Technology Transfer at the University of Chicago

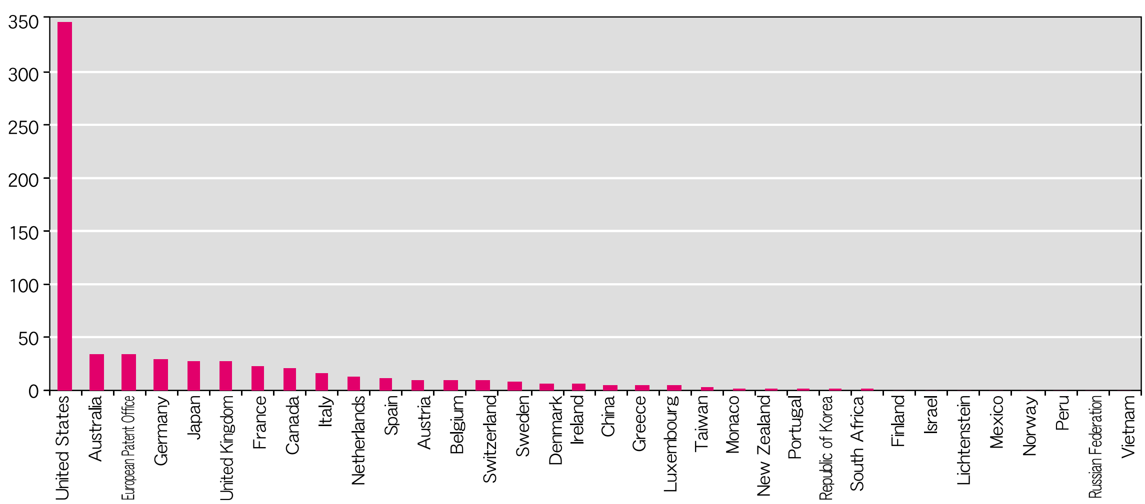
技術の移転と活用の現状

Senior Project Manager,
University of Chicago Office of Technology & Intellectual Property
Dr. Eric Ginsburg

The University of Chicago, a private university located on the south side of the city of Chicago, was founded in 1890 by John D. Rockefeller, who also founded Standard Oil Corporation. It is now a famous research institution consisting of about 2,000 faculty (including six Nobel laureates) and 13,000 students. It is less well known that the University currently owns approximately 350 issued US patents, over two hundred patents from European countries, 28 issued Japanese patents (plus about 65 pending Japanese applications), and over 60 more from a dozen other countries (See Figure 1). All of these inventions were invented by University faculty, staff, or students and are managed by the University's Office of Technology & Intellectual Property.

Patents were obtained on inventions made by University of Chicago faculty as early as the 1930's. However, these older patents were owned and administered by the United States governmental agencies that funded the work. Before 1980, the government had no easy process to commercialize inventions from research it funded at universities. In 1980, the efforts of administrators from several American universities, most prominently the University of Wisconsin - Madison, resulted in the passage of the Bayh-Dole Act. This United

Figure 1. Number of issued, unexpired University of Chicago patents, by country, as of 2005. [1]



1) Informal discussions with colleagues at other U.S. universities indicate their filing patterns are similar.

States law was sponsored by Senators Birch Bayh (Democrat from Indiana) and Robert Dole (Republican from Kansas). The new law made universities, rather than the federal government, the default owner of patentable inventions developed by their researchers. It also encouraged universities to commercialize these inventions, and required them to share revenue from commercialization with the inventors.

After the Bayh-Dole Act was passed, patenting activity at the University of Chicago and many other universities in the country greatly increased. Most universities started some sort of technology transfer organization during the 1980's or 1990's. There are ongoing debates about how much the change in the law itself caused the increase in patenting.[2,3,4] Whatever the cause, the increase is large. The number of patents filed by universities increased by a factor of four from 1981 to 1991.[5] The University of Chicago created a non-profit, wholly-owned affiliate in 1987, named ARCH Development Corporation, to manage its intellectual property and to help form startup companies. The name had a double meaning. First, it represented the idea of an "arch" connecting the academic world to the commercial world. In addition, the letters in "ARCH" stood for "Argonne National Laboratory" and "Chicago". Argonne National Laboratory is a national research facility near Chicago. It employs about 1,000 scientists and engineers who carry out a wide range of basic and applied research. Argonne is operated by the University of Chicago for the U.S. Department of Energy's Office of Science. ARCH Development managed intellectual property from both Argonne and the University of Chicago from 1987 to 2000, when a separate technology transfer office was created at Argonne.

