The Bayh-Dole Act Turns 30

By Vicki Loise, CAE, and Ashley J. Stevens, CLP

In December 2002, the normally stiff upper lip English weekly *The Economist* gushed:[1]

Possibly the most inspired piece of legislation to be enacted in America over the past half-century was the Bayh-Dole act of 1980. Together with amendments in 1984 and augmentation in 1986, this unlocked all the inventions and discoveries that had been made in laboratories throughout the United States with the help of taxpayers' money. More than anything, this single policy measure helped to reverse America's precipitous slide into industrial irrelevance.

The savior of America? Heady stuff indeed.

So, what is all the hoopla about? What on earth is Bayh-Dole? Why is Senator Birch Bayh remembered not for his substantial role in fundamentally changing U.S. society—he authored the 25th and 26th amendments to the Constitution (respectively, changing the rules for the Presidential and Vice Presidential succession and lowering the voting age to 18) and Title IX, the law which, by changing how women are treated in college athletics, transformed women's role in society—but instead, for an obscure law which changed the way universities manage their patents?

The Act's very name takes us back to what today, just thirty years later, feels like a bygone era of bipartisanship. Back in those distant days, a Republican and a Democrat would decide that something was important to do, would jointly author an act, would bring their colleagues into a coalition to discuss and amend it, and eventually it would be passed. Some of the U.S.'s greatest pieces of legislation were born this way.

The Background to the Act

The Act was born of desperation. To quote *The Economist* again:

Remember the technological malaise that befell America in the late 1970s? Japan was busy snuffing out Pittsburgh's steel mills, driving Detroit off the road, and beginning its assault on Silicon Valley. Only a decade later, things were very different. Japanese industry was in retreat. An exhausted Soviet empire threw in the towel. Europe sat up and started investing heavily in America. Why the sudden reversal of fortunes? Across America, there had been a flowering of innovation unlike anything seen before.

At its heart, therefore, Bayh-Dole was a competitiveness and economic revitalization initiative. It was intended to reconnect academic research and innovation to the mainstream economy after three disastrously controversial cases in the mid 1960s (concerning, repectively, Gatorade, 5-fluorouracil and the phenylketonuria test) in which the government asserted ownership of patents based on research it had funded.[2] This resulted in a Chinese wall being erected between academic and corporate research. Research was literally described as being "contaminated" by federal funding because of the government's licensing policies—the government would only grant non-exclusive licenses to patents it owned. It will be important to remember its origins later in this commentary when we start to look at the criticisms of it.

What is the Act and isn't the Act?

The Act was remarkably simple. It gave institutions the unambiguous right to claim title to inventions made with federal funding. The funding agency couldn't deny the request unless it had made a "determination of exceptional circumstances" in advance. Disclosing the invention and claiming title had to be done within defined time limits. A single set of rules governed all funding agencies.

There were remarkably few rules and conditions. The institutions had to:

- Grant licenses to the patents rather than assign their title to them;
- Disclose the government's interest in patent applications and notify the government before abandoning any patent application;
- Share the income they received with the inventors—how much to share was left up to individual institutions;
- Use any residual income retained by the institution for research and education;
- Grant a royalty-free non-exclusive license to U.S. Government for its own use;
- Require licensees to manufacture products in the U.S. that were to be sold in the U.S.; and
- Give preference to small businesses.

As a final safeguard, the government retained the

1. Innovation's Golden Goose. *The Economist*, December 12, 2002.

2. In the case of 5-fluorouracil, just $120 of reagents were erroneously charged to a grant out of a $500,000 project funded by Roche. However, the government still took title to the patents.

right to grant a compulsory license in the public interest if the invention was not being practiced.

The Act provided no new funding for these new commercialization responsibilities, a topic we shall return to later. On balance this was probably a positive at the time, since there was no need for the Act to be periodically reauthorized when new funds were appropriated. There was therefore no opportunity for the provisions of the Act to be tinkered with and institutions have been able to make long term investments in implementing the Act. As a result, a body of licensing expertise and practical experience has been developed within academia over the past thirty years.

Was Bayh-Dole that miraculous? Well, Birch Bayh's laconic co-sponsor, Bob Dole, once dryly observed that it sounded like an advertisement for bananas! The Act is in fact massively misunderstood. It's not about whether professors at research universities should work on real world problems—they have been ever since Boston University gave an obscure professor of Vocal Physiology and Elocution—Alexander Graham Bell—a year's paid leave of absence in 1875[3] so that he could apply his understanding of sound waves to electricity, thereby creating the telephone.[4]

It's not about whether professors at research universities should apply for patents if their work on real world problems results in something useful—like any lone inventor, they need to get patents on their inventions if they hope to attract the funding necessary to develop them. Bell's two patents are arguably the most valuable patents the world has ever seen.

And it's not about whether professors' inventions should be developed—of course their inventions should be developed if they're truly useful.

