HISTORICAL PERSPECTIVE

Frederick Cottrell in the 1912 *Journal of Industrial and Engineering Chemistry*: Laying the Foundations of University Technology Transfer

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This paper discusses a discourse by Frederick Cottrell in the 1912 *Journal of Industrial and Engineering Chemistry*, which analyzed the formation of the Research Corporation, an organization that was in many ways a forerunner of the modern university technology transfer offices of today. The Research Corporation and university technology transfer offices present contrasting methods of encouraging university science; however, both encounter problems that have attracted significant academic comment. The impact of the Research Corporation decreased with the passing of the 1980 Bayh−Dole Act, a piece of legislation that encouraged technology transfer from within U.S. universities, a direction that Cottrell had deliberately eschewed 68 years previously. The Bayh−Dole Act has influenced university technology transfer protocols across the world; however, many believe that the conflicts first described by Cottrell detrimentally affect the culture and norms of academic research today. This paper first explores the historical context of Cottrell's initial thesis, second analyzes the Bayh−Dole Act, the decline of the Research Corporation, and the rise of the university technology transfer offices, third reviews the literature concerning the intrinsic barriers to university technology transfer, and finally proposes that the intrinsic barriers will lessen as universities continue to evolve toward a more commercial approach to a difficult societal role.

Introduction

This paper reflects upon a discourse by Frederick Cottrell in the 1912 *Journal of Industrial and Engineering Chemistry*.[1] His discourse analyzed the formation of the Research Corporation, an institution devoted to philanthropy in science. Dr. Cottrell, Professor of Chemistry at the University of California,[2] wanted to use university patents and the related intellectual property produced to further academic research. He initially considered using the university as a licensing forum but felt "the possibility of growing commercialism and competition between institutions and accompanying tendency for secrecy in scientific work"[3] would impinge on his goals. To avoid conflicting interests, the Research Corporation was set up as a fully autonomous institution and was in many ways a forerunner of the modern semiautonomous university technology transfer offices that represent university intellectual property interests today. The Research Corporation and university technology transfer offices present contrasting methods of encouraging university "blue-sky"[4] and commercial science; however, both encounter intrinsic problems that have attracted significant academic comment. The impact of the Research Corporation[5] decreased with the passing of the 1950 National Science Foundation Act[6] and the 1980 Bayh−Dole Act,[7] a piece of legislation that encouraged technology transfer from within U.S. universities,[8] a direction that Cottrell had deliberately eschewed 68 years previously. The Bayh−Dole Act was subsequently described in *The Economist* at the close of 2002 as "possibly the most inspired piece of legislation to be enacted in America over the past half-century."[9] The Bayh−Dole Act has influenced university technology transfer protocols across the world; however, many believe that the conflicts first described by Cottrell detrimentally affect the culture and norms of academic research today.[10] This paper first explores the historical context of Cottrell's initial thesis, second analyzes the Bayh−Dole Act, the decline of the Research Corporation, and the rise of the university technology transfer offices, third reviews the literature concerning the intrinsic barriers to university technology transfer, and finally proposes that the intrinsic barriers will lessen as universities continue to evolve toward a more commercial approach to a difficult societal role.

Note: It is appreciated that the *Industrial and Engineering Chemistry Research* journal has progressed since 1912 and this paper does not align fully with "regular" papers; however, the issues explored in this piece influence chemists in both the public and private sectors. The author believes it to be appropriate and timely that a review should appear in the journal that Dr. Cottrell deemed to be suitable for his landmark piece 92 years ago.

"If nature has made any one thing less susceptible than all others of exclusive property, it is the action of

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the thinking power called an idea, which an individual may exclusively possess as long as he keeps it to himself; but the moment it is divulged, it forces itself into the possession of everyone, and the receiver cannot dispossess himself of it. Its peculiar character, too, is that no one possesses the (idea) less, because every other possesses the whole of it. He who receives an idea from me receives instruction himself without lessening mine; as he who lights his taper at mine, receives light without darkening me... Inventions then cannot, in nature, be a subject of property."[11]

Introduction: Historical Background

The industrial revolution, roughly dating from 1760 to 1830, made little use of the growing corpus of scientific knowledge; the mid-19th century, however, saw a new trend, whereby increasingly technology advanced through the application of science. This progression was facilitated by a number of approaches ranging from academic scientists pursuing knowledge for its own sake through "blue-sky" research and academics focusing purely on targeted or commercial research.[12] Through much of the 1900−1940 period,[13] U.S. universities, especially public universities, pursued extensive research collaboration with industry; this trend was identified by Dr. Cottrell in his 1912 paper in *Journal of Industrial and Engineering Chemistry Research*:

