The Effects of Patenting in the AAAS Scientific Community

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Executive Summary

Historically, academic scientists disseminated basic research findings and inventions through free and open channels such as informal sharing, journal publications, or professional conference presentations. In many instances, those basic discoveries had little immediate commercial value for the author to appropriate privately, but proved highly useful for other researchers to build upon. The reward structure of academic science reinforced that practice, awarding prestige and tenure on the basis of discoveries published in journals and provided openly to the scientific community. The patenting of intellectual property (IP) generated by research—though pursued by academics in some fields—primarily was reserved for discoveries made in the commercial sector, which could be developed into marketable products and bring potential monetary rewards to their inventors.

In the United States, the past two decades have seen a rise in the number of patents—most notably in the life sciences—by both industry and academic scientists. Much concern has been raised that this increase in patenting will create an "anti-commons" effect,[1] in which noncommercial academic research is hindered by the imposition of long negotiations and expensive licenses to acquire necessary research inputs from either industry or academia.

Early in 2005, the Project on Science and Intellectual Property in the Public Interest (SIPPI) of the American Association for the Advancement of Science (AAAS) conducted a survey to assess the effects patenting has had on research conducted in academia, industry, the nonprofit community, and government across a range of scientific fields. The survey was conducted using a random, stratified sample of 4,017 individuals drawn from AAAS membership. In designing the survey, we chose to use 2001 as the starting date for recording responses in order to establish a manageable timeframe—and because in many instances it is difficult for an individual to precisely recall how he or she managed an intellectual property issue dating back several years. Moreover, the proliferation of patents since 2001 has made that timeframe appropriate for this survey. A total of 1,111 AAAS members responded to the survey, providing a response rate of 28 percent. Of those respondents, 76 percent reported that they were actively conducting or managing research, or specializing[2] in IP.

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[1] Heller and Eisenberg, 1998.

[2] "Specializing" in IP would entail, for example, working in a university or industry technology transfer office.

This survey report provides insights into the way scientists approach their own intellectual property, including their motivations for protecting it. Although this report analyzes the results of a survey of various AAAS members, it is a precursor—a pilot survey—to a forthcoming AAAS-SIPPI international survey of thousands of scientists and researchers, which will expand the scope of this survey. Nevertheless, the results of this survey suggest that there may be some appreciable differences in the methods by which scientists in different fields and sectors protect and disseminate their IP.

Acquiring Patented Technologies

Overall, 24 percent of respondents conducting or managing research, or specializing in intellectual property, reported acquiring a patented technology for use in their research since January 2001. Within almost every scientific field, industry respondents reported acquiring more patented technology than respondents from academia. The majority of those respondents (79 percent) reported that the technology originated in their own professional field. Additionally, 11 percent of respondents from a field outside of the biosciences identified their technology acquisition as originating in a bioscience field.

For respondents attempting to acquire intellectual property, the greatest overall proportion reported acquiring their last patented technology through the use of a material transfer agreement (MTA). In essence, a MTA is an agreement that provides for the transfer of physical materials or living organisms (e.g., a genetically engineered microbe) between two institutions. Not surprisingly, the use of MTAs was concentrated among bioscience respondents and academic bioscience respondents in particular. For industry bioscience, nonexclusive licensing, in which the holder of the acquired intellectual property innovation is allowed to grant that IP to other licensees as well, was the most common method used in the acquisition of technologies. In both industry and academia, exclusive licensing was one of the least-used methods for technology transfer.

Nonexclusive licenses accomplished technology transfers most quickly, with 39 percent of those transactions completed in under one month. Those were followed by informal transactions such as verbal agreements between two parties (31 percent) and MTAs (27 percent). The greatest proportion of technologies that took over six months to acquire involved exclusive licensing of those technologies.

Forty percent of respondents who had acquired patented technologies since January 2001 reported difficulties in obtaining those technologies. Industry bioscience respondents reported the most problems, with 76 percent reporting that their research had been affected by such difficulties. In contrast, only 35 percent of academic bioscience respondents reported difficulties that affected their research.

Of the 72 respondents who reported that their work had been affected by the technology acquisition process, 58 percent of those reported that their work was delayed. Fifty percent reported that they had to change their research, and 28 percent reported abandoning their research project as acquisition of the necessary technologies involved overly complex licensing negotiations.

Protecting Intellectual Property

Overall, 46 percent of respondents reported that, since 2001, they had made a discovery or created a technology they considered eligible for some form of intellectual property protection. Within every scientific field, a higher proportion of industry respondents reported creating IP than those from academia. Interestingly, the scientific fields with the highest proportions of respondents creating IP were math and computer science (77 percent) and engineering (69 percent).

Of the methods employed to protect IP, patenting was used by 55 percent of those who reported creating IP, and was highest among industry respondents in the fields of chemistry (94 percent) and biosciences (85 percent). Among academic respondents, those in the field of engineering reported the highest rate of patenting (68 percent). Academic respondents in the fields of chemistry (59 percent) and biosciences (56 percent) reported a relatively high degree of patenting as well. Copyright was reported as the second-most common method for protecting IP (21 percent).

Of the 55 percent of respondents who reported using a patent to protect their IP, 41 percent described their most important patented technology created since 2001 as a research tool—a technology that is used to conduct research or analysis and is not the subject of the research itself. That proportion was even higher among university scientists, with 50 percent characterizing their patented technology as a research tool.

Overall, 25 percent of the respondents who disseminated their technology included a research exemption that allowed the patent holder to continue to conduct research on or with the licensed technology. In total, 32 percent of respondents who used licensing in the dissemination of their technology included a research exemption.

Sixty-six percent of all respondents (from industry and academia) who created IP, protected it with a patent, and disseminated that technology reported publishing as the primary means to disseminate or share that IP. Informal sharing was the second-most frequently reported means of dissemination. In sum, 85 percent of respondents that created IP protected it with a patent, and disseminated their intellectual property disseminated it not via licensing, but either through publication, informal sharing, or both methods.[3]

For those who had not disseminated their patented technologies, the most frequently reported reason was that they were developing or commercializing it themselves (65 percent). The top reason among academic respondents as to why they did not disseminate their patented technologies was that they planned to conduct future research with them (40 percent).

Conclusions

Although the survey found that patents were the most common means used by respondents to protect IP—especially in the fields of chemistry and the biosciences—licensing those patented technologies was not the primary means by which respondents within academia acquire or disseminate technology. And although it may be difficult to demonstrate from this unweighted[4] sample, *it appears that academia has been less affected than industry by more restrictive and formal licensing practices in the acquisition and distribution of patented technologies necessary for research*. In fact, difficulties reported by bioscience industry respondents in attempting to access patented technologies outnumbered those of bioscience academic respondents by a ratio of more than 2:1. However, that may be

[3] A 2003 study by Walsh, Cohen, and Arora found that despite numerous patents on upstream technologies (technologies in the early stages of research or innovation), academic researchers experienced few problems in accessing knowledge. In a more recent study, Walsh, Cho, and Cohen (2005) found that the major reason that academic researchers themselves denied requests to intellectual property was that they were protecting their ability to publish.

