technical ability, it will rely on faculty and industry opinion as appropriate.

3. Invest in Patent Application

Policy states that the OTSP must notify an inventor of its intent to pursue a patent within six months, but the OTSP can complete a preliminary patent search and review market implications with a pretty good handle whether or not they will invest in a patent application within three months. This is largely due to the fact that the OTSP now uses an outside web-based service that allows it to do a patent assessment fairly quickly. If the invention passes steps 1 and

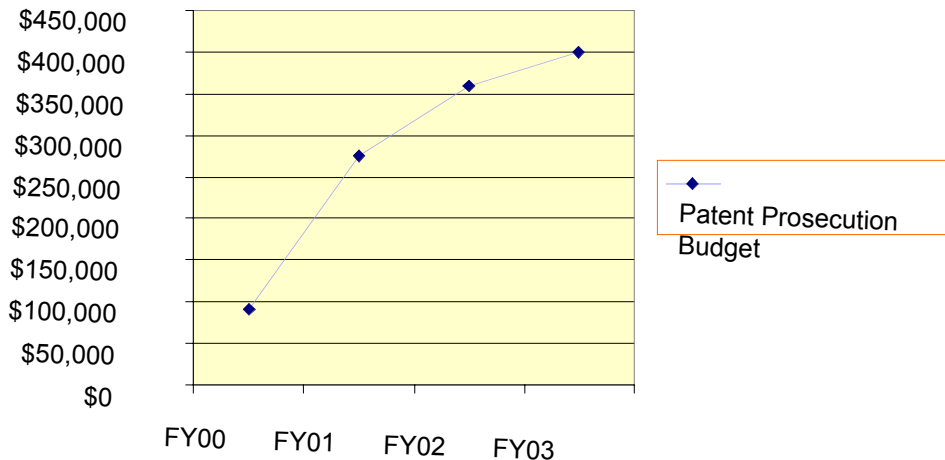
2, then the OTSP may decide to invest in a patent application. **This represents about 50 percent of disclosures, up from only about 10 percent only 2.5 years ago.** While this is a dramatic improvement, many faculty still perceive that the OTSP will not move forward on a patent application unless a licensee is already lined up because of the way disclosures had been handled historically.

Patent Prosecution Budget. One major limiting factor in a university’s decision whether to apply for patents from invention disclosures is the patent prosecution budget. This budget allows universities the money to pay for necessary legal expenses to go through the patent application process on the researcher’s behalf.

Historically, this patent prosecution budget for the university system was very small and severely limited the number of invention disclosures the university pursued for patent rights. In FY99, the University did a study analyzing AAU Universities’ expenditures for patents per \$1 million of research. At that time, the median was \$1,975 and the University only had \$424. At the time, the University needed to increase its patent prosecution budget by four times just to be considered average.

Three years ago, just after the OTSP was created, the patent prosecution budget was \$90K. In FY01, patent expenditures rose to \$275K, in FY02 they increased to \$360K, and this year patent prosecution expenditures are expected to be over \$400K. This represents an increase of 444 percent increase since the OTSP was created less than four years ago. A portion of the two-ninths of the system royalty share goes to go to the OTSP to support this patent prosecution budget. This dramatic increase in the patent prosecution budget will allow the OTSP to use its outside patent attorneys to handle the filing and prosecution of many more patent applications than ever before.

OTSP Patent Prosecution Budget



Today the OTSP will pursue a patent for about 50 percent of invention disclosures submitted. This is a big improvement over the 10 percent that were pursued only three years ago for cases where there was not a licensee already lined up to pay the patent costs. This increase in the number of patent applications is primarily due to the increased patent prosecution budget of the OTSP. The OTSP estimates that the patent prosecution budget will level out around \$450,000 in two or three years and then will grow at the same rate as the university's research expenditures.

4. Patent Application Process

The OTSP includes the inventor in this part of the process. At this stage the OTSP, the outside patent attorneys and the inventor develop the critical strategy for the patent. The crafting of claims is very important, because the claims keep others from practicing the inventions.

A typical patent has 12-40 claims, although OTSP is preparing one patent application that has over 700 claims. Sometimes the U.S. Patent Office will examine the claims and determine that the patent application actually represents several different inventions. The OTSP can also move forward with a new application if the inventor has new data and new claims – this is called a Continuation-in-Part application. In addition, a completely new patent can also be applied for if the original description of the invention (in the original patent application) does not contain a basis for the new claims.

If, for any of the reasons listed above, the OTSP decides not to move forward with the patent application process, the University Patent Regulations allows the University to pursue patent rights through an outside source:

University Patent Regulations: E.2.g: “The Patent Committee shall give consideration as to whether it will be to the best interest of the University and the inventor to place the matter with an entity organized for marketing of patent rights for development by such entity in accordance with its contract with the Curators of the University of Missouri and its general procedure, or for the University to make application for the patent or Plant Variety Protection in its own name.”

While this approach was used in the past when the patenting and licensing office did not have a patent prosecution budget to speak of or have the technical expertise within the office, the OTSP highly discourages this approach today. These entities typically do not have a close relationship with the research enterprise (which the OTSP considers critical to the success of any patenting and licensing entity). In addition, it is often the philosophy of such organizations to make money and not necessarily to get the technology out into the marketplace; they tend to only pursue invention disclosures with the least financial risk. As a result, this approach has not been pursued in the University of Missouri since the establishment of the OTSP.

Another major change in policy at the university is that now the system will continue to retain the intellectual property rights that were disclosed by the inventor even if the OTSP decides not to pursue a patent. The university used to give the intellectual property rights back to the inventor. However, now the OTSP either holds on to the intellectual property or licenses it back to the inventor because a disclosure is considered public property and may have value at some point in the near future.

The University Patent Regulations still officially allow for an inventor to receive back the intellectual property rights if the OTSP does not pursue a patent. It states on filing a disclosure:

University Patent Regulations E.2.i.: In the event the report of the Invention or Plant Variety is submitted to an entity organization for marketing of patent rights with which the Curators have approved a continuing contract and that entity advises that it is not to the best interests of the University to seek a patent thereon, the President shall within a reasonable time seek other means of obtaining a patent or release the rights of the Invention to the employee-inventor.”

While this is stated policy and can be requested by an inventor, it is now rarely granted in practice and the OTSP will recommend it be changed to reflect this in the restructuring of the university’s patent policy. This recent change could be perceived as a negative development on the part of the faculty researcher, and could serve as a disincentive and have a direct negative effect on the number of future invention disclosures (especially if the perception still exists among the faculty that the university does not pursue patents unless a licensee is already lined up to take financial responsibility).

Recommendation: The University should revise the patent policy to encourage commercialization of UM technology and entrepreneurial activities.

II.4: External Board of Advisors

The University of Missouri has revamped its Patent Policy Committee in the last year. The committee formerly reviewed invention disclosures and made recommendations on what to patent. However, with the technical expertise now available in the OTSP this practice is no longer practiced. The committee now meets on a regular basis to advise the University on patent policy decisions and mediate conflicts. The Patent Committee was broken into two subcommittees to look at aspects of the patent policy. This was done for the convenience of the work at hand at the time and was not intended to be anything close to permanent, simply a means of dividing up the work for the next couple of meetings. In the end the Committee met as a committee of the whole and the subcommittees never functioned as originally intended anyway.

The Patent Committee is made up of administrators and faculty from the four campuses, plus ex officio members from the System. The President appoints the campus representatives and receives recommendations from the campuses for these appointments. The committee consists of 20 appointed members--5 from each campus, which include essentially 4 faculty members plus the Chief Research Officer of the campus. The non-voting ex-officio members from the UM System include the VP for Academic Affairs, the Comptroller, a representative of the General Counsel's Office, and the Executive Director of the Office of Technology & Special Projects. There are no representatives from private industry on the Committee.

Recommendation: Establish an OTSP Board of Advisors composed of members from the private sector

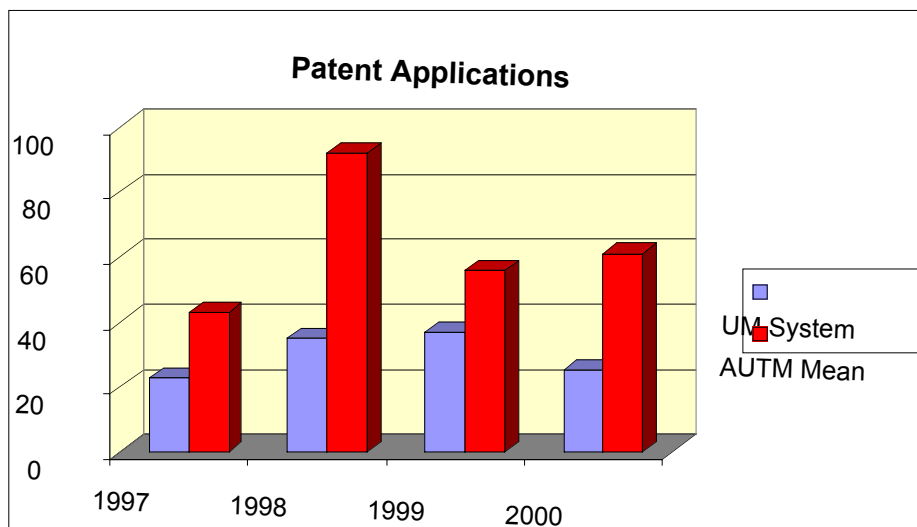
II.5: Patent Applications

The AUTM reports that among 142 universities surveyed, 5,623 new U.S. Patent Applications were filed in FY2000, up from 4,877 the previous year.