The placement of the technology transfer organization in a wholly-owned affiliate, such as ARCH Development, rather than in the University directly, is a model that many United States universities are using or have used in the past. The University of Wisconsin - Madison started the practice by creating the Wisconsin Alumni Research Foundation in 1925 to commercialize the process of enriching foods with Vitamin D.[6] In general, this organizational structure gives the technology transfer office more freedom and flexibility in administrative, financial and employment policies. Other universities that use similar models include the University of Virginia and Arizona State University.

In 2001, however, the licensing function of ARCH was pulled directly into the University itself, and named the Office of Technology & Intellectual Property (also called "UCTech"). Cornell University and others

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2)See for example, a review of the book, "Ivory Tower and Industrial Innovation: University-Industry Technology Transfer Before and After the Bayh-Dole Act.": http://www.historycooperative.org/cgi-bin/justtop.cgi?act=justtop&url=http://www.historycooperative.org/journals/heq/45.2/br_9.html

3)University Licensing under Bayh-Dole: What are the Issues and Evidence? Jerry G. Thursby and Marie C. Thursby: opensource.mit.edu/papers/Thursby.pdf.

4)Similar developments are being observed now in the People's Republic of China. "Rapid Patenting Growth By Academic Institutes in the People's Republic of China," Simon M. Pratt. http://scientific.thomson.com/news/newsletter/2005-06/8279852/

5)University Technology Transfer -- Questions and Answers, University of California Office of Technology Transfer: http://www.ucop.edu/ott/tech.html#2

6)Steenbock and WARF's Founding, Wisconsin Alumni Research Foundation: http://www.warf.ws/about/index.jsp?cid=26&scid=33

have also recently changed their organizational structure from separate affiliates to internal offices. There is evidently a balance between the freedom and flexibility of a separate affiliate and the amount of control a university can have over an internal office. These pressures have led to oscillations in organizational structures over time.

In some cases, in addition to managing and licensing intellectual property, wholly-owned affiliates are sources of funding for startup companies based on university intellectual property. This was one goal of ARCH Development Corporation when it was formed. Twice during its history, however, the decision was made that the funding organization should be spun out of the office and made completely independent, for-profit venture capital firms. ARCH Venture Partners, now a venture capital firm managing over one billion dollars, was formed as an independent entity in 1991. ARCH Development Partners, a venture capital firm specializing in early stage companies in the Midwest U.S., was started in 2001 at the same time that the UCTech office was formed within the University itself.

Why do Technology Transfer?

Louis Berneman, the former head of the University of Pennsylvania technology transfer organization, has listed the five primary reasons for a university to pursue technology transfer. These reasons, shown below, help to frame how technology transfer organizations work and how they are organized. These are:

* Recruit and retain faculty.
* Disseminate the results of university research.
* Increase ties between the university and industry.
* Promote local economic development.
* Make money.

It is important to note that their relative importance can be different at different institutions. Also, at any one time, these five goals are all in tension with one another. For example, prioritizing the recruitment and retention of faculty can lead to setting a low barrier to filing patent applications on faculty inventions. Inventors often want the prestige of being listed on a patent, even if the issued patent claims are too narrow to be valuable commercially. On the other hand, if making money is the key reason for a university to do technology transfer, then it will be much more selective in filing patent applications, possibly not filing on inventions where the market is more uncertain. This may make the university technology transfer office healthier financially, but the university as a whole may have less satisfied faculty members.