[4] For an explanation, see the section "Survey Design," below.

because industry respondents reported creating and holding more intellectual property than academic respondents, as well as the fact that industry relies more on licensing, which entails greater and longer negotiations than other more traditional and informal means of technology transfer still used in academia.

History and Background

The past two decades have seen an increase in patenting by academic and public sector scientists in the United States—most notably in the life sciences. That has blurred traditional distinctions between mechanisms for disseminating basic research findings and applied inventions. Historically, academic scientists disseminated the former through free and open channels such as peer-reviewed journal publications, informal sharing, or professional conference presentations. Those basic discoveries had little immediate commercial value for the author to privately appropriate, but proved highly useful for other researchers to build upon. The reward structure of academic science reinforced that practice, awarding prestige and tenure on the basis of discoveries published in journals and provided openly to the scientific community. Patenting—though pursued by academics in some fields—primarily was reserved for discoveries made in the commercial sector, where marketable products that might bring potential monetary rewards to their inventors could be developed.

Box 1: The Bayh-Dole Act of 1980

The 1980 Bayh-Dole Act transformed the way in which academic research findings traditionally have been disseminated:

"It is the policy and objective of the Congress to use the patent system to promote the utilization of inventions arising from federally supported research or development; to encourage maximum participation of small business firms in federally supported research and development efforts; to promote collaboration between commercial concerns and nonprofit organizations, including universities; to ensure that inventions made by nonprofit organizations and small business firms are used in a manner to promote free competition and enterprise without unduly encumbering future research and discovery; to promote the commercialization and public availability of inventions made in the United States by United States industry and labor; to ensure that the Government obtains sufficient rights in federally supported inventions to meet the needs of the Government and protect the public against nonuse or unreasonable use of inventions; and to minimize the costs of administering policies in this area."

U.S.C. Title 35, Part 2, Chapter 18, § 200.

However, two developments in the latter part of the 20th century affected the traditional model for disseminating academic research findings. First, in 1980, the U.S. Congress passed the Bayh-Dole Act (see Box 1), which eased the process

for university scientists to file for patents on inventions derived from federal funding. That led to the establishment of designated offices (e.g., technology transfer offices) and administrative procedures at many universities to facilitate that process. Second, a series of decisions by the U.S. Patent and Trademark Office, along with various federal courts, enabled the patenting of biological components and organisms. Those types of inventions frequently were made at the more basic stages of research conducted by academic scientists, but could serve as the basis for lucrative pharmaceutical products or products in other fields, as well as a foundation for future exploratory work. Additionally, computer software and business methods also came under patent protections.

A New Paradigm

The new paradigm for the conduct of academic research has led to concerns among various scientists, legal scholars, economists, and other social scientists that the shift in mechanisms for protecting or disseminating basic academic research could impair the collective ability of researchers to advance the work of basic science. Controversial cases such as the BRCA I and II (genes which, if abnormal, can increase the risk of breast cancer) patents, the Oncomouse, the Human Genome Project, accessibility of diagnostic tests, and tools for basic research that have been patented represent major issues arising under the new paradigm.

The potential anti-commons effects of the fragmented ownership of intellectual property and the effects of overwhelming transaction costs for obtaining numerous patented research inputs opened the door to a new set of concerns.[5] Although there are several empirical studies on that matter,[6] they generally focus on specific scientific technologies, fields or sectors, or have relatively small sample sizes—leaving many questions unanswered. Therefore, early in 2005, the Project on Science and Intellectual Property in the Public Interest (SIPPI) of the American Association for the Advancement of Science (AAAS) conducted a survey of its membership to study the effects of patenting and exclusive licensing by scientists in general. The survey is a precursor to a larger forthcoming AAAS-SIPPI survey of scientists representing four countries. The remainder of this report discusses the implementation and results of the 2005 pilot survey.

[5] Heller and Eisenberg, 1998.
[6] Cohen and Walsh, 2002; Murray and Stern, 2005; Sampat, 2004; and Shapiro, 2001.

Survey Design

This survey[7] was disseminated to 4,017 scientists and experts, asking them to provide details about their experiences acquiring patented technology for use in research, as well as their experiences using different methods to protect the intellectual property (IP) they had created. The sample—random and stratified—was drawn from a list of U.S. and international members of the American Association for the Advancement of Science (AAAS), a scientific society with approximately 120,000 members representing a broad array of scientific disciplines. Only members with valid e-mail addresses (a total population of 88,117 individuals) were sampled.[8]

AAAS collects and updates a variety of information on its members, which permitted the stratification of the sample by five characteristics: region, age, scientific discipline, job function, and sector. To facilitate comparisons between regions, age groups, scientific disciplines, job functions, and sectors, certain groups were *oversampled* relative to their representation in AAAS. Those groups contained fewer members than the others. The groups overrepresented in the sample included those identified by AAAS membership data as: (1) members in the disciplines of engineering, mathematics and computer science, physics and astronomy, and social and behavioral science (who were overrepresented relative to biological and medical/biomedical scientists), (2) members residing outside of the United States, (3) members who are 22-44 years of age or over 65 years of age (as compared to members aged 45-65 and members who did not provide their age), and (4) members whose job function is applied research (as compared to those doing basic research and those who did not provide their job function).

The sampling method utilized in this survey is a crucial consideration for interpreting proportions given for the survey sample as a whole.[9] For example,

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[7] A detailed report of the work conducted by the statisticians who assisted in drawing the sample for this survey is available upon request (Mushtaq and Scheuren, 2005).

[8] The original sampling frame, drawn from the AAAS membership database in October 2004, included 88,522 individuals. To ensure the highest quality population from which to draw the sample, two groups were discarded from the sampling frame: Region "Other" (350 members) and Age Group "21 and under" (55 members).

[9] Because of the under- and over-representation discussed in this survey, the data collected would need to be weighted for our analysis to be representative of the underlying population of the 88,117 AAAS members included in the sampling frame.

higher proportions of certain underrepresented groups (such as biomedical scientists) were more likely to have acquired a patented technology for use in their research. Thus, the sample is likely to have a lower proportion reporting that it had acquired a patented technology than the AAAS membership base as a whole.