PATENT APPLICATIONS FILED				
	FY97	FY98*	FY99	FY00
UM System Total	23	35	37	25
AUTM Mean	43	92	56	61
UM System Patent Applications/ \$10 million in Research Exp.	1.6	1.8	1.7	1.1
AUTM Patent Applications/ \$10 million in Research Exp.	2.8	3.6	3.3	3.3
Mean for Patent Applications of Universities within 10 invention disclosures of UM	33	42	47	29

*FY98 only contains AAU Universities

The following graph illustrates the trends in patent applications over the past several years.



The following table gives an example of the breakdown of patent applications per campus:

Patent Applications per Campus	FY01	FY02
UM System Total	39	50
Columbia	32	38
Rolla	4	5
Kansas City	3	5
St. Louis	0	2

The overwhelming majority of patent applications for the UM System come from the Columbia campus, a higher percentage than the breakdown of invention disclosures for each campus. Patents filed at the University have also not risen in conjunction with the growth in federal research dollars. The above tables also show that number of UM System patent applications are much less than the AUTM mean for each fiscal year. However, in an effort to get a more accurate comparison, the table also compares the UM System to universities that have a similar number of invention disclosures. When compared to universities that have between ten less or ten more invention disclosures than the UM System, Missouri compares more favorably, although still below the mean. It is the goal of the OTSP to increase the number of patent applications by 10 percent in the coming year.

Recommendation: Set goals and track the yield of research expenditures by campus to the number of patents filed by campus.

Patents Pending

With regards to the University of Missouri System, in June of FY00 there were 33 patents pending (*The average is 40. Show the average AUTM percentage increase in pending patents over the last three years, and use to forecast and compare our FY01 and FFY02 numbers.* In June of FY01 there was a 90 percent increase to 63 pending patent applications. As of mid-December of FY02 (only halfway through the fiscal year) **there already were 91 pending patent applications, up from only 33 just a year and a half before.** The breakdown for total U.S. patents pending per campus is as follows:

UM System Total	91
Columbia	74
Rolla	11
Kansas City	6
St. Louis	0

Patents Issued

The AUTM reports that 3,272 U.S. Patents were issued to universities in FY2000, up from 3,082 the previous year.

U.S. PATENTS ISSUED						
	FY97	FY98*	FY99	FY00	FY01	FY02 to date
Columbia	11	11	19	9	10	12
Rolla	3	2	2	2	0	4
Kansas City	2	0	1	1	0	0
St. Louis	0	0	0	0	0	0
UM System	16	13	22	12	10	16
AUTM Mean	17	37	23	23		
UM System Patents Issued/ \$10 million in Research Exp.	1.1	0.7	1.0	0.5		
AUTM Patents Issued/ \$10 million in Research Exp.	1.1	1.4	1.3	1.3		

*FY98 contains only AAU Universities

According to the table above, the number of patents issued in the UM System has fluctuated every year. It is extremely difficult to get issued patents, as the data shows: it takes at least \$10 million in research expenditures to produce the innovation that will generate one issued patent. This clearly illustrates again why it is extremely important that the UM System continue to increase the amount of research expenditures at each campus.

TRACKS TO COMMERCIALIZATION

Once the OTSP has decided to invest time and money into a patent application to protect the invention disclosure, it will look at the best strategies to commercialize the invention. This is generally done in either one of two ways, either through licensing the technology out to an established company to commercialize the product, or by helping the researcher develop a new start-up company to pursue product development into the marketplace.

Which Track to Take?

Over 80 to 90 percent of the time the most effective way to commercialize an invention is through licensing. If the technology is sufficiently broad and deep to sustain a new enterprise, the university will often work with the inventor to start a new company. There are a variety of factors that can influence the process of licensing a university technology.

Many technology transfer managers agree that some technologies are more appropriate than others for licensing to start-up companies, often depending on the matching of research competencies of the university with start-up ventures in the area. In addition, large corporations are often more interested in acquiring proven technologies from smaller companies than in developing a nascent technology into a marketable product for themselves. The early stage nature of university technologies sometimes makes it difficult to attract industry's attention to license the technology. The OTSP prefers to license to smaller companies because they are much more aggressive and willing to take on nascent technologies.

It is usually much easier to license a patent as opposed to starting a new company, but it can be worth the extra effort and investment to nurture a start-up so the benefits remain in the state. In order for a university to move forward with a discovery to facilitate the start of a new company, it must be a breakthrough or platform technology that can sustain multiple products and it must have a large market. The technology must have a broad portfolio based on multiple applications. A university will sometimes even bundle several faculty technologies into a single start-up for synergy. While the University of Missouri has not yet done this, the OTSP believes it is a good strategy and is interested in pursuing this approach. Penn State has been successful at utilizing this method in developing the start-up company EIEICO Inc. The company was established based on licenses to a “technology platform” of three patented Penn State inventions.^{xvii}

It is the major responsibility of any technology transfer office to find companies or entrepreneurs that have the capability, interest and resources to develop nascent university technologies into useful products. Criteria used in identifying the licensee include financial and technological resources; a “fit” within the company business plans, previous experience, and marketing capabilities.

The Journal of the Association of University Technology Managers included an article in 2000 that made the following points:

- With regards to the importance of various sources in identifying university technologies to license-in to companies, results shows the extreme importance of the inventor in matching university inventions with industry needs.
- Similarly, a Jansen and Dillon (1999) report for the Journal found that personal contacts of inventors are the most important source of licenses. Their survey of five universities and a national lab regarding leads for licenses confirmed that the overwhelming source of leads originated with the inventor/researcher.^{xviii}

While this data is currently not available, it would be interesting to know the percentage of licensing leads that come from faculty at the University of Missouri.

Structuring the Deal

The philosophy of a university has a direct impact on the structure of its policies surrounding technology transfer. Policy guidelines may be structured quite differently, depending on whether the university system’s philosophy related to patents and licensing is geared more towards making money, or more to get the technology “out there,” or yet another driving objective. The OTSP considers its philosophy to be a mixture of these things. It considers its mission to be to support the research enterprise through technology transfer, move technology into the private sector for the public good, create wealth for Missouri and bring a return on investment to the university and its faculty inventors.

There are a variety of ways in which the OTSP can negotiate the licensing of a university technology. Consistent with industry standards, the OTSP will structure a deal that includes one or more of the following provisions:

- The OTSP will usually ask the licensee to reimburse the university for its patent costs
- There is usually an upfront payment due upon signing the license agreement
- Generally, universities will take less in “pre-market” cash payments from the small company, but larger royalty payments and perhaps stock shares and warrants. The University may opt for a significant equity share in lieu of royalties. Once in awhile

the university will take an equity position in the licensee, especially if it is a university start-up

- They will usually include a royalty on sales, often including minimum annual royalty payments
- The OTSP will set forth milestones (if the licensee does not meet development-event deadlines or commercialize the invention in a certain amount of time). In addition, the University can establish other requirements which, if not met, the University will have the right to take back the license (if the company does not pay the royalties, or oppose infringement on the intellectual property rights, for example).

In deciding which of the above possibilities to use in structuring a licensing deal, the university will take into account the following factors: type of technology, its stage in development, the size of the potential market, the profit margin for the anticipated product, amount of perceived risk, strength of the patents, projected cost of bringing a product to market. Other factors include the estimated dollar value of the research which led to the discovery, scope of the license (exclusive versus non-exclusive, narrow versus multiple fields of use) and royalty rates for similar products.

If it is decided that the technology is broad enough to support a license to a start-up company, the OTSP will do the following:

- The university will do a license agreement with the faculty member
- The university will sometimes take equity in the start-up company
- The university may not require up-front payments, especially if it takes equity in the company.
- There is a royalty on sales

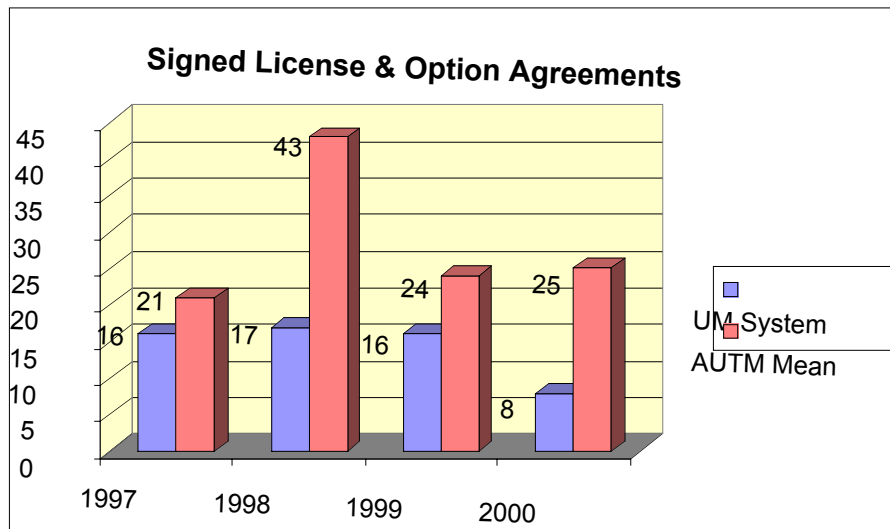
On the flip side of licensing out technology, some universities are taking a proactive approach to licensing in technology that could help round out the technology base to support a start-up company. N.C. State has had some success in attracting “intellectual property donations” that involve arrangements whereby firms donate intellectual property to universities and receive tax breaks in return. N.C. State is then free to further develop and market the technology. Several of these deals are already producing royalty streams.^{xix} The University of Missouri has obtained a similar donation of patents, and is working on obtaining three others.