"During the last few years, the rapid growth of engineering and technical education, coupled with a general awakening to the commercial importance of research in the industries, has brought about a persistent demand the world over for closer and more effective cooperation between the universities and technical schools on the one hand and the actual industrial plants on the other. The value to both sides from such an operation is today generally conceded, but as to the most expedient methods of its accomplishment opinions differ, and we are still in the experimental stage of working out the problems."[14]

As a professor of physical chemistry at the University of California, Dr. Cottrell invented the electrostatic precipitator, a device which could collect fly ash, dust and fumes, acid mists, and fogs that belched from turn-of-the-century plants. The electrostatic precipitator became a primary means for controlling industrial air pollution. Dr. Cottrell, at the age of 34, resolved that science would be the principal beneficiary of his invention, the first patent, No. 895,729, was issued on August 11, 1908. The patent, now long expired, produced a more important and long-lasting effect: the Research Corporation. Established in New York State in 1912, its original objectives were to develop donated inventions and to use any income from the original electrostatic precipitator invention for grants to perform scholarly research. The Research Corporation subsequently served for many years as a leading broker and licenser of university inventions for many U.S. universities:

"The Research Corporation was primarily intended to serve the ever growing number of men in academic positions who evolve useful and patentable inventions from time to time in connection with their regular work and without looking personally for any financial reward would gladly see these further developed for the public good, but are disinclined either to under take such developments themselves or to place the control in the hands of any private interest."[15]

The Second World War transformed the role of U.S. universities as research performers, as well as the sources of their research funding. The role of academia as an engine for research-led economic growth was highlighted in the report "Science: The Endless Frontier" written by Vannevar Bush in response to a request that President Franklin Delano Roosevelt put in a letter in 1944 for a report on how the federal government might promote scientific progress in the postwar era. The response from Vannevar was that the nation's health, economy, and military security constantly required the deployment of new scientific knowledge, that the federal government was obligated to ensure basic scientific progress and the production of trained scientific manpower, and that a new federal agency, the National Research Foundation, should be established with the funds and authority to promote these purposes.[16] This approach met with success in many fields; however, a pertinent success is identified by the development of the academic discipline of chemical engineering through collaborations between U.S. petroleum firms, chemical firms, MIT and the University of Illinois.[17]

The Decline of the Research Corporation

"The idea...was not merely to produce revenue for scientific research but to act as a sort of laboratory of patent economics and to conduct an experiment in patent administration. It was not entirely easy to win the first board of directors to a full appreciation of the relative importance of this second object of the project... namely, that in the end the more important thing might prove to be that they were aiding in a laboratory experiment in the public administration of patents."[18]

In 1946, the Research Corporation was a prominent body within the area of funding basic research at universities because it was one of the few sources for such funds. With the establishment of the National Science Foundation and funding from other governmental agencies and private companies, a more realistic role for the Research Corporation was to start young investigators in their research careers and to help established investigators enter new areas. This marked a decline in the Research Corporation's influence in the university funding field. The Research Corporation in 1982 was beset with significant financial problems because the foundation's technology transfer program was operating at a significant loss, and compounding the financial problems was a dispute with the Internal Revenue Service over tax exemptions. Today, modest funding[19] is directed to faculty at graduate institutions (Research Innovation Awards, Cottrell Scholar Awards, Research Opportunity Awards) and undergraduate institutions (Cottrell College Science Awards).[20]

The Bayh−Dole Act and the Rise of the University Technology Transfer Offices

"The linkage between scientific discovery and the delivery of practical results technology is vital to the wealth of individuals and to the wealth of the businesses and nations. Technology is said to account for half of the economic growth of developed countries."[21]

In the 1970s, some 80% of university research funding was provided by federal agencies; however, despite the vast portfolios of discoveries, there was little technology transfer from the public to the private sector. In 1980,

the federal government held title to approximately 28 000 patents, but fewer than 5% of these were licensed to industry for the development of commercial products. This was in part due to the reluctance of the government to relinquish ownership of federally funded inventions to the inventing university institution. Instead, the government retained title and made the inventions available through nonexclusive licenses to anyone who wanted to use the patents. Not granting exclusive rights made many firms reluctant to invest in new products if competitors could also obtain licenses. The flaws inherent within this approach had already been outlined in 1912 by Cottrell:

