

**Commercial Imbroglios: Proprietary Science and the Contemporary University\***

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*The more we forbid ourselves to conceive of hybrids the more possible interbreeding becomes (Latour 1993).*

*[I]t may now be time to set aside our traditional skepticism about a national industrial policy and adopt a biomedical research strategy combining the creativity and individual skill of traditionally publicly funded programs with the technology investment and team tradition of the commercial sector (Kennedy 2003).*

## Introduction

The last thirty years have witnessed dramatic increases in the depth and variance of university involvement in commerce. Academic institutions play more complicated commercial roles than ever before, University endeavors span the prosecution and marketing of intellectual property, active venture capital investment, and intimate involvement in the far-flung contractual networks that are the knowledge economy's center of gravity. The increasing commodification of academic R&D has spawned new professional groups, shifted faculty career trajectories, reworked academic stratification hierarchies, and sparked transformations in the organizational infrastructure on many campuses. This latter transformation is particularly telling, as technology licensing offices maintain a permeable boundary between the academy and industry.

Alterations to the institutional and organizational arrangements that underpin the traditional academic research mission have prompted a wide range of responses and have been characterized as 'revolutionary.' (Etzkowitz et al. 1998) and as key components of the social 'shockwave' that is transforming the academy (Kerr 2002). Economically oriented pundits laud the legislation (the 1980 Bayh-Dole act) that sparked dramatic acceleration in university research commercialization as a 'golden goose' responsible for the nation's economic resurgence.

[S]uffice it to say that the sole purpose of the Bayh-Dole legislation was to provide incentives for academic researchers to exploit their ideas. The culture of competitiveness created in the process explains why America is, once again, pre-eminent in technology (The Economist 2002).<sup>1</sup>

The same outcomes -- e.g. faculty's increased concerns with exploiting their profitable findings and a proprietary culture of competitiveness in the halls of the academy -- generate deep concerns about the health of the university itself on the part of more reformist critics (Press and Washburn 2000; Bok 2003). As Sheldon Krinsky (2003) frames the issue, proprietary science, private gain, and a culture of secrecy and competitiveness in the academy stand to destroy the primary benefit open science offers to a democratic society; a cadre of autonomous and passionately dedicated experts whose secure positions enable them to 'speak truth to power.'<sup>2</sup> The loss of an academic platform for concerns involving the public good is, on this view, a devastating side effect of increasing commercialization.

Whether appreciative, admonitory, or agnostic, observations about academic research commercialization share common points of departure and thus manifest little disagreement over the causes of the alterations they observe. Estimations of the consequences of commercial endeavors, though, diverge and the implications of a transfigured research university are often separated from the antecedents of change. Debates about academic commercialization rest, at least implicitly, on (1) a notion that the academic and proprietary science represent distinct and contradictory institutional

regimes; and (2) that the university's role as a citadel of science requires a unique place in civil society.

Collapsing distinctions between public and proprietary science shift arrangements and practices on campus, reposition universities relative to other institutions and re-forge the diverse linkages that constitute the modern academy. Such translations necessarily alter both the university and the system of which it is a part. Commercialization's effects derive from systematic transformations in the relationship between basic and commercial science on campus and shifts in the university's broader connections to society. Whether such changes are taken to be beneficial or detrimental depends less on the processes by which realms converge than on expectations academe's characteristic features and their resilience in the face of the market. Commercial engagement may corrode the academy's core, but the features that are at risk are not natural, they are outcomes of distinctive and contingent historical processes. Concerns about the academy's health and prognostications about its future must be grounded in the systematic changes that occur at the intersection of academic and commercial spheres.

The organizational, institutional, and professional arrangements of academic science can be understood on multiple dimensions and the university's place in society bridges multiple institutional orders. Strong distinctions between academic and proprietary knowledge rest on a Mertonian conception of science as an institution characterized by a strong norms and distinct reward systems (Merton 1942/1973, 1968; Dasgupta and David 1987, 1994). Here, science and its organizational home (the university) contributes to the social order precisely by remaining separate from it.

Commercial engagements flout this division. Changes in the university can reverberate to alter adjacent structures and most of civil society is adjacent to academe. Understanding commercialization's effects requires that we appeal to both the stability and distinctiveness of academic arrangements *and* to the fear that these structures are fragile and can be damaged by contradiction. If shifting fault lines within the university are to matter for society as a whole, we must imagine that internal transformations will resonate beyond the citadel's walls. In short, debates about research commercialization blithely span institutional and agentic conceptions of science while situating academic institutions in a complex, changeable network that establishes their character.

University science holds an important place in multiple orders of meaning and can be understood along multiple dimensions. In what follows, I explore the implications of research commercialization in terms of the intersection between a view that emphasizes the stability and autonomy of academic science and an approach that highlights the university's reliance on the diverse networks in which it is embedded. The former view understands commercialization as a process that merges two separate institutional orders to create a hybrid system where new opportunities for mobility re-shuffle the status hierarchy that has governed academic science for half a century. The latter considers commercialization in terms of the changes it wreaks in the universities relationship to the market, the government, the citizenry and other constituencies. Instead of emphasizing integration and changing opportunities, this lens offers insight into the effects shifting social position has on expectations for the university and its science.