Drawing upon experiences since January 2001, the survey instrument consisted of 37 questions divided into two parts. The first posed a series of questions about the acquisition of the last patented technology, material, or method by the respondent, how that technology was transferred (e.g., informal sharing, licensing), the amount of time the acquisition took, and whether or not the respondent experienced any difficulties in acquiring protected technologies since 2001. The second part of the survey posed a series of questions about the last technological innovation or discovery for which the respondent attempted to secure intellectual property protection, whether or not that technology was disseminated and, if so, the method used.

Administering the Survey

The Washington State University (WSU) Social and Economic Sciences Research Center was contracted to administer a Web-based survey and tabulate the results. Selected AAAS members received an e-mail message from WSU inviting them to participate in the survey. The invitation included a greeting from AAAS CEO Alan Leshner, including a link to the online questionnaire and a unique identification code for each participant. Those who did not complete the survey immediately were sent two reminder e-mails following the initial contact, spaced two weeks apart.

However, this analysis addresses the unweighted results. We decided to analyze the unweighted data because of complications in the sampling process that make estimation of confidence intervals difficult. Those statistics are therefore descriptive of the sample only.

Results

A total of 1,111 AAAS members responded to the survey,[10] providing an overall response rate of 28 percent.[11] A majority of those respondents—76 percent (n=843)—reported that they were actively conducting or managing research, or specializing in intellectual property. The following analysis is based on those 843 respondents.

Acquiring Patented Technology

In sum, 24 percent (n=200) of all survey respondents had acquired a patented technology for use in their research since January 2001 (see Appendix Table 1). *Within* almost every scientific field, industry respondents reported acquiring patented technology at a higher rate than those from academia. Of all respondents working within the biosciences field,[12] 34 percent—or 103 out of 307—reported an acquisition of patented technology (see Figure 1), in contrast to the overarching figure of 24 percent (noted above) representing *all* respondents from *all* professional fields. Industry bioscience respondents (53 percent, n=28), as well as those working in academia (30 percent, n=49), reported IP acquisition at higher rates than respondents working in any other field.

[10] Percentages in the Results section used the numerator reflecting the number of people that answered the question that provided the count in the numerator. Non-respondents were not counted in the denominator. Throughout this paper, "n=X" will represent the denominator in the mentioned proportion.

[11] Additional discussion of the response rate is available upon request in Mushtaq and Scheuren, 2005.

[12] Defined as biological science, biochemistry, medical science, or the life sciences.

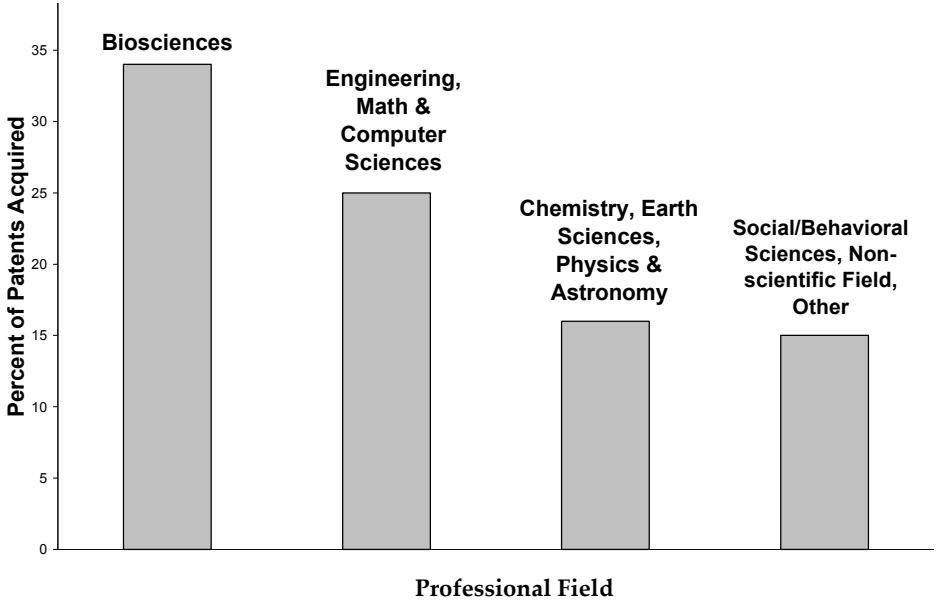

Figure 1. Who is Acquiring Patented Technologies for Use in Research?[13]
Source: AAAS-SIPPI 2005 Patent Survey.

Detailing Circumstances of Respondents' Last Patent Acquisition

Respondents who reported acquiring a patented technology were asked to provide details regarding the last technology they acquired and the field(s) in which the last patented technology they acquired originated (see Box 2). Of the 196 respondents who answered that question, the majority (79 percent, n=155) reported that the technology originated in their own field, as illustrated in Table 1. Additionally, 11 percent (n=21) of respondents from a field outside of the biosciences identified their technologies as originating in a bioscience field.

[13] Percentages are rounded to the nearest whole number.

Box 2: Respondents' Last Patent Acquisition

Survey respondents were provided a matrix of potential combinations of scientific fields and economic sectors from which they acquired the technology. They were asked to place check marks in the matrix to describe the field and sector from which they acquired the technology (e.g., source field: chemistry, source sector: academia).

However, respondents were able to check multiple boxes in the matrix. Many described their technology as originating in several different scientific fields and more than one economic sector, which caused the percentages from that question to total more than 100 percent. Fifteen percent (n=30) of those who acquired a patented technology identified it in more than one field, and 22 percent (n=42) identified it in more than one sector. The most source fields identified by a single respondent were six. It is unclear whether those respondents misunderstood the question (i.e., they thought they were being asked to check appropriate boxes for *all* of the patented technologies they had acquired over the previous four years) or whether the technologies acquired by those respondents indeed originated in several scientific fields and economic sectors. Thus, in the following analysis, percentages of technologies acquired from a particular field or sector were calculated from the total technologies for which that field or sector was checked (although others might have been checked as well).

Table 1: Survey Respondents Reporting Acquisition of Patented Technology, by Scientific Field of Respondent and Scientific Field of Technology

Scientific field	Acquired within own field	Acquired from bioscience field	Total No. in field
Biosciences	90 (90%)	N/A	100
Chemistry, Earth sciences, Physics & Astronomy	25 (61%)	11 (27%)	41
Engineering, Math, Computer Sciences	31 (86%)	7 (19%)	36
Social/Behavioral sciences	9 (60%)	2 (13%)	15
Non-scientific Field	0 (0%)	1 (100%)	1
Other	0 (0%)	0 (0%)	3
Total	**155 (79%)**	**21 (11%)**	**196**

Source: AAAS-SIPPI 2005 Patent Survey.