Rather, the Bayh-Dole Act is quite simply about who should own and manage academic inventions and who should share in the fruits of their success. Before Bayh-Dole, inventions made with federal funding, which accounts for 70 percent or more of the research funding at universities, were owned by the government, which as noted above, believed that no single company should benefit from research that had been publicly funded and so would only grant non-exclusive licenses to the patents. While certainly a high minded and well meaning principle, what it meant in practice was that the first company brave enough to take a license to an academic invention and make the substantial investment needed to prove that the technology worked could then expect to see other companies get a license on the same terms without having to assume a similar financial risk. Not surprisingly, this was an unattractive proposition and by 1978, the government had acquired 28,000 patents this way and had licensed fewer than 4 percent of them. Another major problem was that, the government had no relationship with the inventor, whose active involvement is invariably needed to successfully transfer an embryonic academic technology to a company for development. The government couldn't guarantee a prospective licensee that the inventor would approve of them as a licensee and would collaborate with them to develop the technology.

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The Institutional Ownership Model of Academic Inventions and its Alternatives

Bayh-Dole gave ownership of inventions back to the universities that created them[5] and gave universities the freedom to negotiate license terms that would encourage development. Essentially, it created the "institutional ownership model" of academic inventions.

In the UK, the National Research and Development Corporation was set up in 1949 to ensure that the UK would never again miss out on the commercial benefits from a scientific breakthrough like penicillin, which had been handed over to the U.S. during WWII.[6] The NRDC held a monopoly on British academic inven-

3. {Bruce, 2000 #89}; Bell owned his patents himself, what we will later describe as the "Professor's Privilege" model of academic invention ownership, and Boston University did not benefit financially from its generosity to Bell in providing him with a year's salary so that he could invent.

4. Bell's intellectual predecessor in creating the modern era of instant communications–Samuel Morse–was also a professor, but a professor of Arts and Design at New York University and his invention of the telegraph cannot be attributed to his academic expertise.

5. The term "university" should also be read to include teaching hospitals and non-profit research institutes.

6. In the ultimate insult, the UK even had to pay royalties to Andrew Moyer, the USDA staff scientist who developed the submerged fermentation method. Under practices in the 1930's and 1940's, federal labs didn't take out U.S. patents, but their employees could take out non-U.S. patents in their own names!

tions, but when Margaret Thatcher realized it had failed to recognize and capitalize on major British public sector inventions such as the hovercraft and monoclonal antibodies, she abolished its monopoly in 1987 and started the UK down the same pathway of institutional ownership as the U.S. had adopted.[7]

Given that the government's ownership of academic patents clearly didn't work, what are the alternatives to the Bayh-Dole institutional ownership model of academic inventions?

The only alternative is to let professors own their inventions themselves—the so-called "professor's privilege," which was historically the predominant model in Europe and the rest of the world outside the U.S. and the UK.[8] Observing the long term success of the institutional ownership model in the U.S. and UK, European countries started changing over to the institutional ownership model in the mid-1990's, and Sweden is now the only major European country where the professor's privilege model is still in place.

The professor's privilege model has numerous drawbacks, including:

- Younger faculty frequently can't afford to pay for patent protection, in which case their inventions will go unprotected and undeveloped;
- The vast majority of professors are outstanding at identifying the practical applications of their science and how to develop them, but are frequently not good businessman;
- Since academic patents generally have multiple inventors, often at different institutions, reaching agreement on who will manage the invention will complicate and delay commercialization;
- There are substantial private inurement issues and conflict of interest concerns with allowing publicly funded laboratories to operate for the personal benefit of professors. For instance, how will the professional development needs of postdoctoral fellows and graduate students be safeguarded?

7. Richards, W. G. (2009). *Spin-Outs: Creating Business from University Intellectual Property*, Harriman House.

8. Even in the UK, the Universities of Oxford and Cambridge followed the professor's privilege model, following Oxford's disastrous experience in the 1920's in a fraud case resulting from a professor's invention of a new way to extract sugar from beet. Oxford started moving away from this model as soon as Thatcher abolished the NRDC's monopoly, while Cambridge only started around 2003.

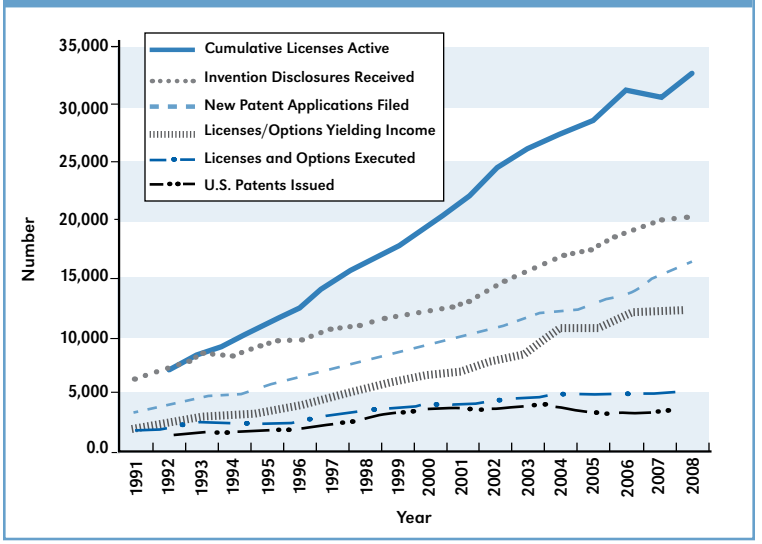
The institutional model has therefore become the norm in the developed world and is now spreading to the developing world, with Brazil, India and South Africa having adopted it.

The Impact of Bayh-Dole

So, what have been the impacts of Bayh-Dole?