License Agreements

The AUTM recorded that in FY2000 there were over 3,606 license and option agreements executed by universities, and almost two thirds (66%) of these commercial agreements were made with small companies (500 employees or less). 7,562 licenses/options yielded income in FY2000, up from 6,683 the year before.

LICENSE & OPTION AGREEMENTS SIGNED						
	FY97	FY98*	FY99	FY00	FY01	FY02 to date
Columbia	14	14	11	4	9	8
Rolla	1	3	5	2	1	2
Kansas City	1	0	0	1	0	1
St. Louis	0	0	0	1	3	2
UM System Agreements Signed	16	17	16	8	13	13
AUTM Mean	20.8	43	24.1	25.4		
UM System Signed Agreements/ \$10 million in Research Exp.	1.1	0.9	0.8	0.4		
AUTM Signed Agreements/ \$10 million in Research Exp.	1.4	1.7	1.4	1.4		
Percentage of UM System Signed Agreements to Small Companies	33%	52%	47%	37%	76%	77%
Percentage of UM System Signed Agreements with out-of-state Companies	87%	88%	56%	62%	76%	77%

*FY98 only contains AAU universities



The above table shows that signed UM System license and option agreements have slightly decreased in the past couple of years, and remain below the AUTM mean. Based on

available data, it takes almost twice as much research expenditures to get a license agreement at the UM System as it does for the average AUTM university surveyed.

The OTSP prefers to license to smaller companies because they are more willing to license nascent technology and will be more aggressive in developing the technology. With this new emphasis, the UM System has dramatically increased the percentage of small companies to which it licenses technology from 33 percent in FY97 to 76 percent in FY01. This is a very positive development in the last two years since the formation of the OTSP.

Terms of the license agreement are negotiated by the OTSP and the licensee and cover a variety of issues. These include, but are not limited to the following: grant of license, scope (e.g., exclusive v. non-exclusive, territory (worldwide or only some countries), all fields of use v. limited fields of use), payments (can include any or all of patent cost reimbursement, upfront payment, milestone payments, minimum annual royalties, royalties as percent of sales), equity provisions if applicable, reference to separate stock agreement if equity in the company is taken by the University, reference to a separate research agreement if the University continues to be involved in R&D related to the technology, development and commercialization diligence requirements, licensee indemnification of the University, warranties of University, term of the agreement and provisions for termination, provisions surviving termination, , confidentiality, use of University and licensee name, notices, relationship of the parties, assignment, contract modifications, applicable law.

Intellectual Property

The Council on Government Relations stresses the granting of rights must be specific to the scope of work funded. When an invention results from industrially funded research, the sponsoring company is commonly granted first options to license patents and commercializes the invention. When both federal and industrial funding support a research program, it is appropriate to grant an industrial sponsor the right to receive licenses to subsequent inventions.

The University of Missouri expects to retain intellectual property for all inventions by university faculty. This is the norm for most universities, although there are exceptions. The University of Wisconsin has a presumption that faculty own their own inventions. Unless there is a clear linkage to a campus research project, other innovations developed by faculty are considered outside the domain of intellectual property in which the university has claim.^{xx}

A company's background technology may be in the form of trade secrets or patents. Companies with a short product life cycle rely more on trade secrets than license and patents. However, the University of Missouri rarely licenses know-how and it is difficult for the university to have or license trade secrets. It is fundamental to any university to conduct research and publish results. If a company does not want this, then it will typically go to a contract researcher laboratory for collaboration. One complicating factor relating to I.P. is a company's desire to maintain technology as a trade secret instead of pursuing a patent. The reasons for this are numerous but often times it is impossible to reverse engineer a development or process, and hence by not pursuing a patent the competitive edge can be maintained. In exchange for maintaining a trade secret, it is not unusual for companies to offer a faculty member an incentive such as guaranteed sponsor research, new equipment or hiring students.

Exclusive versus Non-Exclusive

There are typically two types of licenses, exclusive and non-exclusive. The Council on Government Relations states university decisions on whether to license a patent only to one company or to a number of companies are based on several factors. However, universities are generally most influenced by two major determinants: what kind of licensing is most likely to lead to rapid commercialization, and what kind of licensing is in the public interest.

Patents that are broad in scope and can be used in multiple industries or patents that are so basic that they form the building blocks for new technologies are most likely to be licensed non-exclusively, or by fields of use. Non-exclusive licenses allow for licensing to multiple parties and can be less demanding on the licensee. Non-exclusive licenses may also be granted when participation of several companies offers better opportunity for broad development and use of the invention or when an invention has already been substantially developed for commercial sale.

Exclusive or partially exclusive licenses may be granted to encourage investment of substantial resources when needed to support commercialization. An exclusive, “field-of-use” license is a way to protect a market for a company while enabling the university to identify more than one licensee to assure public utilization of the markets. Universities most frequently will grant exclusive licenses to patents that require significant private investment to reach the marketplace or are so nascent that exclusivity is necessary to induce the investment needed to determine utility (such as the development of new drugs).

The AUTM reports that in FY2000 50 percent of new licenses and options executed were exclusive and 50 percent were non-exclusive. The OTSP reports that over 85 percent of all licenses at the University of Missouri are exclusive licenses. (One reason for this higher percentage over the AUTM number is that the University of Missouri does not license as many research tools as other universities). This percentage is a positive sign for companies that are interested in working with the university.

II.7: Process Communication

Each campus has an office that coordinates sponsored research programs. The MU Office of Sponsored Program Administration (OSPA), for example, serves as a one-stop shop and is responsible for preparing research agreements with industry sponsors at the Columbia campus. The OTSP advises the OSPA on all issues related to intellectual property in research agreements.

Intellectual property terms of the research or license agreement are negotiated by the OTSP and the licensee and cover a variety of issues. Research agreements include, but are not limited to, the following components: statement of work, period of performance, project costs/award, invoice submission/payments, title to equipment, deliverables/reports, records, termination, publication, intellectual property, confidential information, use of University name, notices, relationship of parties, assignment, contract modifications, indemnification, and applicable law. Some places, like MIT, make quick, hard-nosed decisions on research and intellectual property agreement terms. However, MIT has a long history and reputation for outstanding research. University of Missouri does not have that luxury to take a hard-nosed approach to licensing agreements.

Negotiations on licensing agreements typically take months. All licensing negotiations on behalf of the University of Missouri are conducted by the OTSP in coordination with the Office of General Counsel. The University states that one of the biggest problem for delays in time are that researchers will often go and cut deals with the company. Longer delays are created

when faculty negotiate terms separately with an industrial partner that are unacceptable to the University and must be renegotiated. Much time would be saved if the faculty member employed the services of his or her sponsored program office, and through it the OTSP during the initial draft of the agreement. These habits of the faculty were created long before the OTSP was created. This is part of the culture change that needs to occur.

What takes time with industry agreements is the negotiation between lawyers for both parties to come to mutually agreeable terms with regard to the intellectual property rights. The delay is due to the response time by the University to the company, and then the time it takes the company to respond to the University. The University needs to streamline the contract approval process and provide a single contact for industry to work with the University. In an effort to make interaction with industry more efficient, the OSPA is making an effort and has reduced processing times for research agreements.^{xxi}

REDUCED PROCESSING TIMES FOR STANDARD DOCUMENTS HANDLED BY OSPA	
Time period from OSPA receipt of award notice, until notification of investigator	Mean of 24 Hours
Proposal review time period from OSPA receipt of complete proposal until proposal transmittal to sponsor	Mean of 2.7 days
Time period from OSPA receipt of award notice, until account is set up	Mean of 12 days
Reduce document (consulting agreements, confidentiality agreements, subcontracts, etc.) review time	*Does not specify processing times or goals
Time elapsed from the time a draft clinical trial agreement is received by OSPA until an account is set up	Mean of 45 days
Limit the number of proposal reviews that exceed one week	*Does not specify how many

While not represented in the above table, the OTSP effectively reduced the mean review time of intellectual property language in research agreements from 8.6 days in FY00 to 2.3 days in FY01. While the process still takes time, it has improved. Goals should be set to make the process transparent and speed up the intellectual property negotiations.

Other universities are also trying to increase the efficient interaction between university and industry. In 1999 Georgia Tech introduced the “Internet Contracting Officers Log” to facilitate project administration. This log keeps faculty informed about the status of proposals submitted through their industry contracting office. Faculty researchers can log into the system and see a list of all their project proposals being handled through the industry contracting office and may view the history of any of their own individual proposals.^{xxii} MU currently has a similar system in place, but an electronic routing sheet should be formally adopted. In addition, the University of Missouri System has been working over the past year to implement a similar and comprehensive system, called PeopleSoft. It went live in November and December of 2002, and allows faculty researchers to expedite the filling out of forms for research proposals, as well as track where their proposals are in the process. This system should greatly improve the efficiency and ease for which a faculty participates in research proposals.

Recommendation: Communicate more regularly with faculty about the status of disclosures, patent applications, and license agreements.

II.8: Licensing Agreement Templates

Licensing agreements need to be clear, concise and easily understood by all parties involved. The University of Missouri currently has one non-exclusive boilerplate sponsored research contract available for industry to fill out if they are interested in the fast track. The language in the section on Patents and Copyrights reads:

The University retains all ownership to any patents, copyrights, processes, inventions and other proprietary intellectual property of any nature developed as a result of the research or investigation conducted under this contract. The University hereby grants Sponsor a six (6) month option from the date of notice to Sponsor by University for a nonexclusive license for any resulting patents. Should Sponsor exercise such option within the six (6) month period, a reasonable and customary rate will be negotiated together with the other terms and conditions of the nonexclusive license.