Similarly, 196 respondents identified the sector from which they acquired the patented technology. Most acquired the technology either from industry (59 percent, n=115) or academia (51 percent, n=99; see Figure 2), with 10 percent

(n=19) acquiring the technology from government, and 8 percent (n=15) from a nonprofit source. The primary source sectors of technologies varied with scientific field. Technologies identified with biomedical or biological science were acquired from academic sources in 59 percent (n=66) of cases, and from industry sources in 51 percent (n=57) of cases. Meanwhile, technologies identified with engineering were acquired from industry in 79 percent (n=23) of cases and from academic sources in 41 percent (n=12) of cases. Technologies identified with math and computer science came from academia in 45 percent (n=13) of cases and from industry in 83 percent (n=24) of cases.

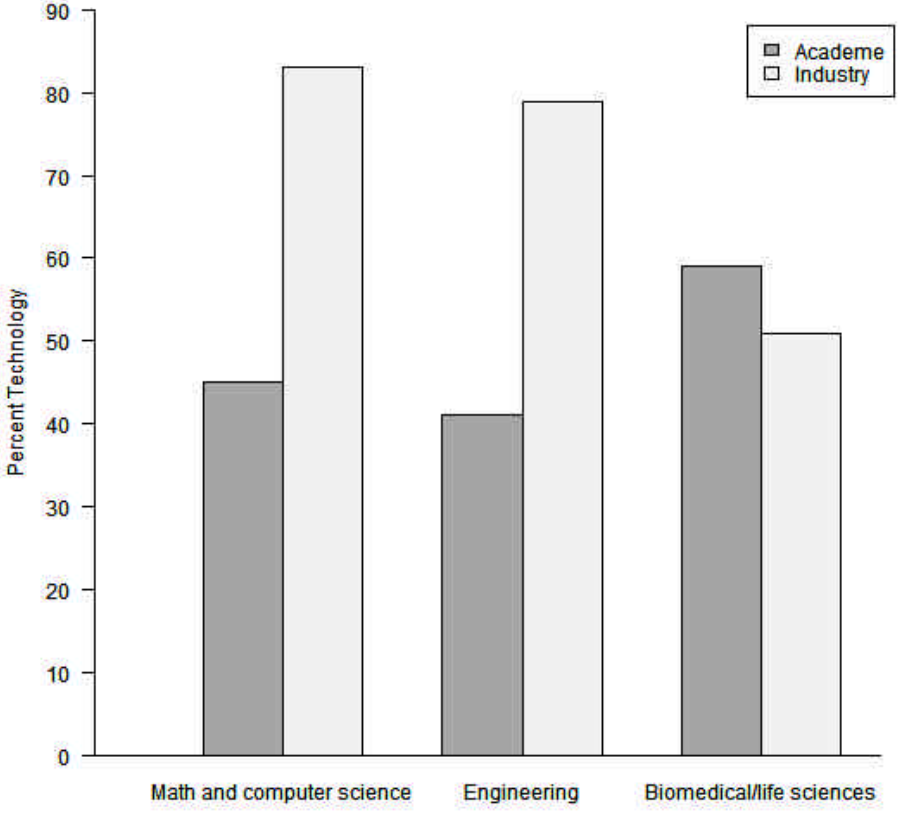

Figure 2. Sector from Which Patented Technology Was Acquired
Source: AAAS-SIPPI 2005 Patent Survey.

Methods and Terms Involved in Acquiring Technologies

The greatest overall proportion of respondents reported acquiring their last patented technology through the use of a material transfer agreement, or MTA (35 percent, n=67). The use of MTAs was concentrated among bioscience respondents (n=45) and, in particular, academic bioscience respondents, among whom 65 percent (n=32) used MTAs.

Nonexclusive licenses were used most frequently in the acquisition of patented technology by industry bioscience respondents. Whereas 57 percent (n=16) used nonexclusive licensing, only 32 percent (n=9) used an MTA. Among university bioscience respondents who had acquired a patented technology, only 8 percent (n=4) used a nonexclusive license to effect the transfer.

Among respondents who had acquired patented technologies, 29 percent (n=57) used a nonexclusive license. In particular, nonexclusive licenses were highly used by respondents in social and behavioral sciences (67 percent, n=10) and respondents in math and computer science (60 percent, n=6).

Exclusive licenses were employed in only 20 percent (n=40) of all technology acquisitions, and were used in a greater proportion of acquisitions by industry respondents (32 percent, n=21) than acquisitions by academic respondents (16 percent, n=15). For bioscience respondents, exclusive licenses were used in 19 percent (n=20) of technology acquisitions, with 29 percent (n=8) of industry bioscientists and 18 percent (n=9) of academic bioscientists reporting acquisitions involving exclusive licenses. Confidentiality agreements were used in 20 percent (n=39) of all acquisitions.

Overall, 30 percent (n=60) of respondents who had acquired a patented technology reported that a research exemption by the patent holder was one of the conditions of the transaction. Transfers involving biological or biomedical technologies were most likely to include research exemptions, with 40 percent (n=31) and 36 percent (n=16) of those transfers including the licensing terms, respectively. Technologies originating in academia were more likely to include a research exemption than technologies originating in other sectors, with 40 percent (n=41) of technologies acquired from academia and only 23 percent (n=27) of technologies acquired from industry including a research exemption.

Time Taken to Negotiate Acquisition of Technology

The survey asked respondents about the length of the process for their last acquisition of patented technology and the form of that transaction (see Figure 3 and Appendix Table 2). The fastest acquisition of technology occurred with transactions that entailed nonexclusive licenses: 39 percent (n=22) of transactions involving a nonexclusive license were completed in under one month.

The greatest proportion of transactions taking over six months to negotiate involved an exclusive license (33 percent, n=13). The fields of physics and astronomy (27 percent, n=3) and biomedical science (26 percent, n=11) had the highest proportion of transactions taking over six months.