First, after 1980, universities responded and started creating offices of technology licensing ("OTL"), albeit at a somewhat slower pace than might have been expected. Only twenty three universities had OTL's prior to Bayh-Dole. Starting in 1983, the rate of creation increased dramatically and today, all major research institutions have an OTL.

Figure 1. Change In Core Measures Of Technology Transfer Activity



The level of basic technology transfer activity—invention disclosures, patent applications, patent issuances, licensing—has increased steadily too. The Association of University Technology Managers ("AUTM") has conducted an Annual Licensing Activity Survey since 1991. Figure 1 shows how key measures of activity have increased since the inception of the Survey.

Universities have used a diverse pattern of commercial arrangements. Existing small companies (i.e., companies with 500 employees or fewer) account for 50 percent of licenses, while large companies account for 35 percent of licenses. Spin-out companies—newly created companies formed specifically to commercialize a particular academic technology—account for 15 percent of licenses. These proportions have held fairly constant for a number of years.

There has been an increasing trend towards non-exclusive licensing and in FY2008, non-exclusive

licenses accounted for 56 percent of all licenses issued. Licenses to spin-out companies and to potential drugs, where substantial investments will be required, are almost always exclusive.

The income earned by universities from licensing has increased substantially, from $7.3 million in 1981[9] to $3.4 billion in 2008.[10] Paradoxically, however, despite this high level of income, technology transfer is still a money losing proposition for most universities. Two factors account for this:

1. Income is highly concentrated in a few "big hits." 24 percent of the $3.4 billion in income reported in 2008 was reported by Northwestern University, which had discovered Lyrica, licensed it to Pfizer and monetized part of its royalty stream in 2008. City of Hope Hospital, which has patents on key techniques for producing monoclonal antibodies, reported 12 percent of the total, and Memorial Sloan Kettering, Children's Hospital of Philadelphia and the University of California system reported the next 16 percent. The final 47 percent was shared among the remaining 180 respondents to the Survey; and

2. The majority of the income that is generated—typically 60-80 percent—is distributed to the inventors for their personal benefit and to the inventors' laboratories and colleges to be spent on research (both of which the Bayh-Dole requires) to incentivize them to participate in the technology transfer process. Only a small portion is used to offset the costs of technology transfer.

As a consequence, a recent study[11] showed that, in 2006, 52 percent of U.S. institutions spent more on technology transfer than the entire income they generated from the activity, while only 16 percent kept enough of the income they generated to cover their costs. This is probably inevitable—ninety five percent or more of the economic impact of technology transfer is outside the university, in the private sector, reflecting the enormous private sector investment usually needed to take an embryonic academic technology from the laboratory to the marketplace. And this is reflective of technology transfer professionals' priorities—finding the best method for getting science into the public's hands. However, to 84 percent of university presidents, their technology transfer operations showed red ink. University presidents normally don't like to see red ink—every professor, every degree, every program is expected to support itself—"Every tub must stand on its own bottom" is an ancient proverb that is famously associated with Harvard's philosophy of financial management.

Back in 1980, the sponsors of the Act were concerned that the results of America's publicly funded scientific research were not benefiting the public from either a quality of life or an economic development standpoint. This has changed dramatically over the past 30 years:

- As early as 1992, stories started to appear in the business press talking about how regions anchored by research universities were becoming centers of high tech job growth.[12]
- 154 FDA approved drugs have been brought to market since 1980 which were discovered in whole or in part at U.S. public sector research institutions.[13]
  - From 1990—2008, 9 percent of all drugs approved by the FDA, and 21 percent of the most innovative drugs approved by the FDA, were based on discoveries at public sector research institutions.
  - As shown in Figure 3, the rate at which public sector researchers started discovering these drugs stepped up significantly in 1980,[14] the year Bayh-Dole was passed.
  - In 2008, worldwide sales of these drugs was estimated to be $103 billion.
- Well known products such as the Web browser, email programs that can attach documents, the V-chip, hollow optical fibers, the nicotine patch, the PSA test, Google, the Honeycrisp apple, cochlear

9. Stevens, A. J. (2003). "20 Years of Academic Licensing—Royalty Income and Economic Impact." 38: 133-140.

10. (2010). *AUTM Licensing Activity Survey FY2008: Survey Summary.* R. Tieckelman, R. Kordal and A. Sanga. Deerfield, IL, Association of University Technology Managers.

11. Abrams, I., G. Leung, et al. "How U.S. Academic Licensing Offices are Tasked and Motivated—Is it All About the Money?" *Research Management Review* 17.1 (Fall/Winter 2009).

12. "Hot Spots—America's New Growth Regions." *Business Week*. October 19, 1992.

13. Stevens, A. J., J. J. Jensen, et al. (2010). "The Contribution of Public Sector Research to the Discovery of New Drugs and Vaccines." *Nature Biotechnology* submitted.

14. At first blush, the drop off since the early 1990's might be interpreted as indicating that this was a relatively brief "bubble" phenomenon; however, these are the dates of discovery of drugs that subsequently received FDA approval, and owing to the long lead time of developing a drug, many drugs discovered since then are still working their way through the clinical testing and FDA approval process. Figure 2 shows that drugs discovered through public sector research are still being approved by the FDA at a healthy rate.

implants, lightning detection technology, the Hib vaccine, improved guardrail systems and cell phone technologies all have their roots in university research.[15]

• From 1980-2008, 6,652 start-up companies were formed and 3,381 of these companies were still operating at the end of 2008.[16]

o 72 percent of these companies had their primary place of business in the institution's home state.

o Every state, except Alaska, has had at least one start-up company formed as a result of licensing technology from university research.

o In 2008 alone, 595 new start-up companies were formed—11 every week.

o In a study of just 100 university spin-outs, total employment at 81 of the companies was 167,000, and total revenues at just 31 of these companies were $95 billion in 2008.