A major difference between this contract and those used by many other institutions like Dartmouth or Harvard is that their contracts include language in the boiler plates that read something like: “there will be a period of x months to *negotiate* the license...and will not offer a commercial license to any other party during this time.” Furthermore, many universities will have several boilerplate contracts, including those for jointly owned intellectual property, or a company expects no intellectual property.

The UM System has several boilerplate provisions, including for exclusive and non-exclusive options and language saying what the university invents it will own, what the company invents it will own, and what is involved jointly will be owned jointly. The University provides a six-month option for the company to obtain a license for the university’s interest in university inventions and joint inventions. The OTSP is also in the process of restructuring its licensing templates. The OTSP is working with the Office of General Counsel to put together more standard agreements that will be much more complex and will include additional boilerplates.

Some universities, such as Purdue, have standard agreements and several standard clauses that can be inserted or changed in contracts without further approval from university attorneys.^{xxiii} Such a policy that empowers the OTSP would make it much easier and more efficient for the UM System to negotiate with industry partners. The OTSP and General Counsel’s Office are working to establish such standard clauses.

N.C. State has implemented a system whereby colleges can directly implement industrial research contracts of \$25,000 or less, and do so at a reduced overhead rate, as long as the firm signs a standard agreement.^{xxiv}

Recommendation: The University should revise the University “template” license agreement with additional approved standard clauses that can be inserted and removed, as well as create additional boilerplate agreements for simple transactions.

Master Agreements

Companies want to form strategic partnerships with universities. Master agreements work well when a company has a large portfolio of research at a single institution. It serves as an overall agreement that provides a menu of options for sponsored work, with individual budgets and scopes of work added subject to the master agreement. However, these are extremely difficult and time consuming to negotiate and generally do not pay off unless the company has many research projects with the university. Currently the University of Missouri has one master agreement with Monsanto.

The OTSP meets once a week with the Office of General Counsel to go through all outstanding issues for the week related to licensing or patenting. Since beginning this approach of direct face time with the Office of General Counsel, the OTSP feels that the process of getting a response in a timely manner has greatly increased.

II.9: Licensing Royalty Income

The University of Missouri will accept advance understanding of license terms in research arrangements, but typically does not like to agree to royalty rates ahead of time because it is never known what will be invented and therefore what its value will be. However, most university technologies still require a good deal of research and development before they are ready for the marketplace and therefore place a high level of risk for the licensee. This should be taken into account in the licensing negotiation. For this reason, fees and royalty rates are rarely large because of the considerable investment still required by the licensee. The Council on Government Relations states that license fees rarely reach into the six figures for a single patent, but more often range from a few thousand to a few tens of thousands of dollars. Royalty rates range from less than one percent (for some process technologies) to perhaps eight percent (for a patented compound with a significant market). The majority of royalty rates are in the 3-6 percent range, based on net sales.

The AUTM reports that Gross License Income received by U.S. universities in FY2000 was \$1,108,939,995, up from \$675,957,625 the year before.

ROYALTY INCOME						
	FY97	FY98*	FY99	FY00	FY01	FY02
UM System Royalty Income Received	\$1,381,589	\$1,481,378	\$1,544,985	\$1,568,904	\$3,894,499	\$1,739,240
AUTM Mean	\$3,685,443	\$8,694,154	\$4,611,511	\$7,579,049		
UM System Royalty Return on Investment	1%	0.8%	0.7%	0.7%		
AUTM Royalty Return on Investment	2.4%	3.4%	2.7%	4.2%		

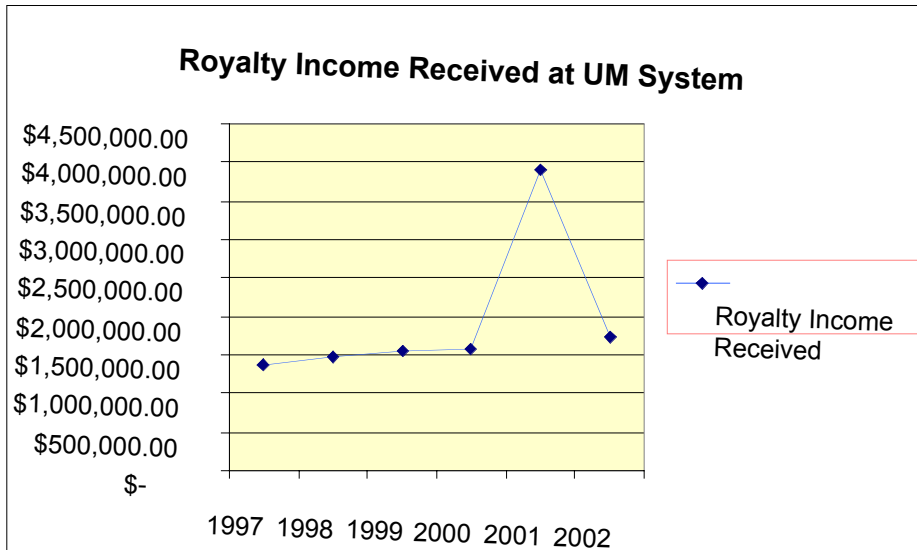
*FY98 only includes AAU Universities

Royalty Return on Investment = royalties as a percentage of Total Research Expenditures

AUTM data consistently documents that gross revenues generated from a university’s licensing activity average approximately 4% of the research dollars spent by that institution (net revenues are even less after paying the administrative and legal costs of the technology transfer activity). Few campuses benefit from patents for “blockbuster” products. Of the reported 20,968 active licenses in FY2000, only 125 (.6%) generated more than \$1,000,000 in licensing income. The University of Missouri has had only three or four such licenses.

Licensing revenue for the university has gone from \$1.6 million in FY00 to \$3.9 million in FY01, more than double that of previous years. (This large jump is primarily due to two large up-front licensing payments). This large increase in licensing revenue is the primary reason for the large increase in the patent prosecution budget, which, in turn, has been responsible for the large increase in pending patents. The UM System royalty income is below the AUTM Mean

from FY97 to FY00. In accounting for the university's return on investment, royalty income at the UM System only accounts for about 1 percent of total research expenditures. It is the goal of the OTSP to increase the licensing income by 10 percent in the coming fiscal year.



When the OTSP brings in licensing income, the monies have historically been distributed in the following manner:

- The inventor gets one-third (1/3) of the royalties
- The campus research office gets two-ninths (2/9) of the royalties
- The campus department gets two-ninths (2/9) of the royalties
- The system level gets (2/9) of the royalties

This breakdown is consistent with the AUTM recommended disbursement of royalty income. It is a strong incentive to the researcher that the inventor automatically gets one-third of all royalties to an invention at the UM System. While one-third of the royalties is a competitive share, other universities are even more generous: faculty researchers at N.C. State currently receive 30% of all gross royalties for inventions, this number will be increased to 40 percent in 2003. Texas A&M inventors receive over 40% while Carnegie Mellon University gives faculty inventors 50% of revenues from licensing.^{xxv}

Royalty payments can not only be strong incentives for researchers to disclose a discovery, but it can also be an important tool in increasing the technology transfer office and patent prosecution budgets. As previously stated, a portion of the system share of royalties automatically gets put back into the OTSP's patent prosecution budget.

The University of Missouri may be unique in disbursing the inventor's share before recouping patent costs. Other universities only disburse the share to the inventor after reimbursement costs to pursue the patent have been taken out. The University considered a change in policy to be consistent with the mainstream of universities and reimburse patent costs before distributing licensing income to the faculty-inventor(s).

However, upon hearing this new approach, many faculty have expressed deep concern that such a policy does not serve as a good incentive to the faculty researcher because his or her share can be drastically diluted. They view such a policy as putting the inventor last in line instead of first in line to receive any benefits from their research, and as such there is little incentive for faculty to disclose new inventions or discoveries. This has to be a win-win situation for both the University and inventor.

The University is now reconsidering its position and one of the Patent Committee groups is considering a compromise: The inventor will receive an incentive payment immediately upon filing a patent. In addition, the inventor will receive a portion of the first money to be generated when the license is signed before money is taken out to cover patent costs. Finally, after all patent costs are covered the inventor will also receive his or her one-third share of the remaining royalty.

Recommendation: The University should develop a royalty disbursement policy that includes an appropriate incentive for faculty to disclose inventions and participate in the filing of patent applications.

Outcome III: Promote Local Entrepreneurship

There were four start-up companies launched in FY01. One start-up company was launched in FY02.

Start-up Companies Formed						
	FY97	FY98	FY99	FY00	FY01	FY02
UM System Start-up Companies	Not Available	Not Available	1	3	4	1
AUTM Mean	2	3.7	2	2.6		

The AUTM reports that there were 344 new companies formed during FY99 based on their annual survey of member institutions. In order for start-up companies to develop and thrive, there needs to be an environment present that can nurture the creation and development of these new start-up companies. This section examines the other seven factors as necessary for a start-up environment to flourish at the University of Missouri System.

- The Southern Technology Council, a division of the Southern Growth Policies Board, did a comprehensive benchmarking study in 1995 titled, “Benchmarking Best Practices for University-Industry Technology Transfer: Working with Start-Up Companies.”^{xxvi} This study identified practices and policies that either hinder or facilitate university technology transfer to new companies. It identified nine major influencing factors or variables that are critical as to whether an environment exists where universities can successfully promote the creation of start-up companies from academic research.