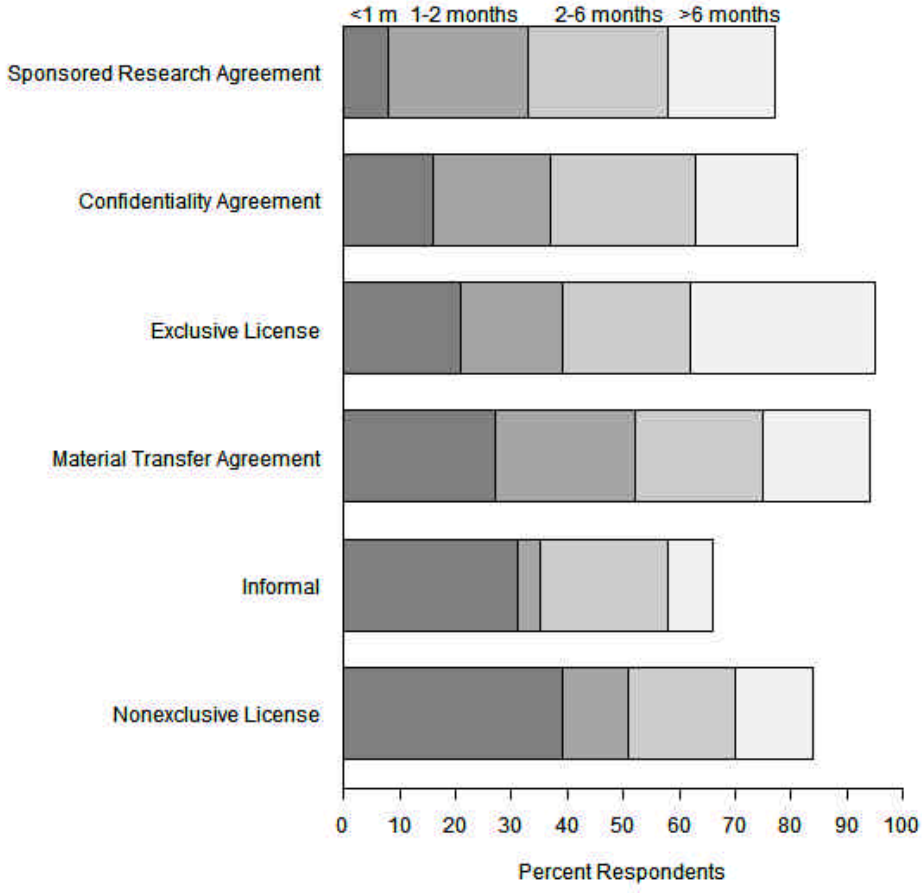

Figure 3. Time to Acquire Patented Technology by Method of Acquisition
Source: AAAS-SIPPI 2005 Patent Survey.

Acquisitions of technologies from industry were completed faster than those from academia, possibly because more acquisitions from industry were executed using nonexclusive licenses and upfront fees. Whereas 35 percent (n=37) of acquisitions from industry were negotiated in under one month, only 25 percent (n=23) of acquisitions from academia were completed in that span of time, as MTAs were used more frequently.

Difficulties Affecting Research

We asked respondents whether their research had been affected by difficulties in obtaining patented technology since January 2001 (see Figure 4 and Appendix Table 1). Of the 179 respondents to that question, 40 percent (n=72) reported that their research was affected by difficulties in obtaining that technology. Bioscience respondents working in industry reported problems at the highest rate—76 percent (n=19). In the case of university-based bioscience researchers, 35 percent (n=16) who had acquired patented technologies reported difficulties that affected their research. A recent survey by Walsh et al. (2005) undertook a similar endeavor with respect to university-based biomedical researchers.[14]

[14] In recent research reported in *Science* (Vol. 309, 2005) by Walsh et. al., 414 biomedical researchers from academia, government, and the nonprofit community were questioned about their experiences with intellectual property. The authors reported that "Of the 32 respondents who were aware of relevant IP, four reported changing their research approach and five delayed completion of an experiment by more than 1 month." That suggests (but is not identical to) a rate of 28 percent—similar to the results in our survey—of biomedical scientists who use patented technologies reporting difficulties due to the patents. In our sample, of the 75 bioscience respondents from the academic and GNHC (Government, Nonprofit Organization, Healthcare Organization, or Self-Employed/Consulting Firm) sectors, 33 percent (n=25) reported difficulties. The percentages in both studies are remarkably similar.

However, Walsh et. al.'s 2005 research report yields findings different from the 2005 AAAS-SIPPI study concerning the number of scientists that have acquired patented technology, reporting "32 out of 381 respondents (8%) believed they conducted research in the prior 2 years using information or knowledge covered by someone else's patent." In our study, we found 31 percent of bioscience respondents from the academic and GNHC sectors reporting the use of patented technology in their research. That discrepancy might be due to subtle differences in definitions. Whereas Walsh et al. asked whether the scientists *believe* they have used technology that was "covered by someone else's patent," we asked specifically whether patented technology had been acquired. Walsh et al. also report that only "5% (18 out of 379)" of their respondents "regularly check for patents on knowledge inputs related to their research." That suggests that there are potentially substantial differences between the two populations sampled in the two studies.

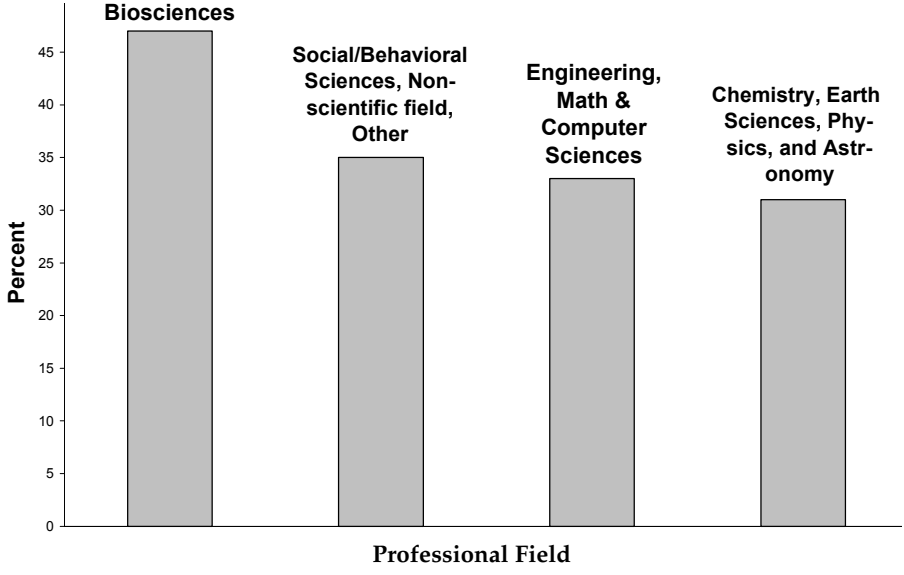

Figure 4. Whose Research Has Been Affected by Difficulties with Acquired Patented Technologies? [15]

Source: AAAS-SIPPI 2005 Patent Survey.