"A procedure adopted by many men in academic and public positions in an attempt to bring various inventions before the public and at the same time prevent private monopoly has been to secure patents as a matter of record and then throw them open gratis...this does not accomplish all that had been hoped for it: A certain minimum amount of protection is usually felt necessary to put a new invention on the market.... because 'what is every bodies business is nobodies business'."[22]

In 1980, Congress concluded that the public would benefit from a policy that permitted universities to own federally funded patented inventions and become directly involved in the commercialization process through the provision of semiautonomous university technology transfer offices. The aim was that the U.S. economy would be stimulated through the licensing of new inventions from U.S. universities to U.S. industry. The result was the Bayh−Dole Act of 1980, an act clearly driven by economics rather than science, with the U.S. government aiming to "promote economic growth by subsidizing research and development expenditures."[23] The U.S. government wanted a return on federal money used for academic, publicly funded research, and over time this need became more important as intellectual creation through research and development became increasingly costly. As early as 1988, the United States, Japan, West Germany, Great Britain, and France were spending a total of approximately $630 million on research and development per day. In 1993, the total daily research and development expenditure in the large industrial western economies had grown to approximately $1 billion;[24] a significant portion of this money was spent in university institutions.

The Rise of the University Technology Transfer Offices

Technology transfer offices have increased in importance because of the funding issues and the predescribed governmental legislation. A recent legal case held may further increase the university technology transfer offices both in the U.S. and on a larger international scale.

Madey versus Duke University.[25] In the mid-1980s, Madey was a tenured research professor at Stanford University; he had an innovative laser research program, which was highly regarded in the scientific community.[26] In 1988, Madey left Stanford University to assume a position as professor in Duke University's physics department.[27] Duke University subsequently built an addition to its physics building in order to accommodate Madey's laboratory.[28] Madey worked at Duke University for nearly a decade but resigned in 1998 after being removed as the laboratory director.[29] Duke University continued to use some of the laboratory equipment, including the equipment embodying Madey's patents. Because of this unauthorized use of Madey's patents, Madey sued Duke University for patent infringement.[30] Duke University defended on the grounds that the work was the subject of government licenses[31] and that it was protected by the experimental use exception.[32] The District Court held that "the defense was viable for experimental, nonprofit purposes" and placed the burden on Madey to "establish that [Duke's] use of the patent had 'definite, cognizable, and not insubstantial commercial purposes'."[33] The holding relied upon Duke's patent policy, which states that Duke is "dedicated to teaching, research, and the expansion of knowledge ... [and] does not undertake research or development work principally for the purpose of developing patents and commercial applications."[34] The court found that these statements refuted any contention that Duke University was in the business of developing technology for commercial applications.[35]

Madey subsequently appealed to the Court of Appeals for the Federal Circuit, which held that the district court had applied an overly broad version of the experimental use defense and remanded for application of the narrower version set out in its opinion. The Court of Appeals for the Federal Circuit further held that no "conduct that is in keeping with the alleged infringer's legitimate business, regardless of commercial implications" is immunized from a claim of patent infringement.[36] It went on to state that the sanctioning and funding of research projects with arguably no commercial application whatsoever by institutions such as Duke University "unmistakably further the institution's business objectives, including educating and enlightening students and faculty participating in these projects."[37] In the view of the Court of Appeals for the Federal Circuit, "the district court attached too great a weight to the non-profit, educational status of Duke."[38]

In this holding, the Court shifted the focus of the experimental use defense from the commercial versus noncommercial nature of the experimentation and the profit versus nonprofit status of the alleged infringer to merely a question of whether the use was in furtherance of the alleged infringer's legitimate business.[39] The profit or nonprofit status of the user is no longer determinative in the U.S. The court noted that even projects undertaken without direct commercial application often "unmistakably further the institutes legitimate business interests ... These projects also serve for example to increase the status of the institution and lure lucrative research grants, students and faculty."[40] To determine whether the experimental use exemption applies, the courts must consider not simply the legitimate business of the alleged infringer but the specific uses to which the patented inventions at issue were put. The courts may look to whether the funding grant proposal described an intended commercial use or whether the infringing research resulted in the filing of additional new patents. "As a practical matter, due to most research funding requirements for development of commercial applications for a technology, such as for federal funding under the Bayh−Dole Act,[41] the vast majority of university conducted research will not be exempt from infringement liability as an experimental use."[42]