III.1: Licensing to Missouri companies

Of course, it is desirable to license a technology to an in-state company whenever possible. Data shows that at least 75 percent of UM System licenses each year consistently go to out-of-state companies, although the OTSP prefers to license to in-state companies whenever feasible. While not atypical, it would certainly make a bigger impact on Missouri’s economy if more deals were licensed to Missouri’s companies. N.C. State’s Office of Technology Transfer has the flexibility to negotiate lower royalty rates for firms that agree to commercialize the technology locally. A penalty clause kicks in if the licensee moves out of state, and thus protects the university’s financial interests.^{xxvii} Such a policy would be a solid example of how the University of Missouri can fulfill its fourth mission to promote economic development.

Recommendation: Develop and implement a marketing plan to aggressively promote university invention disclosures to Missouri industry..

III.2: Economic Development as an Institutional Mission or Goal

Universities that identify the importance of technology transfer, establishing start-up ventures and economic development as central missions and goals tend to perform better at working with start-up companies. It is important that this mission and goal exist at several different levels, including the Chancellor, President or Board of Curators, and Department heads.

Virginia Tech outlines as a goal of the university to “Create policy that encourages and nurtures faculty economic development efforts.”^{xxviii} Ohio State has the following mission statement that leaves no room for ambiguity:

Become the catalyst for the development of Ohio’s technology-based economy. Increase collaborations with the private sector to enhance research, successfully transfer University technology, and provide experiential learning and career opportunities for students.^{xxix}

Unfortunately, in the case of the University of Missouri System, nowhere in the Vision, Core Values, or Strategic Goals and Objectives of the 2001 University System Strategic Plan did it explicitly state anything about the importance of technology transfer, commercialization or economic development.

Despite this fact, there is evidence that university leadership understands that this needs to change, and that the mission of the University of Missouri in today’s society does indeed include an important role in economic development. The University System Environmental Scanning Factor looks at rising issues of importance that will affect the university in the coming years. The EnScan Perspectives 2001-2002 reports:

“The University has the potential to play a major role in the statewide Life Science initiative and in formulating an economic development plan for the State.” It also states, “The University has the opportunity to capitalize on this wealth of knowledge by seeking avenues for commercializing the intellectual property created by faculty and staff. Annually, business and industry invests millions of dollars in research and development for the ultimate commercialization of consumer products. By collaborating with industry in such efforts, the University can market its own intellectual resources in an effort to diversify and increase resources.”

More importantly, the President of the University Board of Curators sees the clear need for this to be part of the university’s mission. In the January 2002 University of Missouri System Spectrum Newsletter, Curator Board President John Mathes urged the Board to focus on three areas of governance during 2002: leadership development, strategic planning and entrepreneurial opportunities. He said, “The University is well positioned to become an agent of change in society, but it must continue to build research infrastructure if it is to capitalize on opportunities in such emerging fields as genomics, proteomics, nanotechnology, biotechnology and information technology. *Equally important, we must create and encourage a process that supports the migration of discoveries to the marketplace.*”

Campus Chancellors are also stressing the importance technology transfer. In the "Development of Missouri’s Life Sciences Corridor" panel on March 4, 2002, Columbia Chancellor Wallace said more than 600 MU faculty across six colleges and schools are involved in life-sciences research but that to continue to improve its status as a life-sciences research institution, MU must "streamline" some of what it does and welcome commercial partners. "Some say public institutions should erect a barrier between itself and commercialization," Wallace said, "*but indeed if society is to reap the harvest in its investment in our basic research, then I think we must encourage our faculty entrepreneurs and we must encourage the process of commercialization.*"

In the past, not all of the four campuses have had reference to the importance of economic development in their mission statements. However, the quotes below make reference to the importance of technology transfer and commercialization of intellectual property from the three finished campus plans.

UMC ~ “One important thrust in the area of technology development for the near term will be to establish baseline measures and the capacity to gauge progress against these measures. We will not, however, stand still while these measures are developed. The Office of Technology and Special Projects (OTSP) will be brought rapidly to scale and immediately begin offering services to faculty, identifying and protecting intellectual property, and encouraging entrepreneurship on campus. Merger of the former University Patents and Licensing Office with this new office has already been accomplished, and the work of streamlining policies and processes has begun. In seeking new sources of venture capital and construction of a business incubator building, MU has set about creating a solid infrastructure to support the imaginative work of its faculty and the economic development of the state.” (taken from the Research Master Plan that accompanies the UMC Strategic Plan).

UMR ~ “Support activities that promote economic development and technology transfer that meet the research and human resource development needs of the nation.”

UMSL ~ “Introduce a streamlined technology transfer procedure including the evaluation of research transferability, applicability for new technologies, marketability, and competitiveness. Coordinate efforts with regional trade associations and businesses and engage faculty and students in the process.”

“Establish a new incubator operation to house startups that will include entrepreneurs from the University and from local research labs. The operation would be housed in a location adjacent to the University with initial development costs covered by research grants.

Since the first draft of this report, outgoing University of Missouri President Dr. Manuel Pacheco has stated that the fourth mission of the University of Missouri is economic development. This is an historic revelation and change that will affect the culture at the University of Missouri. Campus and department strategic plans should reflect goals and outcomes that will track and measure the University’s participation and success in economic development.

Recommendation: The University should work in partnership with state government and the business sector in developing strategic plans for Missouri economic development.

III.3: Personnel Policies and Practices

Beyond simply stating that promoting start-up companies and economic development is a mission or goal of the university, the university needs to have specific policies or actions implemented into practice to truly have a positive effect on this environment.

Faculty consulting is one way to facilitate the transfer of university research into the marketplace. The AUTM reports that institutions that encourage liberal faculty consulting policies enhance a faculty’s teaching and research duties. This is usually conducted when intellectual property needs to be further developed. Consulting activities also provide opportunities for faculty to expand their professional experience. The University of Missouri

generally allows one day a week, or 30 days during the academic year to be used for consulting purposes. In addition, University faculty will often consult during the summer months to bring in additional income.

In addition to traditional consulting to companies, faculty entrepreneurs involved in a start-up business developed from their technology also need flexible sabbatical leaves of absence or temporary part-time appointments to get the business off the ground. UM System policy currently allows six-month sabbaticals to further professional development related to research, but a change in policy to allow six-month sabbaticals or part-time pay for faculty to start a business would completely change the atmosphere to support such endeavors. There need to be personnel policies in place that make faculty feel that they do not have to choose between being an educator and being an entrepreneur. For example, the faculty could do X number of hours of research per year, and get 10 percent of the company in return (because they are not putting anything into the business except ideas and their risk is zero). Such a sabbatical would also allow faculty to be the lead PI on an SBIR/STTR proposal.

There is not anything in the current policy to preclude this from happening, but it needs to be encouraged by the administration and department chair. There are several ways this can be done. A faculty could reduce their time by 50 percent and get a 50 percent salary while working on a start-up company, or get half of a salary for one year or a full salary for a half-year.

Recommendation: Explicitly include in the faculty leave policy that the University will allow flexible sabbatical or development leaves of absence not only for professional development related to research, but for a faculty researcher to launch a start-up company.

III.4: SBIR/STTR Programs

In addition to federal funding of basic research, the competitive grants from the federal Small Business Innovation Research (SBIR) and the Small Business Technology Transfer (STTR) programs are an outstanding way for university entrepreneurs to do proof-of-concept and prototype development work from their basic research. This seed money is often a first critical step before such innovations can attract angel and other venture capital.

Both are highly competitive programs, and each has three different phases (with no federal SBIR or STTR funds supporting the third stage). Phase I is a feasibility study to evaluate the scientific and technical merit of an idea. Phase II expands on the results and pursues further development, while Phase III moves the innovation out of the laboratory and into the marketplace. Whereas the SBIR program is for for-profit businesses only, the STTR program requires that a nonprofit research institution (e.g., university) be a partner in the application. Many university faculties have participated in the SBIR program through the years by establishing a legal business in time for receiving the funding award. Ten federal agencies participate in the SBIR program each year, while five federal agencies participate in the STTR program.

The following table shows Missouri's rank, number of proposals, and dollar amount in the thousands for SBIR phase I & II awards during the fiscal years 1997 through 2000, based on data provided by the SBA:

Missouri SBIR Awards							
	Rank	Phase I Awards	Dollar Amount	Phase II Awards	Dollar Amount	Total Awards	Total Dollar Amt
1997	31	15	1,260	5	2,323	20	3,583
1998	26	14	1,076	9	5,416	23	6,492
1999	29	16	1,082	5	2,920	21	4,003
2000	29	16	1,518	6	3,454	22	4,972

*Dollar amount per 1,000

The above table shows that Missouri has remained steady at around 30 out of 50 states competing for SBIR awards. There is clear room for improvement from this status quo of past years.

The following table shows Missouri's rank, number of proposals, and dollar amount in the thousands for STTR phase I & II awards during the fiscal years 1997 through 2000:

Missouri STTR Awards							
	Rank	Phase I Awards	Dollar Amount	Phase II Awards	Dollar Amount	Total Awards	Total Dollar Amt
1997	14	1	100	3	1,246	4	1,346
1998	50	1	65	0	0	1	65
1999	17	3	300	2	735	5	1,035
2000	36	2	254	0	0	2	254

*Dollar amount per 1,000

The above table shows that Missouri has been very inconsistent in its performance on STTR awards, ranging from as high as being ranked 14 to being ranked at the bottom with 50 in 1998. This great fluctuation does not indicate a strong STTR program that has a steady stream of proposals with university participation.