Similarly, the dissemination of results and the pursuit of profit can be in direct conflict. On the one hand, the university must file a patent on certain types of technology for them to be commercialized. For example, a new pharmaceutical chemical compound will not make it to market unless a company has patent protection to justify the huge expense of clinical trials. But many basic research tools will be used as soon as their discovery is published, whether or not a patent is filed. Some have argued that patenting and nonexclusively licensing basic research tools is just a mechanism to make money and slow the spread of basic knowledge. In fact, the U.S. National Institutes of Health (NIH), who fund most biomedical research in the U.S., have published guidelines on patenting research tools to make sure that the results of NIH-funded research are widely shared.[7] It is interesting to note, however, that one of the most financially successful patents in the history of United States academic technology transfer was a patent on a basic research tool. US 4,237,224 (known as the "Cohen-Boyer patent"), filed by Stanford University, claimed recombinant DNA cloning. Stanford executed over 400 nonexclusive licenses to the patent, and raised over $300 million for the university before the patent expired.[8]

As another example, local economic development can be a high priority for universities in regions suffering from high unemployment. This is especially true for public universities that receive funding from their state government.[9] This could influence whether a technology is licensed to a local startup company with fewer resources to commercialize a technology, rather than a different licensee with more resources located in a different state.

In summary, these different purposes of an academic technology transfer office must be balanced and prioritized. Priorities will vary across different institutions. They depend on factors such as geography, the local economy, whether the institution is public or private, and the general level of entrepreneurial spirit among the faculty and administrators.

Invention and Patenting Assessment

There are also more specific factors that come into play when faculty members submit their inventions to an office. First, individual faculty members submit their inventions for very different reasons. At one extreme, some professors are philosophically opposed to patenting any inventions, and may only submit their inventions because they are contractually obligated to. At the other extreme, there are very entrepreneurial faculty who wish to play a large role in starting a company to commercialize their work. These faculty members view patents as forming a cornerstone of their company.

In addition to considering the inventor's interests, an assessment process is carried out that takes into account the specifics of the invention. At the most basic level, the question that needs to be answered is whether there is a reasonable likelihood that the costs incurred in filing a patent will ever be recovered through licensing. Obviously, the more funding (either from licensing past inventions, or allocations from the general university budget) a technology transfer office has, the more risks it can take. Using a variety of sources, the person assigned to the case judges the potential market for the invention, looks for potential dominating patents, and evaluates the patentability of the invention.

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7) Principles and Guidelines for Recipients of NIH Research Grants and Contracts on Obtaining and Disseminating Biomedical Research Resources: Final Notice: http://ott.od.nih.gov/RTguide_final.html

8) Bertram Rowland and the Cohen/Boyer Cloning Patent: http://www.law.gwu.edu/Academics/Academic+Focus+Areas/IP+and+Technology+Law/Alumni+Patents/Bertram+Rowland+and+the+Cohen+Boyer+Cloning+Patent.htm

9) All four-year public universities in the United States, except for the military academies run by the federal government, are run by the individual states.

The wide variety of inventions submitted to the office make the assessment process challenging. Also, since the University of Chicago has neither an engineering department, nor a medicinal chemistry department, many of the inventions are at a very early stage in their development. The majority of the inventions are from the University's Biological Sciences Division (BSD). About 70% of the patents issued to the University in 2004 and 2005 were from the BSD (See Table 1). Typical inventions from the BSD faculty members include the identification of genetic pathways in humans that may be pharmaceutical targets, genetic pathways in microorganisms that may be antiinfectives targets, methods for determining treatments based on a patient's genetics (pharmacogenomics), surgical devices, and medical imaging techniques. Most of the other inventions the office receives are from the physical sciences departments. These have included optical trapping technology, improved microfluidics techniques, coating techniques, methods of organic synthesis, and methods of synthesizing nanomaterials.

The office decides to file patent applications on approximately half of the inventions it receives. There are several reasons that we do not file on the remaining half. Frequently, we find very relevant prior art that the professors are unaware of because it has not been published in a major journal in their field. Even if no relevant art is found, other inventions would serve too small a market to justify the cost of patenting. Some inventions, such as certain methods of manufacturing or computer algorithms, are not patented as it would be too difficult to detect infringement, making licensing or enforcement unlikely. In other cases, the research leading to the invention was sponsored by a company. Or sometimes using the invention requires a technology, such as a drug, that is covered by one company's patents. In these cases, before we file an application, we try to determine whether the sponsor of the research, or the owner of the dominating patent, would want to license the application. Finally, there are certain submissions that we choose to protect through copyright or trademark only.