The Association of American Medical Colleges, the American Council on Education, various individual

colleges, universities and medical schools, and several other organizations argued in a petition for *certiorari*[43] set out in an *Amicus curiae*[44] brief in June 2003 that the Court of Appeals for the Federal Circuit decision is in contrast to the historical exemption that nonprofit educational institutions enjoyed when their research was noncommercial.[45] They claim that "in determining the type of 'experimental use' entitled to exemption, courts historically drew the line between commercial and noncommercial research."[46] In their *Amici Curiae* brief in support of Duke, these various organizations cite a study "based upon 70 interviews with personnel at biotechnology and pharmaceutical firms and universities" that confirms that "university researchers, to the extent that they are doing non-commercial work, are largely left alone" and that in those rare instances when universities received letters alleging infringement "the typical response was effectively to ignore such letters and inform the [patent] holder that the university was engaged in research, did not intend to threaten the firm's commercial interests, and would not cease its research."[47]

The *Amicus curiae* also argued that the Court of Appeals for the Federal Circuit decision "effectively eliminate[s] the experimental use exception for research institutions" because "no research institution will be able to demonstrate that its experimental use of any patent fails to further the institution's legitimate business."[48] In so doing, the holding disrupts the "balance between the need to promote innovation and the recognition that imitation and refinement through imitation are necessary to invention itself", which is embodied in the federal patent laws[49] and overrides Congress' legislative judgment turning "the experimental use exception on its head"[50] and "threatens to delay or stymie research".[51] The Supreme Court, in Festo Corporation versus Skoketsu Kinzoku Kogyo Kabushki Co. Ltd., held that Congress alone has the responsibility for making fundamental changes to settled law because such changes "risk destroying the legitimate expectations" of the investing community.[52] The Writ of *Certiorari* seemed to have identified a number of pertinent points that needed clarification in the Supreme Court. The Writ of *Certiorari* concerning Madey was denied on June 27, 2003, leaving the Court of Appeals for the Federal Circuit decision as a binding but not altogether clear precedent in the U.S.

University technology transfer facilitated through technology transfer offices will continue to increase in importance; however, it is essential that the intrinsic barriers that have been identified by theoretical and empirical academic research be addressed.

Intrinsic Barriers to University Technology Transfer

(i) Technology Transfer Profitability. Universities technology transfer offices and their industrial counterparts are using the patent system extensively and routinely requiring licensing and royalty payments for patent use, raising the costs and administrative complexity associated with scientific research. This particular barrier was identified by Cottrell in 1912:

"The thing that has impressed us particularly is the difficulty and complexity of administering patents in this way for public purposes, and the value of the experience and information on the subject already amassed by the Corporation in this regard and available to those interested. The idea that you can sit back and write licenses has been too generally assumed when people discussed the administration of patents by universities. Even the Research Corporation started with much of this in mind. The thought was to have a small staff confining themselves largely to making licenses, allowing the licenses to make the installations. For that reason the Corporation began with only 10 thousand dollars working capital...however, it was found necessary to go much farther than merely granting licenses. Service had to be given in providing plans, outlining directions and coordination research that kept developing in the industry."

The complexity of patent management results in high running costs of univiersity technolgy transfer offices, and this, in turn, limits the financial returns from patent licensing;[53] it has been estimated that only 41% of university technology transfer offices yield a positive net income in the U.S.[54]

"The direct economic impact of technology licensing on the universities themselves has been relatively small (a surprise to many who believed that royalties could compensate for declining federal support of research). Although a very few, and highly visible, blockbuster inventions...have made tens of millions for universities, most university licensing offices barely break-even."[55]

Waiting for the hugely profitable blockbuster patent is not a viable economic reality[56] for all universities.[57] Examples of blockbuster patents include the $160 million that The Michigan State University has earned over the life of two cancer-related patents,[58] the $27 million that Iowa State University has been paid for the fax algorithm, and the $143 million earned by Stanford University for the recombinant DNA gene-splicing patent.[59]

"In the fall of 1965, the University of Florida football coach enlisted a professor to develop a high energy drink to replace the nutrients his players were perspiring away on the humid practice field. The university now receives $4.5 million per year in royalties from Quaker Oats Corporation as a result of this professor's invention: Gatorade."[60]