Those who reported that difficulty obtaining patented technology had affected their research were asked to specify how their work was affected. Overall, 58 percent (n=42) responded that their research had been delayed, 50 percent (n=36) had to change the research, and 28 percent (n=20) had to abandon it. The most common reason that respondents provided for having to change or abandon their research was that acquiring the patented technology involved overly complex licensing negotiations (58 percent, n=26; see Figure 5). High individual royalties was the next most frequent response, reported by 49 percent (n=22) of respondents. That necessary patents were not licensable was an answer provided by 40 percent (n=18) of respondents, while breakdowns in licensing negotiations was reported as a reason by 36 percent (n=16). Six or fewer respondents attributed the need to change or abandon their research to the following reasons:

[15] Note: The percentage for each field is based on the number of respondents within their own field who reported difficulties. For example, 44 of 90 bioscience respondents reported difficulties.

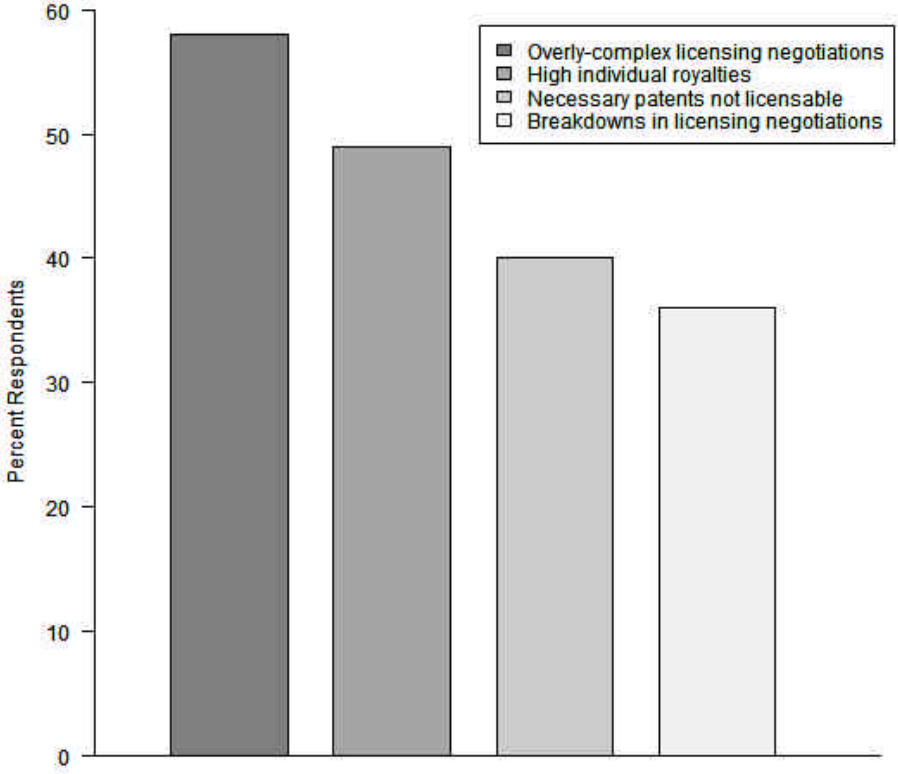

Figure 5. Type of Difficulty in Acquiring Patented Technologies[16]
Source: AAAS-SIPPI 2005 Patent Survey.

inability to determine the IP status of the technology, notification of an infringement claim, or the fact that royalties were required for multiple patents.

Creating Intellectual Property

Overall, 46 percent of respondents reported that, since January 2001, they had created a technology or made a discovery that they believed was eligible for intellectual property protection(s) (n=372).[17] Within each scientific field, a higher proportion of industry respondents reported creating IP than respondents from

[16] Based on 179 respondents.
[17] Out of a potential 843 respondents, 808 of those surveyed responded to the question upon which the figure of 46 percent is based.

academia. The scientific fields with the highest proportions of respondents creating IP were math and computer science (77 percent, n=30) and engineering (69 percent, n=70). Within math and computer science, 90 percent (n=9) of industry respondents and 67 percent (n=14) of respondents from academia created IP. Within engineering, 80 percent (n=35) of industry respondents created IP, in contrast to 59 percent (n=19) of respondents from academia. In most other fields, the proportion of industry respondents who created IP was almost double that of academic respondents who had created IP.

Of the methods used to protect IP, the greatest proportion of respondents who created IP (55 percent, n=204) used patents. Patenting was highest among industry respondents who had created IP in the fields of chemistry (94 percent, n=16) and biosciences (85 percent, n=29), respectively. Among academic respondents who had created IP, those in the field of engineering reported the highest rate of patent use, at 68 percent (n=13). Academic respondents in the fields of chemistry and biosciences reported relatively high patent use as well, with patents reported by 59 percent (n=10) in chemistry and 56 percent (n=32) in the biosciences who had created IP.

Copyright was the second-most common method used to protect IP (21 percent of all respondents who had created IP copyrighted their work: n=77). Across all scientific fields except engineering, the proportion of respondents from academia that used copyright was higher than the proportion from industry. Additionally, 36 percent (n=134) of all respondents who had created IP protected it by withholding data, delaying publication, not publishing at all, or a combination of those approaches. In 55 percent (n=74) of such cases, the respondents also had protected their IP with patents.

Details of Most Important Patent

Respondents who used patents to protect IP that they had created since January 2001 were asked to provide details regarding their most important patent (see Appendix Table 3). Of the 204 respondents that reported using a patent to protect IP, 194 provided information on those patents. Of those, 41 percent (n=79) described their most important patent as a technology whose value is wholly or partially as a research tool. That proportion was higher among university scientists, with 50 percent (n=33) characterizing their patented technology as a research tool.

Motivations for patenting (see Appendix Table 4) differed somewhat between sectors, although "protecting technology from imitation" ranked as the most

important reason for all three (industry, academia, and the combined GNHC sector). For university respondents who had applied for a patent, "acquiring private R&D funding" was the second-most important reason for their doing so. For industry and the GNHC sector, however, that reason ranked 10th and 6th in importance, respectively. For industry, "preventing competitors' patenting and application activities" was the second-most important reason behind their motivations for patenting. Acquiring public R&D funding was ranked 8th by university patent applicants, 8th by patent applicants in the GNHC sector, and 12th by industry applicants.

Overall, 62 percent (n=117) of respondents who had created IP and attempted to protect it with a patent reported that they also had disseminated the technology in some way. When we examined issued patents, we found that 67 percent (n=52) were disseminated and 58 percent (n=61) of technologies with patents under examination or appeal were disseminated. A greater proportion of respondents (66 percent, n=77) reported publishing to disseminate their technology than any other method.[18] Informal sharing was the second-most frequent method, reported by 54 percent (n=63) of respondents. A total of 85 percent (n=99) of respondents reported that they had disseminated their technologies either through publishing, informal sharing, or both methods. Eighty-eight percent (n=45) of academic respondents and 76 percent (n=26) of industry respondents reported that they had disseminated their technologies either through publishing, informal sharing, or both methods.