In the majority of cases, when the University does choose to file a patent application, only a United States patent is pursued. In many cases, foreign rights have been lost due to a publication or presentation by the inventors. This is not a problem in the United States, due to the one year grace period provided by U.S. patent law. Also, if a patent is not licensed, our office must strongly believe that it will be licensed soon in order to justify the additional costs of foreign patents. If foreign rights have not been lost through advance publication, we frequently file a PCT application one year after our priority date. The PCT application costs approximately $2,000 to $3,000 dollars. The decision whether or not to nationalize is then made before the 30 month deadline. The cost of nationalizing varies, depending on local fees and whether or not a translation is required, but it can cost as much as $10,000 for each country chosen. This accounts for the relatively small fraction of non-U.S. patents shown in Figure 1. The office can only afford to nationalize inventions that have been licensed, or which have a very high likelihood of being licensed in the future.

Licensing

Our office does not file patents for purely defensive purposes, to prevent anyone else from using a technology. Instead, we work to license them to commercial partners who will bring the technology to market. In some cases, however, if the technology will be disseminated quickly through academic publications, and will be used by companies for commercial profit, we will try to nonexclusively license the patent. The goal in these

Table 1. University of Chicago US Patents issued in 2004 and 2005.

Patent Number	Patent Title
6,937,776	Method, System, and Computer Program Product for Computer-Aided Detection of Nodules with Three Dimensional Shape Enhancement Filters
6,916,610	Method for Generation of Longer cDNA Fragments from SAGE Tags for Gene Identification
6,911,532	Vertebrate Apoptosis Gene: Compositions and Methods
6,900,012	Plant Artificial Chromosome Compositions and Methods
6,901,156	Method, System and Computer Readable Medium for an Intelligent Search Workstation for Computer Assisted Interpretation of Medical Images
6,898,303	Method, System and Computer Readable Medium for the Two-Dimensional and Three-Dimensional Detection of Lesions in Computed Tomography Scans
6,891,964	Computerized Method for Determination of the Likelihood of Malignancy for Pulmonary Nodules on Low-Dose CT
6,870,037	Methylthioadenosine Phosphorylase Compositions and Methods of Use in the Diagnosis and Treatment of Proliferative Disorders
6,863,406	Apparatus and Method for Fabricating, Sorting, and Integrating materials with Holographic optical Traps
6,858,391	NOD2 Nucleic Acids And Proteins
6,858,833	Use of Multiple Optical Vortices for Pumping, Mixing and Sorting
6,855,114	Automated Method and System for the Detection of Abnormalities in Sonographic Images
6,846,084	Apparatus for Using Optical Tweezers to Manipulate Materials
6,847,032	Optical Peristaltic Pumping With Optical Traps
6,846,670	Genetically Engineered Herpes for the Treatment of Cardiovascular Disease
6,836,558	Method, System and Computer Readable Medium for Identifying Chest Radiographs Using Image Mapping and Template Matching Techniques
6,819,790	Massive Training Artificial Neural Network (MTANN) for Detecting Abnormalities in Medical Images
6,813,375	Automated Method and System for the Delineation of the Chest Wall in Computed Tomography Scans for the Assessment of Pleural Disease
6,804,628	System for Surveillance of Spectral Signals
6,797,942	Apparatus and Process for the Lateral Deflection and Separation of Flowing Particles By a Static Array of Optical Tweezers
6,764,768	Controlled Release Compositions
6,754,380	Method of Training Massive Training Artificial Neural Networks (MTANN) for the Detection of Abnormalities in Medical Images
6,737,634	Use of Multiple Optical Vortices for Pumping, Mixing and Sorting
6,738,499	System for Detection of Malignancy in Pulmonary Nodules
6,734,289	Gastrokines and Derived Peptides Including Inhibitors
6,724,925	Method and System for the Automated Delineation of Lung Regions and Costophrenic Angles in Chest Radiographs
6,716,422	Vaccine Adjuvants for Immunotherapy of Melanoma
6,696,484	Methods and Compositions for Regulation of 5 Alpha-Reductase Activity
6,694,046	Automated Computerized Scheme for Distinction Between Benign and Malignant Solitary Pulmonary Nodules on Chest Images
6,683,973	Process, System and Computer Readable Medium for Pulmonary Nodule Detection Using Multiple-Templates Matching
6,676,263	Performance Improvements of Symmetry-Breaking Reflector Structures in Non-Imaging Devices
6,678,399	Novel Subtraction Technique for Computerized Detection of Small Lung Nodules in Computer Tomography Images