• Another study found that from 1996 to 2007 university licensed products created over 279,000 jobs[17] and that academic technology transfer contributed as much as $187 billion to U.S. GDP between 1996 and 2007.[18]

• An entire industry, biotechnology, was created from university start-up companies.[19]

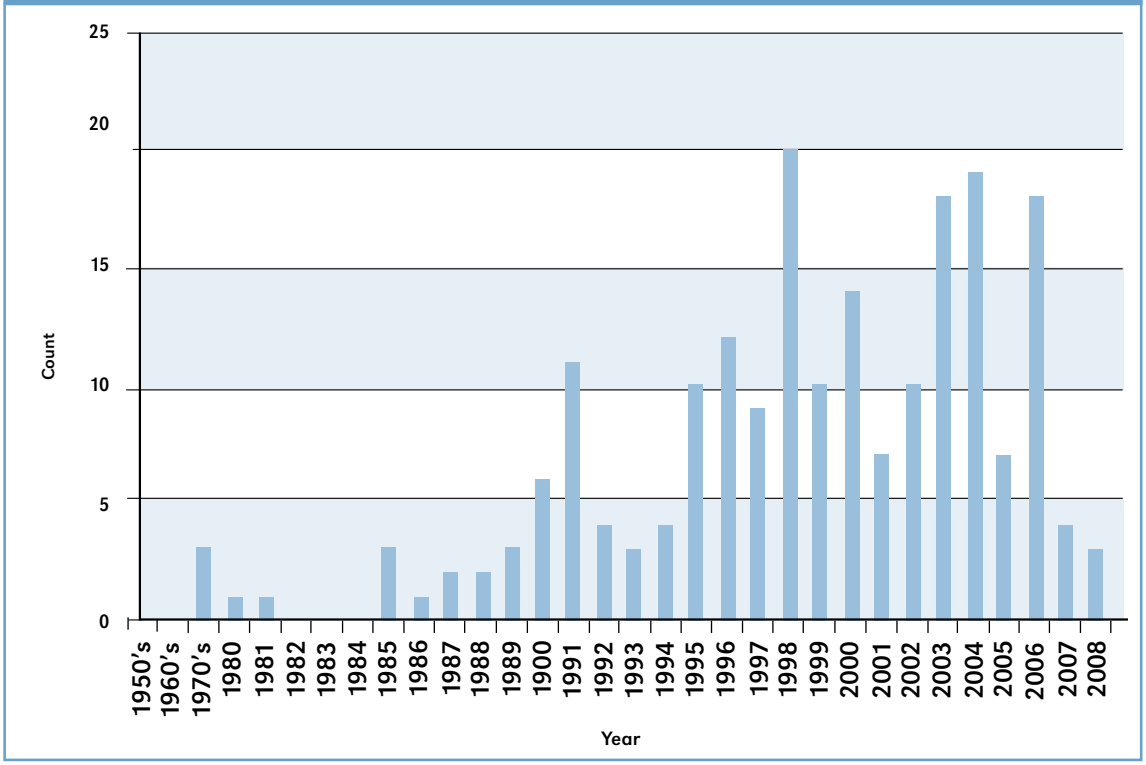
o 76 percent of biotechnology companies have a license from a university.

o At least 50 percent of current biotech companies got their start as a result of a university license.[20]

o These biotech companies represented over 1.42 million jobs in 2008.[21]

o The bioscience sector represents an employment impact of 8 million jobs, with 5.8 jobs created for every new bioscience job.[22]

Figure 2. NDA Approvals Of Drugs Discovered Through Public Sector Research



15. AUTM, The Better World Project, *www.betterworldproject.org.*

16. AUTM, *AUTM U.S. Annual Licensing Activity Survey FY 2008: Survey Summary*.

17. D. Roessner, J. Bond, S. Okubo, M. Planting, *The Economic Impact of Licensed Commercialized Inventions Resulting from University Research*, 1996-2007 Final Report presented to the Biotechnology Industry Organization, September 9, 2009.

18. ibid.