The proportion of both industry and university inventors who disseminated their technology within their own sector was higher than the proportion that disseminated it within other sectors. Whereas 81 percent (n=38) of university inventors disseminated their technologies within academia, only 57 percent (n=27) disseminated their technologies within industry. Similarly, 91 percent (n=29) of industry inventors disseminated their technologies within their own sector, whereas only 63 percent (n=20) disseminated their technologies within academia.

Overall, 25 percent (n=29) of respondents who had disseminated a technology included a research exemption for themselves. Overall, 32 percent (n=15) of respondents who had used some form of licensing in the dissemination of their technology also included a research exemption.

[18] The "method of dissemination" question was answered by 116 of 117 potential respondents.

Among industry respondents who had not disseminated their patented technology, the most frequently reported reason was that they were developing or commercializing it themselves (65 percent, n=33). The top reason among academic respondents who had not disseminated the patented technology they had created was that they planned to conduct future research with it (40 percent, n=6). Only three academic respondents (20 percent) did not disseminate their technology because they were developing or commercializing it themselves.

Conclusions

This survey provides some insights into the way scientists manage their own intellectual property, including their motivations for protecting it. Since this analysis does not draw upon a weighted sample, limited conclusions can be made about the salience of intellectual property for AAAS members. Nevertheless, the results suggest differences in the way that various subpopulations of scientists handle intellectual property matters.

Although the survey found that patents were the most common means used by respondents to protect their IP—especially in the fields of chemistry and the biosciences—the licensing of those patented technologies was not the primary means by which respondents within academia acquired or disseminated technology. Thus, it appears that academia might be less affected than industry by more restrictive and formal licensing practices in the acquisition of necessary patented technologies for research.[19] In fact, difficulties reported by bioscience industry respondents in attempting to access patented technologies outnumbered those of bioscience academic respondents by a ratio of more than 2:1. However, this could be because industry respondents reported creating and holding more IP than academic respondents, as well as the fact that industry relies more on licensing, which entails greater and longer negotiations than other more traditional and informal means of technology transfer still used within academia. Future AAAS-SIPPI investigations will explore the relationship between intellectual property and the conduct of scientific research in greater detail.

[19] A 2003 study by Walsh, Cohen, and Arora also found that despite numerous patents on upstream technologies, academic researchers reported experiencing few problems in accessing knowledge.

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Appendix

Table 1: Respondents Reporting Difficulties Obtaining Patented Technology that Affected Their Research, by Scientific Field and Employment Sector

Field of respondent	Sector of respondent[20]	Total	No. who acquired (acq) patented technologies (pt) for use in research, since 2001				Of those who acquired pt, No. reporting that difficulties affected research (pt w/ diff)			
			acq pt	no pt	nr[21]	% acq pt	diff	no diff	nr	% pt w/diff
Bioscience	GNHC[22]	81	26	54	1	**33%**	9	13	4	**41%**
	Industry/ Business	53	28	25		**53%**	19	6	3	**76%**
	University/ College	164	49	115		**30%**	16	30	3	**35%**
	Other	11	0	10	1	**0%**				
Chemistry	GNHC	14	0	14		**0%**				
	Industry/ Business	25	11	13	1	**46%**	4	6	1	**40%**
	University/ College	47	8	39		**17%**	1	5	2	**17%**
	Other	5	0	5		**0%**				
Earth sciences	GNHC	15	0	14	1	**0%**				
	Industry/ Business	3	1	2		**33%**	0	1		**0%**
	University/ College	18	1	17		**6%**	0	1		**0%**
	Other	4	0	4		**0%**				

[20] The values for this variable are counts derived from the sector of employment as reported on the AAAS membership form—not as reported on the survey.
[21] nr = no response.
[22] GNHC: Government, Nonprofit Organization, Healthcare Organization, or Self-Employed/Consulting Firm.

Field of respondent	Sector of respondent[20]	Total	No. who acquired (acq) patented technologies (pt) for use in research, since 2001				Of those who acquired pt, No. reporting that difficulties affected research (pt w/ diff)			
Physics and Astronomy	GNHC	26	4	22		**15%**	2	2		**50%**
	Industry/ Business	12	3	9		**25%**	0	3		**0%**
	University/ College	73	13	60		**18%**	4	6	3	**40%**
	Other	16	1	15		**6%**	0	1		**0%**
Engineering	GNHC	19	2	17		**11%**	0	2		**0%**
	Industry/ Business	46	17	29		**37%**	6	9	2	**40%**
	University/ College	36	7	28	1	**20%**	1	5	1	**17%**
	Other	6	0	6		**0%**				
Math and Computer sciences	GNHC	4	2	2		**50%**	0	2		**0%**
	Industry/ Business	11	2	9		**18%**	1	1		**50%**
	University/ College	21	5	16		**24%**	2	3		**40%**
	Other	5	1	3	1	**25%**	1	0		**100%**
Social/ Behavioral sciences	GNHC	23	2	21		**9%**	1	1		**50%**
	Industry/ Business	6	3	3		**50%**	1	2		**33%**
	University/ College	64	10	54		**16%**	4	6		**40%**
	Other	6	0	6		**0%**				
Non-scientific field	GNHC	0	0	0						
	Industry/ Business	4	0	4		**0%**				
	University/ College	2	1	1		**50%**	0	0	1	
	Other	3	0	3		**0%**				

Field of respondent	Sector of respondent[20]	Total	No. who acquired (acq) patented technologies (pt) for use in research, since 2001				Of those who acquired pt, No. reporting that difficulties affected research (pt w/ diff)			
Other	GNHC	4	1	3		**25%**	0	1		**0%**
	Industry/ Business	2	1	1		**50%**	0	1		**0%**
	University/ College	8	1	7		**13%**	0	0	1	
	Other	6	0	5	1	**0%**				
Total		843	200	636	7	**24%**	72	107	21	**40%**

Source: AAAS-SIPPI 2005 Patent Survey.

Table 2: Length of Time to Acquire Technology, by Method of Transfer

Method of Transfer	Less than 1 month	1-2 months	2-6 months	Over 6 months	Do not know
Informal	8 (31%)	1 (4%)	6 (23%)	2 (8%)	9 (35%)
Exclusive License	8 (21%)	7 (18%)	9 (23%)	13 (33%)	2 (5%)
Nonexclusive License	22 (39%)	7 (12%)	11 (19%)	8 (14%)	9 (16%)
Material Transfer Agreement	17 (27%)	16 (25%)	15 (23%)	12 (19%)	4 (6%)
Sponsored Research Agreement	2 (8%)	7 (25%)	7 (25%)	5 (19%)	4 (60%)
Confidentiality Agreement	6 (16%)	8 (21%)	10 (26%)	7 (18%)	7 (18%)
Other	2 (40%)	0 (0%)	0 (0%)	0 (0%)	3 (60%)
Do not know	2 (20%)	0 (0%)	1 (10%)	0 (0%)	7 (70%)
Total	55 (30%)	34 (18%)	40 (22%)	27 (15%)	28 (15%)

Source: AAAS-SIPPI 2005 Patent Survey.