A blockbuster patent can dominate the total license income at a research university; for example, $18 million of The Michigan State University's $18.3 license income in 1997 came from the two cancer-related drugs.[61]

It is rare for a university to have the luxury of a blockbuster patent to keep a technology transfer office solvent in the eyes of the central university. Compounding the solvency problems is that the appearance of a blockbuster patent is impossible or at the very least difficult to predict and thus licensing income is unstable.[62] University technology transfer offices must be as efficient as possible, and to this end, the U.S. Association of University Technology Managers assists universities to find individualized best technology transfer practices.[63]

(ii) Problematic Valuation and the Need for Parity of Ability. With universities encountering the realities of commercial interactions, parity must be ensured between university technology transfer lawyers and industry lawyers to enable equity in contractual licensing. Consequently, the professional capacities of the technology transfer office must match those of professional corporate lawyers and licensing agents, a costly and perhaps unviable endeavor for all universities globally.[64] Universities must avoid being dragged across

the table by battle-hardened industrialists interested only in licensing the university intellectual property well below its value.[65] In the U.S., the altered regulatory framework, since the 1980s, has resulted in a strengthened role of university technology transfer offices. "These offices are routinely equipped with professionally trained staff, at the bigger institutions including contract lawyer, patent agents, licensing experts and sometimes even litigation lawyer."[66] This, however, is not the case on a global scale because many universities are unable to cover the "administrative and financial costs to cover patent searches, infringement opinions, ... and the inevitable litigation."[67] Will international universities be resilient enough to match commercial lawyers and hard-hitting industrialists? This remains to be seen.[68]

(iii) Problematic Interactions between Academics and Technology Transfer Offices. "Pure research is arduous, demanding, and difficult. It requires unusual intellectual powers. It requires extensive and specialized training. It requires intense concentration, possible only when all the faculties of the scientist are brought to bear on a problem, with no disturbances or distractions."[69]

Many academics see technology transfer as an unnecessary external interference. Academics are responsible for their research group's finances and can move their funding (and well respected laboratories in the case of Madey) to other university institutions. The leverage and/or control over academic processes by technology transfer offices is thus limited in many cases.[70] The difficulties can take many forms because interactions between academics, technology transfer staff, and industry players are generally complex because all parties in the equation have different missions, objectives, structures, organizational cultures, and research orientations.

(a) Publish, Patent, or Perish. Tension exists between publishing results and patenting them.[71] In the scientific arena, publication and the subsequent discussion of research results is the coin of the realm. Research results must be verified by repeatable experiments and cross checked by academic peers. Several rounds of publications and feedback are considered necessary[72] because the university is evaluated largely on the basis of published research. Industry is concerned with keeping information from competitors and may demand that no publications come from research to enable intellectual property rights to be asserted.[73] These differences take on particular importance when it comes to decisions regarding the freedom to publish research results coming from collaborative or highly commercial research.[74] Secrecy in academia is not how research has traditionally proceeded; a recent survey of firms in the manufacturing sector indicates that the four most important channels through which firms benefit from university research are publications, conferences, informal information channels, and consulting.[75] Even in pharmaceuticals and chemical engineering where patents and licenses are more important than in other industries, firms rely heavily on these other channels of knowledge and technology transfer.[76] These channels do not provide any revenue for the technology transfer office, the university institution, or the academic research group.

(b) Personality issues. "Today the feeling is widespread that science and commerce should not, must not mix. There is a queasy suspicion that the process of discovery is in some way corrupted if it is driven by profit."[77]

The idea of the academic scientist as a stereotypical, bespectacled, middle-aged man with a basic unwillingness to cooperate with industry, an inability to keep secrets, a perchance for perfectionism, little understanding of practical realities, and chronic communication difficulties is unrealistic. However, the inability of professors to productively reach beyond their academic disciplines for communication with technology transfer staff and industry personnel has been identified in the academic literature,[78] as have the inability to measure adequately the success of interactions[79] and the failure to set reasonable goals.[80] Communication between academic and technology transfer staff is essential because potential projects killers (in the form of patent tolls) are cheaper to address in the planning stage than downstream in the market place; thus[81]

"it is incumbent upon university researchers to address issues of potential patent infringement and licensing requirements with the staff of the university technology licensing office as early as possible to avoid punitive fees and the disruption of ongoing research."[82]