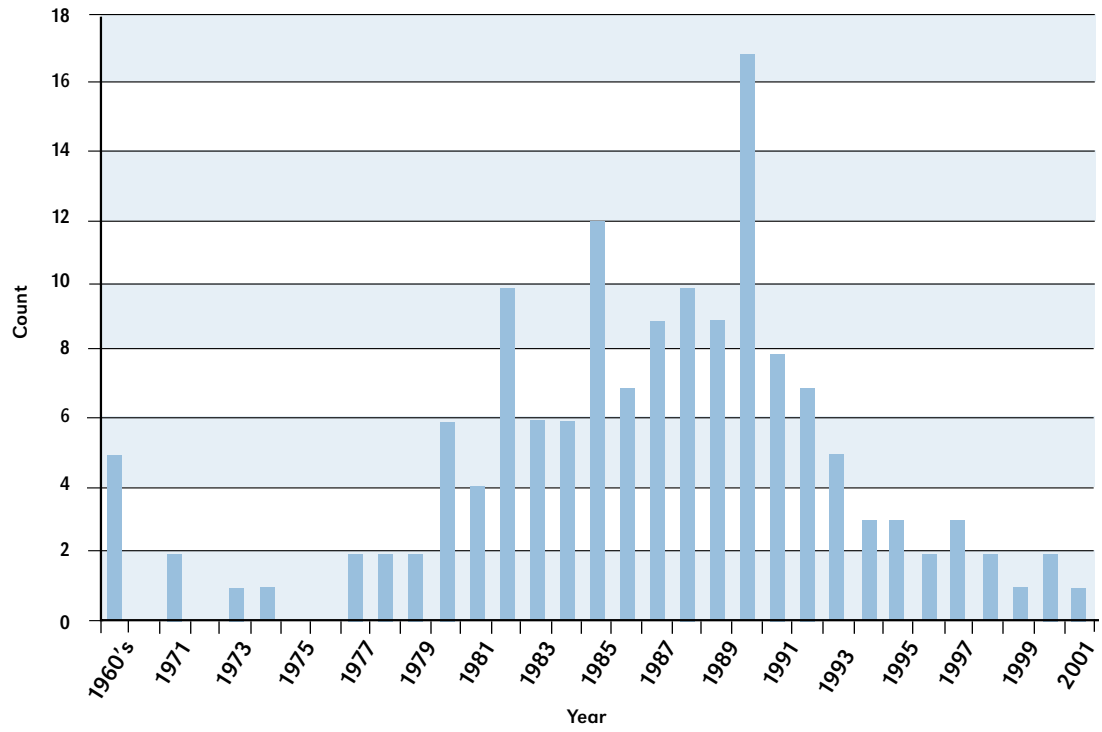
19. ibid.

20. BIO, *BIO 2009 Member Survey "Technology Transfer & the Biotechnology Industry."*

21. Battelle Technology Partnership Practice, *Battelle/BIO State Bioscience Initiatives* Report, 2010.

22. ibid.

Figure 3. Discovery Of FDA Approved Drugs Discovered Through Public Sector Research



Are There Downsides?

These examples show that Bayh-Dole has certainly delivered the economic benefits that were hoped for. But has the law of unintended consequences also come into play? Have there been bad effects? After all, just three years after its euphoric 2000 article, *The Economist* ran another article titled "Bayhing for blood or Doling out cash?"[23] in which they started to identify some of the issues with the Act, based on the strident criticisms of a coterie of academics who have made a living criticizing Bayh-Dole and attributed negative consequences to it.

The most serious of these are that:

1. Bayh-Dole has changed the nature of academia;
2. It has shifted the focus of research away from ground breaking, fundamental research to incremental applied research;
3. It has instilled a culture of secrecy on campus; and
4. The public good has not been protected.

Fortunately, there is an equally vigorous industry of academic economists who have applied rigorous economic methodologies to study technology transfer. Their findings show that academic entrepreneurship benefits rather than harming the academic enterprise. For instance:

- In a long term study covering a number of universities, Jerry and Marie Thursby found that only 6 percent of faculty are frequent invention disclosers, while two thirds never disclose anything in their entire careers. They also found that despite a tenfold increase in the level of disclosures over the course of their study, there hadn't been a shift from basic to applied research.[24]
- Blumenthal had found that faculty members receiving industrial funds had more peer-reviewed articles published in the previous three years, participated in more administrative activities in their institutions or disciplines, and were more commercially active than faculty members without such funding.[25]

23. (2005). "Bayhing for blood or Doling out cash?" *The Economist*.

24. Thursby, J. G. and M. C. Thursby (2003). "Patterns of Research and Licensing Activity of Science and Engineering Faculty." *Working Paper*. Atlanta, GA, Georgia Institute of Technology., available at: *http://hdl.handle.net/1853/10723.*

25. Blumenthal, D., M.D., M.P.P, E. G. Campbell, Ph.D., et al. (1996). "Participation of Life-Science Faculty in Research Relationships with Industry." *Science* 335(23): 1734-1739.

- Shane found that professors who'd started companies raised twice as much grant funding to support their academic research as professors who'd not started a company.[26]
- Lowe found that the publication rate of professors who started companies went up five years before they started the company and that this elevated rate continued for five years after they started the company. He also found that professors who started companies were more than ten times as likely to be superstars (as measured by citations to their papers) than their peers who had not started companies.[27]
- Sauermann *et al.* found that life sciences and engineering professors who patented a lot did so because they wanted to change society.[28]

Those who assert that patenting academic inventions introduces a culture of secrecy on campus totally fail to understand the patenting process. The very essence of patenting is that the inventors are required to make full and complete disclosures of their inventions, so that others can build on them, in return for being given a period of exclusive use of the invention. Since 2001, even U.S. patent applications have been a matter of public record—previously patent applications were confidential until the resultant patent was issued, so transparency has increased even further.

Applying for patent protection on an academic discovery creates an additional, parallel track for communicating the scientist's research results—their discoveries are published in academic journals in the normal way and presented at scientific conferences and freely disseminated to the scientific community, while, in addition, intellectual property is created from the discoveries which can then be licensed to a company for commercial development.