Table 3: Respondents Reporting Creation of Intellectual Property (IP), and Method by which They Protected IP, by Scientific Field and Employment Sector of Respondent

Field	Sector	No.	Created IP since Jan 1, 2001				Patent	Copyright	Other[23]
			yes IP	no IP	nr	% IP	No. (%)	No. (%)	No. (%)
Bioscience	GNHC	81	33	42	6	44%	14 (42%)	2 (7%)	10 (30%)
	Industry/ Business	53	34	16	3	68%	29 (85%)	3 (9%)	18 (52%)
	University/ College	164	57	102	5	36%	32 (56%)	14 (25%)	17 (30%)
	Other	11	2	8	1	20%	0 (0%)	1 (50%)	2 (100%)
	Total	309	126	168	15	43%	75 (60%)	20 (16%)	47 (37%)
Chemistry	GNHC	14	9	4	1	69%	4 (44%)	0 (0%)	5 (56%)
	Industry/ Business	25	17	6	2	74%	16 (94%)	0 (0%)	10 (59%)
	University/ College	47	17	28	2	38%	10 (59%)	4 (24%)	5 (29%)
	Other	5	1	4		20%	0 (0%)	0 (0%)	1 (100%)
	Total	91	44	42	5	51%	30 (68%)	4 (9%)	21 (49%)

[23] Protected IP by withholding data, delaying publication, or not publishing.

Field	Sector	No.	Created IP since Jan 1, 2001				Patent	Copyright	Other[23]
Earth sciences	GNHC	15	2	13		13%	1 (50%)	0 (0%)	2 (100%)
	Industry/ Business	3	1	2		33%	1 (100%)	0 (0%)	0 (0%)
	University/ College	18	6	12		33%	0 (0%)	2 (40%)	3 (50%)
	Other	4	1	3		25%	0 (0%)	0 (0%)	1 (100%)
	Total	40	10	30		25%	2 (20%)	2 (25%)	6 (60%)
Physics and Astronomy	GNHC	26	7	19		27%	4 (57%)	2 (40%)	2 (29%)
	Industry/ Business	12	10	2		83%	7 (70%)	1 (10%)	0 (0%)
	University/ College	73	24	45	4	35%	10 (42%)	7 (30%)	11 (46%)
	Other	16	3	13		19%	2 (67%)	0 (0%)	0 (0%)
	Total	127	44	79	4	36%	23 (52%)	10 (24%)	13 (30%)
Engineering	GNHC	19	13	6		68%	4 (31%)	1 (8%)	3 (23%)
	Industry/ Business	46	35	9	2	80%	30 (86%)	5 (15%)	11 (31%)
	University/ College	36	19	13	4	59%	13 (68%)	1 (7%)	8 (42%)
	Other	6	3	3		50%	3 (100%)	0 (0%)	0 (0%)
	Total	107	70	31	6	69%	50 (71%)	7 (11%)	22 (31%)

Field	Sector	No.	Created IP since Jan 1, 2001				Patent	Copyright	Other[23]
Math and Computer sciences	GNHC	4	4	0		100%	3 (60%)	1 (20%)	2 (40%)
	Industry/ Business	11	9	1	1	90%	4 (44%)	2 (22%)	5 (55%)
	University/ College	21	14	7		67%	5 (36%)	5 (36%)	5 (36%)
	Other	5	3	1	1	75%	2 (67%)	0 (0%)	2 (67%)
	Total	41	30	9	2	77%	14 (45%)	8 (26%)	14 (38%)
Social/ Behavioral sciences	GNHC	23	6	17		26%	0 (0%)	2 (33%)	2 (33%)
	Industry/ Business	6	4	2		67%	0 (0%)	2 (50%)	3 (75%)
	University/ College	64	22	42		34%	2 (9%)	16 (73%)	4 (18%)
	Other	6	2	4		33%	0 (0%)	0 (0%)	0 (0%)
	Total	99	34	65		34%	1 (6%	20 (59%)	9 (26%)
Non-scientific field	Industry/ Business	4	4	0		100%	3 (75%)	1 (25%)	0 (0%)
	University/ College	2	0	1	1	0%	0 (0%)	0 (0%)	0 (0%)
	Other	3	2	1		67%	2 (100%)	1 (50%)	0 (0%)
	Total	9	6	2	1	75%	5 (83%)	2 (33%)	0 (0%)

Field	Sector	No.	Created IP since Jan 1, 2001				Patent	Copyright	Other[23]
Other	GNHC	4	1	2		50%	0 (0%)	1 (100%	0 (0%)
	Industry/ Business	2	2	0		100%	2 (100%)	1 (50%)	1 (50%)
	University/ College	8	3	4	1	43%	1 (33%)	1 (33%)	1 (33%)
	Other	6	1	4	1	20%	0 (0%)	1 (100%)	0 (0%)
	Total	20	8	10	2	44%	3 (43%)	4 (57%)	2 (29%)
Total		**843**	**372**	**436**	**35**	**46%**	**204 (55%)**	**77 (21%)**	**134 (36%)**

Source: AAAS-SIPPI 2005 Patent Survey.

Table 4. Motivations for Patenting, by Sector

Reason for Patenting	Industry	University	GNHC
Protecting technology from imitation	1	1	2
Preventing competitors patenting and application activities	2	7	3
Improving technological portfolio of institution	3	3	1
Improving org. negotiations (e.g., exclusive licensing, joint ventures)	4	12	5
Improving academic rep of institution	5	8	4
Improving R&D cooperation	6	9	6
Timing scientific publications	7	4	7
Generating licensing income	8	6	11
Acquiring private R&D funding	9	2	8
Cooperating with other institutions	10	13	9
Acquiring venture capital	11	10	13
Number of scientific publications	12	11	12
Acquiring public R&D funding	13	5	10
Other concerns	14	15	14
Mergers with other institutions	15	14	15

Source: AAAS-SIPPI 2005 Patent Survey.

Note: Ranks of average ratings for each potential reason for patenting, by sector. In original question, 1=not at all important, 2=slightly important, 3=somewhat important, 4=very important.

GNHC: Government, Nonprofit Organization, Healthcare Organization, or Self-Employed/Consulting Firm.