Opening channels of communication is important and can be facilitated by industry-sponsored multiuniversity technology transfer conferences,[83] faculty consulting for firms, ongoing studentship programs, graduate students doing field work for industry projects, the presence of a clear university patent policy, and universities receiving gifts of grants from industry. Ties with other governmental insitutions can also facilitate the improvement of university/industry/technology transfer communication interactions. [84]

Conclusion

The Research Corporation and university technology transfer offices present contrasting methods of encouraging university "blue-sky"[85] and commercial science; however, both encounter the aforementioned intrinsic problems. Technology transfer offices face many of the problems the Research Corporation faced because organizations with altruistic goals often find it difficult to compete effectively in the world of commerce.

"In the long run,...a balanced approach, which in some cases may involve lower financial returns on university patents and licenses, will enhance universities' contributions to domestic and global economic welfare"[86] and allow universities to "fill their 'new' role as engines of economic development while at the same time doing what they have done for centuries, nurturing the intellectual capacity of the race, questioning everything, and pursuing knowledge for the sake of knowledge. The need for independent and powerful intellectualism in academe is as crucial as the need for curricular reform, vocational education, research commercialization and academic entrepreneurship."[87]

From 1912 to 1948, Cottrell's Research Corporation played an important role in the progression of academic science. Today the Research Corporation's research budget may seem modest in comparison to other funding bodies; however, it serves as a reminder that a balance must be achieved between the utopian goals of academia and the harsh realities of industrial commerce. Cottrell put forward the idea of noncommercial technology transfer and also identified the problems of bridging the public private research divide. Nearly a century later,

his writing appears to be surprisingly astute; so astute, in fact, that parts of his manuscript in the 1912 *Journal of Industrial and Engineering Chemistry* could be issued by a technology transfer department today:

"The rapid growth of engineering and technical education, coupled with ... the commercial importance of research in the industries, has brought about a persistent demand the world over for closer and more effective cooperation between the universities and ... industr[y]. The value to both sides from such an operation is today generally conceded, but as to the most expedient methods of its accomplishment opinions differ, and we are still in the experimental stage of working out the problems."[88]

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(3) Cottrell, F. Patent experience of the research corporation. *Trans. Am. Inst. Chem. Eng.* **1932**, *28*, 222−225.

(4) *Collins English Dictionary*, 2003: "of or denoting theoretical research without regard to any future application of its result: a blue sky project."

(5) The Corporation's licensing activities now are managed by an independent organization: Research Corporation Technologies, founded in 1987. For further information on the Research Corporation, see http://www.rescorp.org.

(6) Which "established the National Science Foundation to promote the progress of science, to advance the national health, prosperity, and welfare; to secure the national defences and for other purposes." Excerpt from the First Annual Report of the National Science Foundation 1950−51. President Harry Truman approved the Act on May 10, 1950. Today the National Science Foundation has a $4 billion annual budget: http://www.nsf.gov/od/lpa/nsf50/nsfnumbers.htm.

(7) Alongside Bayh−Dole (named after the forwarding Senators Birch Bayh and Robert Dole; also referred to as the Patent and Trademark Law Amendment Act) stands a related raft of legislation that includes the Stevenson−Wydler Technology Innovation Act of 1980 and the more recent Technology Transfer Commercialisation Act of 2000. Katz and Ordover (1990) have analyzed the 14 congressional bills that relate to technology transfer passed in the 1980s.

(8) The recent increases in university patenting and licensing are frequently asserted to be a direct consequence of the federal policy initiative that resulted in the Bayh−Dole Act of 1980. Although the Act's importance is widely cited, its effects on U.S. research universities and on the U.S. innovation system have been the focus of little empirical analysis [Henderson, Jaffe, and Trajtenberg (1998) and Mowery, Nelson, Sampat, and Ziedonis (1999) are important exceptions].

(9) *The Economist. Innovation's Golden Goose*; Dec 12, 2002.

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(11) Jefferson, T. Written in a letter to Isaac McPherson on the 13th August 1813. Thomas Jefferson also served on the first U.S. patent board.

(12) Williams, T. *Science: A* history of discovery in the twentieth century; Oxford University Press: Oxford, U.K., 1990.

(13) U.S. universities were moving science from the laboratory to industrial commercialisation as early as the 1920s (the University of Wisconsin at Madison established a technology licensing office in 1925).