During FY01 Missouri businesses received SBIR and STTR awards from only three of the federal agencies: the USDA, NIH and DOD. Missouri did not receive any awards from NASA, NSF, EPA, ED, DOE or DARPA, meaning there is a huge untapped potential for Missouri to increase its number of SBIR and STTR awards. Furthermore, SBA data shows that all award winners for FY01 were from the St. Louis metro area, illustrating the need for a greater participation from the rest of the state.

While not a focus of the former patenting and licensing office, increasing the number of SBIR and STTR awards is becoming an important objective of the OTSP. OTSP Director Tom Sharpe was responsible for developing a successful SBIR outreach program at the University of Mississippi that was funded by the U.S. Department of Commerce. Beginning this year, the OTSP is working with the state's FAST program to increase the number of SBIRs in Missouri.

The Executive Director of the OTSP was on the committee that designed the FAST proposal and was especially active in setting the detailed goals and objectives of the program once it was funded. The OTSP is integral to the FAST program, providing linkages to faculty who can support small businesses external to the University, reaching in to the University to let faculty know about the SBIR/STTR opportunity and assisting them in obtaining SBIR/STTR awards. The OTSP now works closely with the FAST program managers.

There are very specific timetables and windows of opportunity for faculty members to submit proposals and participate in the SBIR/STTR program. A limiting factor and point of frustration in the past for faculty members has been delays in negotiating the intellectual property rights for SBIR proposals. The OTSP can help to increase faculty participation in the program by removing intellectual property barriers. It should not depend on who you are or what department you are in with regards to the University and its relationship with a faculty member. This should be a simple process and should not be drawn out where the University picks the “winners” at this early stage. This process stifles deals and often loses the opportunity completely. Faculty members will not sacrifice their time on a proposal if later, after the proposal is submitted, the University says what it can and cannot do with regards to intellectual property.

Recommendation: The OTSP should prepare a standard intellectual property agreement and working document for faculty participating in the SBIR/STTR program

III.5: Conflict-of-Interest

University policy should accept that conflicts will occur in business-academic relationships and find creative and workable ways to manage them, and the conflict of interest policy should reflect this philosophy. Some universities, such as the University of Utah, let companies owned by faculty contract with the university for research projects, including the participation of the faculty member and his/her laboratory.^{xxx} It has even been said that technology transfer managers should create conflicts of interest, while the lawyers help resolve them. The conflict of interest policy and process should be very clear and easily understood by faculty. There should be few direct prohibitions and a decentralized approach to administration of the rules.

Many successful universities have a very clear conflict of interest policy form. Cornell University has a form that is very thorough, identifying categories of possible conflicts. This includes conflicts of interest versus commitment, covering not only financial interests but issues with supervisors, confusion over ownership, equity versus stock, board positions, misuse of university resources, sponsored research. It also outlines Conflicts of Disclosure and Avoidance, Resolution of Conflicts (for faculty and supervisors), and Committees on Conflicts in the process. In addition, the policy even has an appendix showing examples of general considerations, permissible activities, apparent conflicts, possible conflicts and clear conflicts of commitment. Most universities include a supervisory signature to attest to the statements given by each employee, and require all personnel to disclose conflict-of-interest statements on an annual basis, even if no conflict exists.

The University needs to work on processes and policy related to conflict of interest, especially with regard to encouraging and promoting start-up companies. The University acknowledges that way the current process has been implemented on the campuses appears to many faculty that the research officers are “talking out of both sides of their mouths.” On one hand, the research officers are encouraging faculty to begin start-ups but, on the other hand, they caution them to keep their new business at an arms length to prevent an apparent, if not actual, conflict of interest. There needs to be an independent group that publicly can say everything is okay.

To help alleviate this problem, the Conflict of Interest (COI) Committee on the Columbia campus has been reorganized and is now administered through the Chancellor's office instead of the Office of Research. The Conflict of Interest Committee is comprised of six to eight people. The committee is now moving towards meeting on a monthly basis. This committee reviews all conflict of interest disclosures, which are different from invention disclosures, and recommends to the Deputy Chancellor whether there is a conflict and if a conflict exists how to deal with it: eliminate the conflict, minimize the conflict, and/or manage the conflict. The Executive Director of the Office of Technology & Special Projects is a member of the Conflict of Interest Committees on the Columbia and Kansas City campuses.

The University of Missouri conflict of interest form is short (three pages) and too generic for faculty to understand what is actually needed. The COI Committee is currently reviewing the form and considering revising it to render it more instructive to the faculty concerning what kinds of information are needed to make an evaluation regarding the potential conflict

The OTSP and Conflict of Interest Committee will use this to draw up a conflict of interest management plan for faculty involved in a start-up company. Currently the process takes too long to settle issues – conflicts and potential conflicts should be able to be resolved within a month or so. . The OTSP stresses that an educational program that explains what are appropriate and inappropriate conflicts of interest must accompany any revisions in the form. It is not the form but faculty and department chair awareness that is key to the successful implementation of a conflict of interest policy.

Recommendation: Develop an education program for faculty and staff and an efficient but credible process for identifying and managing potential conflicts of interest.

III.6: Technology Transfer Showcase and Faculty Entrepreneur of the Year

Universities need to align reward systems with institutional goals and objectives. Once the University of Missouri has clearly defined the importance of technology transfer and economic development in the goals and objectives of its own strategic plan, reward systems can be promoted in several ways.

In addition to financial incentive of royalty income previously discussed, faculty recognition by peers is important. This is often seen in the form of an Inventor of the Year awards, or plaques to every faculty member who got a patent that year. Ohio State's Fisher College of Business has an annual business plan competition, as does University of Wisconsin with the G. Steven Burrill Technology Business Plan Competition. Winners of Purdue University's Burton Morgan Entrepreneurship Competition receive \$50,000 in prize money and free office space in an incubator.^{xxxii}

The University of Missouri has begun an annual Technology Transfer Showcase, an evening event that celebrates innovation and entrepreneurship of faculty from among the four campuses. This also serves as an important outreach activity of the OTSP to educate faculty members, and as a forum to reach out to the business community with a message that the University of Missouri is interested in collaborations related to research and licensing. This year, the first annual Faculty Entrepreneur of the Year award will be given, including a check for \$15,000, and faculty will be recognized who have submitted invention disclosures, received

patent applications or patents, have had an invention licensed that is creating royalty income, or have started a company.

The President of the University System and Chancellors of the four campuses all participate to show support for this event. Some universities, like Ohio State, even have the Governor participate to show the importance of technology transfer to the state's economy. Currently, the Technology Transfer Showcase is an evening event, but could easily be held in conjunction with other supporting and related activities and events. This coming year the Technology Transfer Showcase will be held in concert with Molecular Biology/Life Sciences Week on the MU campus. Virginia Tech Intellectual Properties Inc (VTIP), a nonprofit affiliate of Virginia Tech university, sponsors an all-day workshop for the Virginia Tech community on intellectual property issues.^{xxxii} The University should also seek other venues around the state to recognize the Faculty Entrepreneur of the Year as well.

Recommendation: The University should expand the evening Technology Transfer Showcase to hold in conjunction with other related and supporting activities and events.

III.7: Tenure Policies

In some schools the preparation of material to obtain a patent and the successful completion is given weight in the tenure and promotion process. This gets to the heart of what drives faculty. Faculty became university employees because they want a fruitful career in teaching and research. If tenure and promotion criteria do not reward efforts in the area of technology transfer, there is no incentive to pursue it, and it will not foster an environment that supports it. In addition to research productivity, teaching and service, consideration of these criteria in the promotion and tenure considerations is key to changing the faculty and organizational culture at the University of Missouri.

The University states that this is now done in their more technically oriented disciplines. Since technology transfer has been incorporated in the campus strategic plans, it should follow that faculty review committees should more favorably weigh patent and licenses as evidence of scholarship. The challenge is that tenure promotion is done department by department – it first moves through the department, then to the college, and then to a campus review. If technology transfer is not embraced by the department culture, than this may not receive as positive weight in some departments versus other departments.

N.C. State recently revised its promotion and tenure guidelines to contain language that is quite supportive of faculty entrepreneurs. It stresses the importance of “managerial and technical innovation” and makes a point that applied research produces “practices and technologies useful to society.”^{xxxiii} Recently developed promotion and tenure guidelines for the College of Food, Agricultural and Environmental Sciences at Ohio State has broadened the concept of scholarship to include the transformation and application of knowledge, and have legitimized the use of patents as an indicator of research excellence.^{xxxiv} The University of Wisconsin handbook states, “Every tenure case should include evaluation of the faculty member’s accomplishments in the context of the Wisconsin Idea.” This includes faculty involvement in outreach activities, in which outreach service may include “technology transfer.” Evidence for excellence in outreach research may include the “issuance of patents and evidence of intellectual property such as copyrighted materials.”^{xxxv}

Recommendation: The University should outline a process to encourage that the preparation of material to obtain a patent and the successful completion has considerable weight in the tenure and promotion process.

III.8: Research Foundation

The Board of Curators must send a message to get across that faculty members will not hold all of the risk or be punished in any way for pursuing entrepreneurial activities, but instead show that such work is welcomed. However, it is the nature of the university, especially a public university, to be risk averse. In order to create a culture and environment that does not stifle entrepreneurship, there must be a way to indemnify the university. Many universities have found a way to do this through setting up the technology transfer offices in a separate but related organization from the university. This has allowed the offices much greater flexibility in structuring deals, as well as receiving a larger share of royalties to reinvest. Those programs that have been successful are closely tied to the research enterprise of a university, and reinvest earnings back into the research enterprise and patenting operations.