Particularly since 1995, with the availability of provisional patent applications[29] in the U.S., patenting and publishing are entirely compatible and the one will not delay the other. Academic exclusive licenses routinely reserve the rights to pursue basic research for all academic institutions.

American academics have embraced this freedom. Fiona Murray at MIT studied publications in *Nature Biotechnology* from 1997 to 1999 and identified that for just under 50 percent of the papers, there was a corresponding **issued** U.S. patent, a phenomenon she termed the "patent-paper pair."[30] A more recent study looked at the life sciences publications in 6 months of *Science and Nature*, journals that do not tend to favor scientific discoveries that have commercial potential as *Nature Biotechnology* undoubtedly does, and found that 32.7 percent of the biomedical research articles surveyed in the study were associated with underlying patent applications[31]—17.9 percent directly covered the research disclosed in the scientific publication, while 11.7 percent related to an enabling technology that was utilized in conducting the research.

Finally, some critics have asserted that universities are only interested in the financial gain that can result from licensing technologies and ignore social considerations. It's important to remember that Bayh-Dole was passed for economic development reasons, and as we have shown above, it has admirably fulfilled this mission. A recent study showed that maximizing financial gain only accounts for around 10 percent of the driving forces and motivations of TLO's.[32] The profession has started formulating ethical practices, such as "In the Public Interest: Nine Points to Consider in Licensing University Technology,"[33] and the "Statement of Principles and Strategies for the Equitable Dissemination of Medical Technologies" to ensure availability of university-discovered drugs at affordable prices in the developing world.[34] Currently AUTM is developing guidelines for the licensing of genetic tests, an emotionally charged area of medical practice.

26. Fini, R., N. Lacetera, *et al.* (2010). "Inside or Outside the IP-System? Business Creation in Academia." *Research Policy 39* (Issue 8): 1060-1069.

27. Lowe, R. and C. Gonzalez-Brambila (2007). "Faculty Entrepreneurs and Research Productivity." *The Journal of Technology Transfer* 32(3): 173-194.

28. Sauermann, H., W. M. Cohen, *et al.* (2010). "Complementing Merton: The Motives, Incentives, and Commercial Activities of Academic Scientists and Engineers," Sumantra Ghoshal Conference on Managerially Relevant Research, London Business School. In fairness, they also found that physical sciences professors who patented a lot did so in the hope of financial gain.

29. A provisional patent application can be as little as a scientific manuscript or a grant application with a cover sheet. A provisional application is not examined and must be converted to a regular utility application within a year or it is abandoned.

30. Murray, F., Stern, S., "Do Formal Intellectual Property Rights Hinder the Free Flow of Scientific Knowledge? An Empirical Test of the Anti-Commons Hypothesis," *Journal of Economic Behavior and Organization* (2007), doi:10.1016/j.jebo.2006.05.017.

31. Lebovitz, R. M. (2007). "The Duty to Disclose Patent Rights." *Northwestern Journal of Technology and Intellectual Property* 6 (Fall 2007): 36-45.

32. Abrams, I., G. Leung, et al. "How U.S. Academic Licensing Offices are Tasked and Motivated—Is it all about the money?" *Research Management Review* 17.1(Fall/Winter 2009).

33. *http://www.autm.net/Nine_Points_to_Consider.htm.*

34. *http://www.autm.net/AM/Template.cfm?Section=Global_Health&Template=/CM/ContentDisplay.cfm&ContentID=3848.*

One of the biggest problems in technology transfer is the "Valley of Death"—the difficulty in finding sources of private capital to fund the earliest, high risk stages of technology commercialization. Traditionally, government has only funded basic discovery research and, other than in defense technologies, provides relatively little in development funding. Although the funding required to demonstrate commercial proof of principle during the earliest stages of commercialization is relatively low, the risk is extremely high, so private sources of capital are reluctant to supply the funding until some demonstration of viability has taken place. This "Catch 22" situation is called the Valley of Death, a term first coined at least as early as 1985,[35] though the underlying economic mechanisms were enunciated by the Nobel prize winning economist, Kenneth Arrow, in 1962.[36]

Like beauty, the Valley of Death lies in the eye of the beholder, and there are many Valleys of Death. For biotechnology companies, going from Phase 1 or 2a clinical testing to Phase 2b or 3 clinical testing presents enormous financing challenges and is their Valley of Death.

In technology transfer, the Valleys of Death come much earlier. They are also shallower, at least in terms of the amount of funding needed, but that doesn't make them any easier to navigate.

As discussed above, funding the technology transfer function itself is a major issue at most universities and is the first Valley of Death. Senators Bayh and Dole anticipated that the cost of technology transfer would be included in the indirect cost base of universities. When the administrative component of indirect costs was capped at 26 percent in the early 1990's, this avenue was closed off, and, as was discussed above, for most universities, technology transfer represents a net cost.

Overall, universities only spend 0.59 percent of their research budgets on converting the results of that activity into intellectual property and licensing it[37] and on a national policy level, this undoubtedly represents a serious under-investment. However, university presidents have a difficult time understanding why they should lose money so that the economy as a whole can benefit.