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(19) As a comparison, today the National Science Foundation has an annual budget of $4 billion, whereas the Research Corporation total annual "grant totals amount to between six and seven million dollars"; http://www.rescorp.org/history.htm.

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(26) United States Court of Appeals for the Federal Circuit: http://www.ll.georgetown.edu/federal/judicial/fed/opinions/01opinions/01-1567.html.

(27) Madey, 307 F.3d at 1352.

(28) Contained in the laboratory are several pieces of equipment that practice the subject matter disclosed and claimed in two patents owned by Madey: U.S. Patent 4,641,103 ("the '103 patent"), which covers a "Microwave Electron Gun", and U.S. Patent 5,130,994 ("the '994 patent"), titled "Free-Electron Laser Oscillator For Simultaneous Narrow Spectral Resolution And Fast Time Resolution Spectroscopy". Madey, 307 F.3d at 1352.

(29) Madey, 307 F.3d at 1352.

(30) Madey, 307 F.3d at 1353.

(31) 28 USC 1498 implements the rights of the United States government to assert eminent domain with respect to acts carried out on its behalf as provided by the Fifth Amendment to the Constitution. Under these provisions, use of a patented invention by the Federal government is not an act of patent infringement but can give rise to an action for compensation. Any such action must be brought before the Court of Federal Claims and not before the normal district courts. This particular topic is beyond the scope of this paper.

(32) For further information concerning the experimental use exception, see: Hantman, R. Experimental use as an exception to patent infringement. *J. Pat. Trademark Off. Soc.* **1985**, *67*, 617−644. Bee, R. Experimental use as an act of patent infringement. *J. Pat. Off. Soc.* **1957**, *39* (No. 5), 357−377.

(33) Madey, 307 F.3d (citing Summary Judgment at 9−10 (citing Roche Prods., Inc. v. Bolar Pharm. Co., 733 F.2d 858, 863 (Fed. Cir. 1984)).

(34) Madey v. Duke University, 307 F.3d 1351, 1362 (Fed. Cir. 2002). Madey v. Duke University, No. 1:97CV1170 (M.D.N.C. June 15, 2001) (Summary Judgment Opinion) (citing Summary Judgment at 11).

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(36) Madey v. Duke University, 307 F.3d 1351, 1362 (Fed. Cir. 2002).

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(39) Sutherland, Asbill, Brennan Attorney in law. Patent licensing requirements under Madey v. Duke University, July 22, 2003: http://www.sablaw.com/files/tbl_s10News%5CFileUpload44%5C12161%5C210213_1.pdf.

(40) The Federal Circuit reversed on both issues. On the government license issue, it held that there was insufficient evidence before the court to conclude whether in the present case the work carried out under a government contract was "for the United States" as required by 28 USC 1498(a).

(41) 35 U.S.C. §200 et seq.

(42) Sutherland, Asbill, Brennan Attorney in law. Patent licensing requirements under Madey v. Duke University, July 22, 2003: http://www.sablaw.com/files/tbl_s10News%5CFileUpload44%5C12161%5C210213_1.pdf.

(43) A writ from a higher court to a lower one requesting a transcript of the proceedings of a case for review. From the Latin *certiorari*, (we wish) to be informed, from *certior*, comparative of *certus*, certain. To be informed of, or to be made certain in regard to. In this instance it is in regards to a document filed with the Supreme Court asking the Supreme Court to review the decision of a lower court.

(44) A party that is not involved in a particular litigation but that is allowed by the court to advise it on a matter of law directly affecting the litigation. From the Latin: *amicus* = friend + *curiae*, genitive of *curia* = court. In this instance, it refers to a writ served by 31 *Amici curiae* including the Association of American Medical Colleges, the American Council on Education, the Association of American Universities, the Association of University Technology Managers, Massachusetts Institute of Technology (MIT), and New York University (NYU). They argue that Madey "erects a significant roadblock to the advancement of science" because of the "chilling effect [it will have] on all academic scientific research."

(45) Brief of *Amici curiae* Association of American Medical Colleges at 5.

(46) Brief of *Amici curiae* Association of American Medical Colleges at 6.

(47) Brief of *Amici curiae* Association of American Medical Colleges at 8. Walsh, J.; Arora, A.; Cohen, W. The patenting and licensing of research tools and biomedical innovation. *Patents in the Knowledge-Based Economy*; National Academy of Sciences: Washington, DC, 2003; Vol. 2, No. 35.