Another reason some universities have moved this operation outside of the university is related to the “hold harmless clause” that appears in almost all sponsored research agreements with universities. Many industries will not go along with this, feeling that there are legitimate cases where a university should have accountability. As a result, universities have lost many research opportunities because of the clause.

There are several different successful models for examination. The Georgia Tech Research Corporation (GTRC) holds title to all intellectual property developed at the Georgia Tech, and actively encourages faculty participation in start-up companies.^{xxxvi} Purdue’s Office of Technology Commercialization is housed within the Purdue Research Foundation and reports to the vice president for research.^{xxxvii} At Virginia Tech, technology transfer is administered through Virginia Tech Intellectual Properties Inc (VTIP), a nonprofit affiliate of the university. Virginia Tech assigns intellectual property to VTIP, which in turn organizes its evaluation, protection, and disposition. It sets forth very clear set of guidelines for an inventor in navigating conflict of interest issues.^{xxxviii}

Perhaps the one of the oldest and most successful models of this is at the University of Wisconsin. At UW-M, technology transfer and licensing responsibilities are shared between two organizations. The Office of University Industry Research (UIR) works with faculty members to facilitate the invention disclosure process. It receives all disclosures, ascertains ownership and inventorship, and advises inventors on basic issues of intellectual property. Thereafter, responsibilities lie with the Wisconsin Alumni Research Foundation (WARF). WARF was established in 1925 as an outgrowth of research and technology development related to Vitamin D, and was the initial model of an independent but university-linked technology development organization. WARF reviews submitted inventions, and obtains necessary patents, or other protection for promising inventions, and then works with the inventors to implement a licensing and commercialization plan. After royalty distributions to inventors and others, WARF earmarks the balance of revenues for support of faculty research. This support has amounted to more than \$220 million over the past 15 years. WARF will also take an equity stake in a company rather than a straight licensing deal.^{xxxix}

The University of Missouri actually has a research foundation but does not use it. The University of Missouri stresses that the State of Missouri provides considerable flexibility in how the University can manage its funds. Without this flexibility, which is the situation in many states, a research foundation would be much more appealing. In addition, indemnification has been an issue on some research and license agreements, but the University has always been able to reach agreements indemnifying the University. In other words, the University feels that the issue of indemnification does not seem to be a deal breaker or restrict its business at this time. The University of Missouri is unconvinced of the value or benefit that a research foundation would provide that the University can not do itself. It cites the University of Michigan as an example of a university successful at technology transfer without the use of a foundation.

However, there is also a difference between what a university technically can do and what it actually does. Especially in a time of limited resources where there are many competing interests in a university bureaucracy, there may be many initiatives that a university may want to undertake but has to take a back seat to other issues. There are also other reasons for a research foundation. Product development work and security classified research are very difficult to do at universities. Examples provided by technology transfer offices under the research foundation structure also typically bring in a higher return on investment. The greater autonomy allowed to these agencies provides for more flexibility on issues relating to intellectual property while indemnifying the university's name.

Recommendation: The University should commission an independent study to look at the specific advantages and disadvantages in placing the OTSP in a closely related research foundation.

III.9: Encourage Faculty Entrepreneurship

Recommendation: If the UM System does not commit to patent application or licensing of an invention within a set amount of time, it will either provide a detailed plan for development of the invention disclosure or make the invention disclosure available for development by a campus-related organization and/or the originator of the invention disclosure.

Recommendation: Each campus should make arrangements with a campus-related organization to assist faculty in the entrepreneurial development of their disclosures.

III.10: Facilities and Physical Infrastructure

Allowing the use of university facilities and physical infrastructure is a way that institutions can facilitate the formation of new enterprises due to critical needs of capital. Faculty entrepreneurs that cannot yet afford to rent a space in an incubator still need access to wet labs and other critical research space.

In select cases, the University of Missouri will make space available to a company developing university technology. While there are no legal barriers in state law and regulations that prevent public institutions from facility and resource-sharing arrangements, this is not generally viewed favorably by the university administration. The only reason this is permitted is because there is not currently an incubator right on campus, and use of facilities is allowed only when there is no competing need from other university faculty.

The University of Missouri currently charges full market price to rent any lab space on the select bases allowed. Some universities make facilities available free-of-charge to start-ups for doing prototype development or applied research and then negotiate a more favorable royalty rate as payment for use of the facilities. While the University of Missouri has not done this in the past, the OTSP has indicated it would be open to the possibility if the situation arose.

Recommendation: The University should consider making research facilities available free-of-charge to start-ups for doing prototype development or applied research and then negotiate a more favorable royalty rate as payment for use of the facilities.

III.11: Business Support Systems

The OTSP is also working on a manual for start-up companies during this fiscal year to help faculty entrepreneurs navigate conflict of interest policies and understand the basic premises for entering the business world. Once the OTSP has worked with a faculty entrepreneur through the patenting and licensing process and the entrepreneur is ready to start a new company, the newly formed company may locate in an incubator or innovation center.

Universities that have a higher rate of spin-off companies all have linkages to technology business incubators. These incubators provide the immediate environment needed in close proximity to the university that enables continued interaction with university resources.

The University of Missouri and the Missouri Department of Economic Development have a strong incubator program where each of the four campuses has a state-sponsored incubator, or innovation center, near the university. The innovation centers are as follows:

- Columbia: Missouri Innovation Center
- Kansas City: Brush Creek Enterprise Center
- Rolla: Missouri Enterprise Business Assistance Center
- St. Louis: Center for Emerging Technologies

Each of these innovation centers has an executive director and staff that provides critical support structure for assistance to these advanced technology start-up companies. These centers provide services to entrepreneurs at the earliest stage in the development of promising high-growth, advanced-technology companies. Services the Missouri Innovation Centers provide include the following:

- business, technology and funding resources
- assistance with business plan development
- market research and planning
- help in obtaining patenting and licensing
- facilitating strategic alliances
- connecting companies to prospective investors
- specialized training and education seminars
- specialized facilities

While not limited to university technologies, these innovation centers work directly with the OTSP and the Chief Research Officers at each campus. A primary purpose for the creation of these innovation centers was to capture deal flow coming out of the universities and keep the technology in Missouri through development of viable companies. However, the history of innovation center clients derived from university technology has been mixed at best. Over the last five years between FY97 and FY01, the Missouri Innovation Center in Columbia has served ten clients out of MU, Missouri Enterprise in Rolla has served five companies out of UMR, the Center for Emerging Technologies in St. Louis has served only one company out of UMSL, and Brush Creek Enterprise Center in Kansas City has served zero clients as a result of UMKC technologies. As the numbers show, there has been very little deal flow coming out of the university system for the innovation centers to serve, and the innovation centers have had to find the majority of their clientele from elsewhere.

The Columbia campus is in the process of developing another new incubator facility on campus to meet the growing need for such facilities with wet lab space. In addition, the University of Missouri, in conjunction with the Missouri Department of Economic Development and the Missouri Technology Corporation, has recently created a new research park at Fort Leonard Wood to take advantage of our unique relationship with the U.S. Army and foster technological innovation and development. This research park is in addition to the successful Missouri Research Park currently operated by the UM System in St. Charles. The University of Missouri has shown its clear support in recognizing the importance of such facilities in helping university entrepreneurs make the transition into the business world.

In addition to incubators, universities also need to promote technology entrepreneurial development programs that help create a culture of innovation. Each campus should continue to promote interdisciplinary ties among departments and the business schools to focus on high tech industries and entrepreneurial-minded courses.

While a new company may be formed from technology developed by a faculty researcher, more often than not the faculty member will prefer to be a research advisor to a new company formed around the technology as opposed to a principal that will lead the business plan. Unlike Silicon Valley, there is not a list of entrepreneurs in the area that make a living by building up new companies, selling them off, and then going to the next emerging technology. There is a desperate need to match people with bureaucratic and business skills with creative people.

While there may be no current "list" in Missouri, there are perhaps ways to locate and attract such entrepreneurs. One way this could be done is through a conference with a poster session with entrepreneurs to lay out investment opportunities. Activities of the event could be published in a journal for conference (thus protecting the people involved because they can view it as another publication). This event is different from the annual Technology Transfer Showcase because it targets business managers, not venture capitalists. The people you want there looking at posters are the people interested in starting businesses. One way to attract these people is to find anyone in the last four years that has sold a business for over \$1 million, or anyone that has filed an 1120 and showed more than \$100,000 on it. The realities of starting a business should be discussed with participating faculty at the conference.

Another novel approach used at Georgia Tech includes a recent initiative by its Office of Economic Development and Technology Ventures (EDTV) to create a VentureLab. The program will have a network of VentureLab Fellows, experienced technology entrepreneurs who can provide advice, mentoring and guidance in launching a technology company.^{x1} It is extremely

important that faculty researchers can look to successful entrepreneurs who have “been there and done that” and can share their experiences.

Recommendation: **The University of Missouri – Columbia should promptly complete the new incubator and research park in Columbia. This will provide needed wet lab space while utilizing experienced technology business managers and entrepreneurs who can provide advice, mentoring and guidance in launching a technology company with faculty researchers.**

III.12: Capital and Finance

A promising business can have a great product and a good management team, but if it does not have adequate growth capital the business will surely fail. There are several sources of money that an entrepreneur can tap into including banks, angel investors, professionally-managed venture capital firms, state/federal financing programs, and friends and family members. Normally when an entrepreneur starts a business they will rely on the bank (backed by the entrepreneur’s personal collateral) or friends and family for their start-up capital. However, there comes a point when the new enterprise needs additional risk capital in amounts that surpass what is available from the previously mentioned sources. At this time it is imperative that the entrepreneur win the backing of angel investors or a professional venture capital company willing to take a risk in the business.