cases is to bring in revenue for the University, as Stanford University did with the Cohen-Boyer patent, but not to slow the spread of the invention.

We work to identify licensees by contacting employees from relevant companies. However studies across many universities have shown that the inventors themselves are frequently in the best position to identify potential licensees.[10] Often, they are already in contact with industrial researchers in their field, or they are customers of the relevant companies. Either way, when a company does express interest in a license, a negotiation process starts. Frequently, the nonfinancial aspects of a license are more difficult to negotiate than the monetary terms. Non-profit universities have different priorities than for-profit companies, and these need to be worked out during the negotiation process. According to the data in the most recent AUTM survey,[11] in fiscal year 2004 total licensing income for all United States universities was only 2.6% of the total amount of their research expenditures. In fact, only five universities out of 150 surveyed earned more than 10% of their research expenditures from licensing in 2004. In other words, commercialization of university inventions is typically not a large source of revenue for universities. It can, however, be a risky business. This is especially true since, unlike a company, a university has very little control over the activities of its researchers. Therefore universities insist on licensing terms that protect the university as a whole. For instance, they require that licensees indemnify the university, and that the licensee's liability insurance cover the university, so that universities are protected from lawsuits directed against the company. In addition, unlike industrial licensors, academic licensors will typically, as a matter of policy, offer little or no warranties regarding the quality of the technology or the ability of the licensee to practice the technology without being sued by others for patent infringement. The result of transferring these obligations to the licensee is that the licensee generally pays less than it would if licensing from an industrial partner.

In addition, to make sure university technology gets into the marketplace, the license agreement will also contain diligence terms, requiring that if a product is not commercialized by a certain date, the license will terminate. This is especially true of exclusive licensees. Finally, universities' patent licenses frequently require that the licensee reimburse the university for the amount it spends obtaining patents. For example, in fiscal year 2004, the University of Chicago spent $2.5 million on obtaining patents, and was reimbursed $1.8 million. (The remaining unreimbursed costs came out of the office's total revenue of $8.8 million[12]).

Success stories

As described above, universities do not file patent applications just to frame them and hang them on the wall. One specific example of successful technology commercialization from the University of Chicago

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10)Where do the Leads for Licenses come from? Source Data from Six Institutions, Christina Jansen & Harrison F. Dillon, The Journal of the Association of University Technology Managers, Volume XI (1999). http://www.autm.net/pubs/journal/99/leads.cfm.

11)AUTM U.S. Licensing SurveyTM: FY 2004.

12)At the University of Chicago, 45% of revenues are divided between the inventors personally, their laboratories and their departments. The remaining 55% is used to support office operations.

came from the Department of Radiology. A group of medical physicists in the Department has been working since the 1980's to train computers to analyze medical images in the same way that radiologists do.[13,14] Studies have shown that radiologists examining x-ray images for lung cancer or breast cancer miss a substantial fraction of actual cancers. University of Chicago software acts as a "spell-checker" for radiologists, significantly lowering the number of missed cancers. The University of Chicago licensed both software and patents to R2 Technology in the mid-1990's, and the company first received regulatory approval to sell a product, the ImageChecker®, for analysis of x-ray mammography images, in the United States in 1998. (The ImageChecker was approved for use in Japan in 2000.) Currently, a significant fraction of all screening mammographic images obtained in the U.S. get a second read (the origin of the name, "R2") from an R2 product. Since cancer is more treatable when detected earlier, many lives have been saved. More recently, R2 has also received approval to sell a product to detect lung cancer in CT images of the chest. In Japan, Mitsubishi Space Software[15] offers a product, Truedia/XR, also based on technology from the Department of Radiology,[16] that highlights differences between two chest x-rays taken of a patient at different times. Such changes can result from the growth of a cancerous tumor in the lungs.