(48) Petition for a Writ of Cert. at 13−14.

(49) Bonito Boats, Inc v. Thunder Craft Boats, Inc., 489 U.S. 141, 146 (1989).

(50) Petition for a Writ of Cert. at 14.

(51) Petition for a Writ of Cert. at 16.

(52) Festo Corp. v. Shoketsu Kinzoku Kogyo Kabushki Co., 122 S. Ct. 1831, 1841 (2002) (citing Warner-Jenkinson Co. v. Hilton Davis Chem. Co., 520 U.S. 17, 28 (1997)).

(53) Trune, D.; Goslin, L. University Technology transfer programs a profit loss analysis. *Technol. Forecasting Social Change* **1998**, *57*, 197−204.

(54) Trune, D.; Goslin, L. University Technology transfer programs a profit loss analysis. *Technol. Forecasting Social Change* **1998**, *57*, 197−204.

(55) This is a personal viewpoint by Lita Nelsen, Director of Massachusetts Institute of Technology's Technolgy licencing officer (http://web.mit.edu/newsoffice/tt/1998/aug26/nelsen.html), reprinted from *Science* **1998**, *279*, 1460−61 (No. 5356, Mar 6, 1998).

(56) "Only one in ten new ventures succeeds". Volkmar, S. Incubating more than just eggs: North Carolina's Research Triangle Park: www.biomednet.com/hmsbeagle/55/notes/adapt, posted May 28, 1999, Issue 55.

(57) Survey reveals changing patterns of commercialization activity in U.K. universities (June 12, 2003). "Preliminary results of the second U.K. technology transfer survey are revealing some significant shifts in the patterns of research commercialisation in universities. Universities are employing more technology transfer staff and investing more in protecting inventions arising from university research; licensing activity has increased relative to spinout formation as the prevalent route for research commercialisation, and there has been an increase in commercialisation activity across the board with an overall increase in income generated." http://www.unico.org.uk/prelease.htm.

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(61) Erbisch, F. Office of Intellectual Property, The Michigan State University, East Lansing, MI, 1999.

(62) Mowery, D.; Sampat, B. University patents and patent policy debates 1925−1980. Paper presented at the conference in honour of Richard R. Nelson, Columbia University, New York, Oct 13−15, 2000.

(63) UNICO was founded in 1994 to represent the technology exploitation companies of U.K. universities. It provides a forum for exchange and development of best practice. Member companies transfer technology and expertise through the formation of spinout companies, licensing, consultancy, training, design and development projects, contract research, testing and evaluation, and problem solving: http://www.unico.org.uk. Arrow, K. Welfare economics and inventive activity in the rate and direction of inventive activity. *Natl. Bur. Econ. Res. Princeton* **1962**. Machlup, F. *An Economic Review of the Patent system*; Study No. 15 of the U.S Senate Sub committee on Patents, Trademarks and Copyrights, 85th congress, 2nd session; U.S Government Printing Office: Washington, DC, 1952.

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(65) Then again by the industrialist's lawyers after contractual licensing agreement has been made. Newly established or recently established technology transfer offices cannot be expect to match commercial operations.

(66) Mowery, D.; Sampat, B. University patents and patent policy debates 1925−1980. Paper presented at the conference in honour of Richard R. Nelson, Columbia University, New York, Oct 13−15, 2000. Wicksteed, S. Utilisation of the results of public or publicly funded research and development in the United Kingdom. In *Utilisation of the results of public research and development*; Corsten, H., Junginger-Dittel, K., Eds.; Commission of the European Union: Brussels, 1988.

(67) Brief of *Amici Curiae* Association of American Medical Colleges at 3, Madey (No. 02-1007).

(68) The institution's primary goals in licensing are to ensure the development of the technology in all fields, to comply with its government funding obligations, and to achieve a fair financial return. The company's goals are to obtain broad licensing rights with minimal financial and development milestones and with maximum assurances from the institution that the patent rights will not be tainted by inventorship or other disputes.

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(81) Potential commercialization issues can be identifed at this stage.

(82) Sutherland, Asbill, Brennan Attorney in law. Patent licensing requirements under Madey v. Duke University, July 22, 2003: http://www.sablaw.com/files/tbl_s10News%5CFileUpload44%5C12161%5C210213_1.pdf.

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