The next Valley of Death comes from the difficulty of finding sources of funding to demonstrate proof of concept for the commercial applications of academic inventions. The peer review system tends not to view such grant proposals favorably in comparison with new basic, discovery research. What federal funding is available—primarily through the SBIR and STTR programs—require that the technology already to have been transferred to a company. Even though these are admirable programs which play a critical role in the innovation ecosystem, they are of limited help in showing the viability of academic technologies. Fortunately, some states operate such proof of concept centers and there are some philanthropic initiatives, such as MIT's Deshpande Center, the University of California San Diego's von Liebig Center [38]and the Wallace H. Coulter Foundations Translational Research Partnerships in Biomedical Engineering with 10 universities.[39]

The next Valley of Death for technology transfer is the difficulty in finding start-up funding for university spin-out companies. As shown in Table 1,[40] the most common place that professors turn to fund their start-ups isn't venture capital but friends and family.

Moving beyond the Valleys of Death, another of the issues with technology transfer is that there have certainly been individual cases where there have been bitter lawsuits over ownership of technologies and infringement of university patents and companies seem to get particularly upset if they are sued by an academic institution for patent infringement. These disputes are probably inevitable if universities are to play an important part of the innovation ecosystem—if substantial value is created, there will inevitably be disputes over who should share in it.

Finally, there are issues of conflict of interest and

35. Fawcett, S.L., 1985. "Macro-engineering projects in a free society." *Technology in Society*, 7(4), 361-371. The term was popularized by Congressman Vernon Ehlers, himself a Ph.D. physicist when the term was used in a Report to Congress by the Science Committee, of which he was Vice-Chair in 1998.

36. Arrow, K. J. (1962). "Economic Welfare and the Allocation of Resources for Invention in the Rate and Direction of Inventive Activity." *Science bought and sold : essays in the economics of science* / edited by P. Mirowski and E.-M. Sent. Chicago, IL, University of Chicago.

37. Abrams, I., G. Leung, *et al.* "How U.S. Academic Licensing Offices are Tasked and Motivated—Is it all about the money?" *Research Management Review* 17.1(Fall/Winter 2009).

38. The Kauffman Foundation has published an excellent review of these two programs, showing that projects funded through them have resulted in start-up companies at a rate 6 times higher than for normal and that these companies have attracted venture capital investment 80 times the amount of translational funding that went into the projects. Interestingly though, the overall rate licensing success remained at around 29 percent of all the projects. See *http://www.kauffman.org/advancing-innovation/accelerating-commercialization-of-university-innovation.aspx.*

39. *http://www.whcf.org/Partnership-Award/partnership-award.html.*

40. AUTM Annual Licensing Activity Survey, 2004—2008.

Table 1. Source Of Initial Funding For University Spin-Out Companies

Source	2004	2005	2006	2007	2008
Individuals					
No External Funding	57	55	54	86	76
Friends and Family	94	104	123	135	109
Individual Angels	49	48	82	82	62
Angel Network	26	14	23	32	31
Institutions					
State Funding	36	29	41	63	63
Venture Capital	85	84	81	88	92
Corporate Partner	25	28	45	33	38
Own Institution	26	28	42	51	53
SBIR/STTR	32	43	45	42	43
Other	28	40	52	47	42

export controls that add layers of bureaucracy to scientists wanting to commercialize the results of their science that can be a deterrent to some who would otherwise move down the commercialization pathway.

The Future

Technology transfer has evolved enormously both as a process and as a profession over the 30 years since Bayh-Dole was passed. We've moved from a handful of technology transfer offices to over 200 in the U.S. alone. The average number of employees per office has grown by 85 percent. These professionals are growing in how they support the research enterprise at their institutions. They have moved from the narrow focus of filing patents and administering licenses to recommending paths for development, setting up mentorship and entrepreneur-in-residence programs, helping start-up companies find their initial management teams and helping them find their initial funding. The Annual Meeting of AUTM attracts close to 2,000 attendees from 35 countries, anxious both to learn from the U.S. experience and, increasingly, to share the learnings and best practices that work in their innovation ecosystems.

OTL's and the professionals who staff them are moving from being labeled "technology transfer" or, even more archaically, "technology licensing" to "technology development," working collaboratively with faculty to chart strategic pathways to develop technologies and to get the results of their research into the public's hands. At the end of the day, this is the number one priority of the profession.

The Obama administration is taking a keen interest in university research commercialization. Over 120 responses were received in response to a "Request for Information" on ways of enhancing university research commercialization that was issued by the Office of Science and Technology Policy in March, 2010. Secretary of Commerce Gary Locke convened a day long meeting of academic leaders in February 2010 to identify how the process could be enhanced and has followed up with a series of four regional meetings to solicit new ideas from around the country.

The priorities for technology transfer in the future won't change. It will always be to find someone willing to make the substantial investment needed to improve the viability of a technology and take it to market, because that was the purpose of the Act from the beginning, but how we get there will certainly change.

We need to broaden the base of technology transfer and find creative mechanism by which smaller institutions that do not have a sufficient idea flow to justify their own full time offices can form partnerships with bigger offices, so that when their faculty do have promising ideas they can get the support necessary to turn their ideas into reality.