Another company is also using different licensed technology to provide early warning of potential problems. The technology, called the "multivariate state estimation technique" (MSET), was developed at Argonne National Laboratories and was originally developed to monitor nuclear power plant cooling systems.[17] MSET has been commercialized and expanded by SmartSignal, Inc., a startup company near Chicago. The software monitors data from multiple sensors on a complex system and, in a training phase, models each sensor's data as a function of all the other sensors. During a subsequent monitoring phase, the software compares the actual data from the system to the model and alerts an operator when the system deviates from the model. The technology is much more sensitive than competitive technologies. Many power companies now use the software to monitor generators, and two major U.S. airlines are using the software to alert them to potential problems with their jet engines long before the problems cause flight schedule disruptions.

Another interesting local startup company is Arryx, Inc., which makes equipment for manipulating microscopic objects with light. A physics professor at the University of Chicago developed a method for independently steering large numbers of laser beams, each of which create an optical "trap" (or "tweezer") that is capable of holding a particle or a part of a larger object.[18] Arryx has built a commercial version, called the Bioryx 200, which works with a microscope to manipulate hundreds of microscopic objects independently and simultaneously. Researchers at several institutions have purchased a Bioryx and are now using the instrument to fabricate new materials and to study living cells.

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13)Kurt Rossmann Laboratories for Radiologic Image Research: http://www-radiology.uchicago.edu/krl/.

14)See US Patent 4,907,156, for example.

15)Mitsubishi Space Software Co., Ltd.: http://www.mss.co.jp/businesfield/healthcare/index.html

16)"Current Status and Future Potential of Computer-Aided Diagnosis in Medical Imaging", British Journal of Radiology (2005) 78, 3-19, Doi, K.

17)See US 5,764,509, for example.

18)See US 6,055,106 for example.

A University of Chicago invention on the verge of being a success is methylnaltrexone, a drug being studied for the treatment of the side effects of opioids. The drug is in the last phase of clinical trials in the United States. The drug was invented in 1979 by a University of Chicago pharmacologist who wanted to help a friend with cancer who suffered from the side effects of morphine. The side effects of morphine can be so severe that many patients refuse to take it. Wyeth and Progenics[19] currently have the rights to commercialize the drug and, if all goes well, may receive approval to sell methylnaltrexone in 2006.

Interestingly, the license that brings in the largest revenue for the University of Chicago is based only on copyright, not patents. "Everyday Mathematics" is an elementary school (ages 4-12) mathematics curriculum developed by researchers in the University of Chicago School Mathematics Project, starting in 1983. The curriculum was first published by a startup company, founded with the assistance of ARCH Development. This company was later purchased by a large publisher.[20] Everyday Mathematics workbooks and textbooks are currently used by an estimated 3.5 to 4 million students throughout the country.[21]

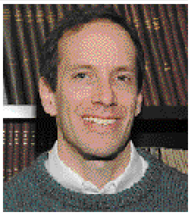
Summary

In summary, technology transfer requires balancing many competing priorities. At the University of Chicago, technology transfer is a vibrant, evolving activity that has led to many successfully commercialized products. Several more will move from the academic world to the commercial world in the next few years. As a result, for the employees in the Office of Technology and Intellectual Property, the work is diverse, challenging and rewarding.

profile

Eric Ginsburg

PhD, Chemistry, California Institute of Technology.
Ten years experience in industrial research and development.
Joined the University of Chicago in 2001.
Currently Senior Project Manager, University of Chicago Office of Technology & Intellectual Property.



19)http://www.progenics.com/Products/MNTX/MNTX.htm

20)http://www.wrightgroup.com/index.php/programlanding?isbn=L000000004

21)There are over 30 million students in elementary school in the United States. Textbooks are usually chosen at the level of the school district in the United States, and there are over 10,000 school districts in the country.