While we have increased the amount of equity investment available in Missouri, there still exists a critical gap in financing to have sustained deal flow for the life span of emerging technologies into growing businesses. Entrepreneurs in our state have an extremely difficult time finding financing to take a nascent university technology from the lab bench and develop a proof-of-concept or prototype stage of the technology. Angel investors often fill this gap, but angel investors in our state have shied away from these advanced technologies due to the high level of risk during this stage.

According to a DED survey of 32 venture capitalists, seed and early-stage capital is the most urgent need of emerging Missouri companies. Later stage financing is not as critical of a concern, since out-of-state investors primarily fill that gap. Most of the deal flow in Missouri happens in the pre-seed and seed stage, during which time the research and development of product is occurring and a start-up company is formed.

The OTSP is in the process of creating an internal technology development fund (an internal seed fund) for the university to help fill this critical gap in financing for emerging technologies. Royalties received from licensing fees will fund this program, and the OTSP plans to launch a \$100,000 per year program when funds become available. In the meantime, it will look at opportunities on a case-by-case basis and invest in such opportunities as it has the funds to do so. The OTSP’s goal is to eventually increase this fund up to \$1 million for proof-of-concept work at the university. For every grant award recipient of its proof-of-concept fund, Georgia Tech connects the faculty researcher with a business advisor, either from the private sector or a university business school. (STC, 35) This could serve as a great tool in connecting faculty researchers early on with business managers.

The Missouri Venture Capital Roundtable, the Seed Capital Investment Board and the Missouri Technology Corporation are also proposing a \$2 million Pre-Seed Commercialization Fund with support from the General Assembly. While not limited to university inventions, the fund will provide proof-of-concept and prototype funding for early-stage technologies trying to attract seed investment. A portion of this fund will also be used to help fund SBIR Phase 0 awards for entrepreneurs competing for SBIR awards. The OTSP has been involved in creating the structure of these funds.

Recommendation: **The University should identify resources to support an internal technology development fund for the university to help the faculty researcher reduce the invention to practice and support proof of concept activity. This could be used as match to also help augment other sources of funding.**

2. CONCLUSIONS

As regions promote the nurturing of research intensive and technology-based enterprises, universities around the country are taking center stage in economic development. As a result, the technology transfer process has come to the forefront in importance as a critical role for not only universities, but economic development organizations as well. The University of Missouri has shown outstanding leadership and commitment in recent years to position itself for this new reality and play an important role in economic development.

The Office of Technology & Special Projects has elevated this activity at the University, and has made significant and needed investments for the University of Missouri to become a leader in this area. Some performance numbers are already showing improvement since only two years ago when the OTSP was formed. In other cases, these investments over the past couple of years should begin to show a turnaround in performance numbers during the next couple of years.

Through a comprehensive review of the influencing factors in the technology transfer process, this report has hopefully demonstrated how difficult a process this is to undertake. As technology moves through the commercialization process at the University of Missouri, it appears from the numbers that there are two key factors that can increase the flow of activity in the technology transfer process at the University. In the long term, the University should continue its current path to increase the amount of federal research dollars flowing into the system. It takes a lot of money to get even one invention disclosure, so increasing the University's share of federal research dollars in priority disciplines is critically important. In the short term, the University must address the decline in invention disclosures. This, in turn, immediately and negatively affects the numbers for possible patent applications, licensing and option agreements, and start-up companies. Because invention disclosures are lower at the UM System than other universities with comparable research expenditures, there are perhaps more immediate steps that can be taken through processes and policy to address this trend.

The recommendations listed in this report are only meant to serve as a guide for further discussion as technology transfer continues to emerge as a critical piece of economic development strategy for the state. In some cases, they are taken from other university operations that are also producing excellent results, in other cases these recommendations are listed to support changes in policy or processes already underway at the University of Missouri. This emerging shift in focus for universities and economic development agencies will blur the lines of old thought and bring together new partnerships for Missouri to become a place where technology and innovation can flourish.

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- ⁱ Association of University Technology Managers. *Licensing Survey, 1997,1998,1999,2000 data*. Norwalk, CT: Association of University Technology Managers.
- ⁱⁱ Tornatzky, L., Waugaman, P., Gray, D. (2002). *Innovation U: New University Roles in a Knowledge Economy*. Research Triangle Park, N.C.: Southern Growth Policies Board.
- ⁱⁱⁱ Association of University Technology Managers, 2000, *op cit*.
- ^{iv} National Science Foundation – John Hurt: <http://www.nsf.gov/pubs/2002/nsf02060/nsf02060.html>
- ^v All information in this report on the statistics, policies and processes of the University of Missouri system related to technology transfer has been provided by the Office of Technology & Special Projects (OTSP) unless otherwise noted.
- ^{vi} Vaughn, D. (2002). *Status on FY2000 Research Funding at the University of Missouri*, P&B 2002, Report 1. University of Missouri System Office of Planning and Budget.
- ^{vii} Research Division Annual Report. (2001). *University of Missouri – Columbia Summary of Grants and Contracts*.
- ^{viii} Tornatzky, L., Waugaman, P., Gray, D. (2002),pp. 46, *op cit*.
- ^{ix} Tornatzky, L., Waugaman, P., Gray, D. (2002),pp. 107, *op cit*.
- ^x National Science Foundation – John Hurt: <http://www.nsf.gov/pubs/2002/nsf02060/nsf02060.html>
- ^{xi} Tornatzky, L., Waugaman, P., Gray, D. (2002),pp. 82, 107, *op cit*.
- ^{xii} Tornatzky, L., Waugaman, P., Gray, D. (2002),pp. 166, *op cit*.
- ^{xiii} Tornatzky, L., Waugaman, P., Gray, D. (2002), *op cit*.
- ^{xiv} Draft Report (April 9, 2002) University of Missouri System Office of Planning and Budget.
- ^{xv} Rogers, E., Yin, J., Hoffman, J. (2000) *Assessing the Effectiveness of Technology Transfer Offices at U.S. Research Universities*. The Journal of the Association of University Technology Managers, Volume XII.
- ^{xvi} Council on Government Relations (1996). *University Technology Transfer*.
- ^{xvii} Tornatzky, L., Waugaman, P., Gray, D. (2002),pp. 71, *op cit*.
- ^{xviii} Thursby, J., Thursby, M. (2000) *Industry Perspectives on Licensing University Technologies: Sources and Problems*. The Journal of the Association of University Technology Managers, Volume XII
- ^{xix} Tornatzky, L., Waugaman, P., Gray, D. (2002),pp. 48, *op cit*.
- ^{xx} Tornatzky, L., Waugaman, P., Gray, D. (2002),pp. 112, *op cit*.
- ^{xxi} OSPA 2002 Strategic Plan
- ^{xxii} Tornatzky, L., Waugaman, P., Gray, D. (2002),pp. 31, *op cit*.
- ^{xxiii} Tornatzky, L., Waugaman, P., Gray, D. (2002),pp. 82, *op cit*.
- ^{xxiv} Tornatzky, L., Waugaman, P., Gray, D. (2002),pp. 46, *op cit*.
- ^{xxv} Tornatzky, L., Waugaman, P., Gray, D. (2002),pp. 53, 95, 149, *op cit*.
- ^{xxvi} Tornatzky, L.G., Waugaman, P.G., Casson, L., Crowell, S., Spahr, C., Wong, F. *Benchmarking Best Practices for University-Industry Technology Transfer: Working with Start-up Companies*. Research Triangle Park: Southern Technology Council, 1995.
- ^{xxvii} Tornatzky, L., Waugaman, P., Gray, D. (2002),pp. 47, *op cit*.
- ^{xxviii} Tornatzky, L., Waugaman, P., Gray, D. (2002),pp. 125, *op cit*.
- ^{xxix} Tornatzky, L., Waugaman, P., Gray, D. (2002),pp. 56, *op cit*.
- ^{xxx} Tornatzky, L., Waugaman, P., Gray, D. (2002),pp. 140, *op cit*.
- ^{xxxi} Tornatzky, L., Waugaman, P., Gray, D. (2002),pp. 89, *op cit*.
- ^{xxxii} Tornatzky, L., Waugaman, P., Gray, D. (2002),pp. 121, 66, *op cit*.
- ^{xxxiii} Tornatzky, L., Waugaman, P., Gray, D. (2002),pp. 53, *op cit*.
- ^{xxxiv} Tornatzky, L., Waugaman, P., Gray, D. (2002),pp. 56, *op cit*.
- ^{xxxv} Tornatzky, L., Waugaman, P., Gray, D. (2002),pp. 112, *op cit*.
- ^{xxxvi} Tornatzky, L., Waugaman, P., Gray, D. (2002),pp. 33, *op cit*.
- ^{xxxvii} Tornatzky, L., Waugaman, P., Gray, D. (2002),pp. 82, *op cit*.
- ^{xxxviii} Tornatzky, L., Waugaman, P., Gray, D. (2002),pp. 120, *op cit*.
- ^{xxxix} Tornatzky, L., Waugaman, P., Gray, D. (2002),pp. 109, *op cit*.
- ^{xl} Tornatzky, L., Waugaman, P., Gray, D. (2002),pp. 33, *op cit*.