We need to find creative new sources of funding translational research. The NSF has started moving in this direction, and has included a $12 million "NSF Innovation Ecosystem" component within its Partnerships for Innovation program in its 2010/11 budget. The NIH is also moving in this direction with its Clinical and Translational Science Awards. An equivalent to the SBIR and STTR program that could be spent entirely within a university, but which is evaluated on the same commercial criteria as SBIR's and STTR's would achieve this. It would not need to be as large as the SBIR and STTR programs—say a 0.15 percent set-aside would generate a meaningful level of funding. Entrepreneurial post doctoral fellowships. To allow graduate students to take the subject of their Ph.D. thesis towards commercialization, carrying out both the proor-of-principle studies and the first strategizing of the commercialization pathways would help in this regard. The Kauffman Foundation has successfully pioneered this concept.

Technology transfer will be recognized as a profes-

sion, with its members having credentials such as the Certified Licensing Professional ("CLP") being awarded by CLP, LLC or the Registered Technology Transfer Professional ("RTTP") being awarded by the Alliance of Technology Transfer Professionals ("ATTP"), a global alliance of formed by AUTM and four regional professional technology transfer associations.[41]

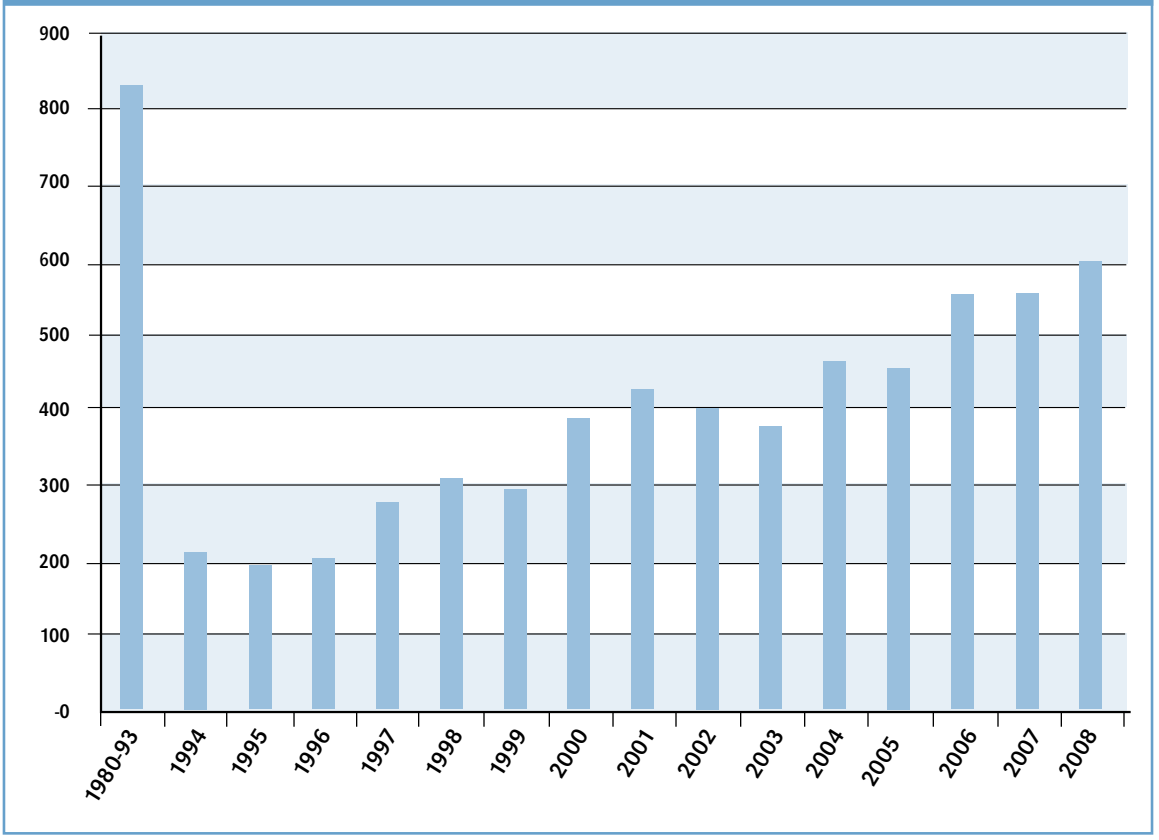
Thirty years from now it is imperative that technology development offices be fully funded by their institutions supported by federal funding. They will be viewed as service centers within their institutions, working to disseminate the results of the institutions' research to the commercial sector, rather than being expected to be cash cows (and inevitably disappointing in this regard), and they will continue to work side-by-side with their industry counterparts to develop science into safe, life enhancing products. Most importantly, they will be advocates for the entire research enterprise.

Conclusion

We can sleep better at night knowing the U.S. has become an innovation powerhouse in part because of the Bayh-Dole Act; that we are getting a massive return on the nation's investment in basic scientific research through the products we use every day; and that the Bayh-Dole Act will continue to create companies and jobs when we need them most. By moving the ownership of inventions back to the people and places who best understand their potential -- the same people and places that made the invention in the first place—and how to develop them, we have put a solid foundation under the U.S.'s innovation ecosystem and ensured that our academic institutions are full participants in that enterprise.

So perhaps Birch Bayh and Robert Dole are being remembered for truly changing American society forever after all. ■

Figure 4. Academic Spin-Out Companies Formed



41. The Association of European Science and Technology Transfer Professionals (ASTP) in Europe, the Association of Technology Managers in Taiwan ("ATMT"), Knowledge Commercialization Australasia ("KCA") in Australia and New Zealand and ParxisUnico in the UK.