Academic research commercialization offers a viable site to examine institutions and hierarchies as outgrowths of the same phenomena that constitute and stabilize

individual and collective actors. The American research university is simultaneously an institution of and an actor in societal transformation. Its stability and efficacy result from dense connections to other actors and institutions. Deepening commercial engagement generates a hybrid university in at least two senses: (1) by grafting -- e.g. collapsing two distinct sets of rules for creation and dissemination of new innovations in the same location; and (2) by translation -- e.g. by extending an entity's reach across separated fields of endeavor, in a supple and contingent network whose solidity constitutes the actor itself (Latour 1993). I explore these dual notions of hybridity in the context of a transforming university embedded in an established political economy with an eye toward demonstrating a conceptual interconnection between (1) the stable, institutionalized, hierarchical social orders that convey power, and (2) the more flexible, effortful, extensive networks that underpin construction.

#### Ontology, Power, and Change

Political economies of power and being are fundamentally relational. Power results from relative position in an objectified hierarchical order where the distribution of resources and opportunities favors those at the top (Wright 1984). Ontology is a largely political accomplishment of enrolling and stabilizing diverse participants into a constellation of relationships (Latour 1987; Mol and Law 1994). While one confronts participants with the necessities of a reified structure, the other constructs real actors through situated, pliable, and far from inevitable extensions.

Possibilities for change, too, vary across these two different conceptions. Hierarchical orderings -- particularly those that match structurally based resource inequity with ascriptive distinctions and expectations -- are stable and capable of resisting

all but the most fundamental change. The structures and institutions of power are durable sources of constraints, interests, and differential opportunities. In reality, change occurs, but it is most likely to do so at the margins (Phillips and Zuckerman 2001) or in interstices generated by disjuncture and overlap (Friedland and Alford 1991; Sewell 1992; Clemens and Cook 1999). In durable systems of power, novelty springs up from the crevices.

In contrast, flux is the natural state of extensive networks. Stability is effortful but necessary to the appearance of objectivity and the mobility of things. Beyond the effort of continuous translation, resilience can result from processes that obscure contingency and shroud underlying linkages. If social ontologies reside in the relational performances of actors, then the attributes of systems are only as stable as the weakest of their assembled components and their capacities for self repair. Within an established social order it is easy to equate destabilization with danger.

These two dimensions of relationality bracket considerations of outcomes for the commercializing research university. Explanations for observed variations in commercial and academic success on campus emerge from examinations of contingent and periodized processes of transformation. Attending to the timing and trajectory of universities' entry into new competitive arenas offers insights into both the opportunity structures and perils of a changing field. Yet transformations that simply reshuffle the hierarchical ordering of a single class of incumbents miss the point that universities exist in a field choked with established players of many sorts. While a view of change in terms of grafting emphasizes timing and point of entry to explain mobility in suddenly destabilized systems, transitions via extension remind us that tracking connections across classes of

actors is also essential and that the effects of such connections need not be felt symmetrically (Kleinman and Vallas, this volume). Diverse networks and institutionalized stratification orders, then, offer alternative views of the same process and those views are complementary rather than exclusive.

In what follows I turn to discussions of the ways in which increasing academic research commercialization can be understood in terms both of shifting hierarchical orders within the existing system of academia and at the same time as a set of extensions and translations that reposition the academy and in so doing serve to constitute novel types of actors and arrangements. Before grounding these seemingly contradictory conceptions of power and construction in a consideration of the transfigured, 'entrepreneurial' university, I sketch an argument that has some potential to resolve the tensions inherent in simultaneous focusing on durable, constraining systems of power and contingent, accomplished networks of being.

#### *Linking topologies of power and emergence*

Knitting together disparate theoretical traditions exceeds this essay's scope. Nevertheless, I take a few steps to ease discomfort with the attempt at bricolage to come. Linking social ontology and stratification requires conceptualizing history and dynamics. The former suggests a source of observed disparities in the power of actors; while the latter highlights features of a system in motion. History suggests the importance of trajectories and dynamics generates windows of opportunity to leave them. Contingency suggests not only localization in time and space but also the possibility that things might have been otherwise; that any particular arrangement emerges from specifiable processes. Yet the field on which such processes play out is neither flat nor empty.



Real things emerge from contingent and situated procedures undertaken in the context of existing interests, relations, and actors (Latour 1999). Contestation occurs during stabilization because emerging entities gain their observable attributes through the pattern of their relationships, but those relationships also alter existing configurations. But ontological performances and power exercises can flop. Some entities are stillborn (Latour, 1996) and mandated changes can meet resistance or mere symbolic compliance from established players (Smith-Doerr, this volume). Things are no less real for having been constructed but construction always occurs in a space littered with prior successes and failures.<sup>3</sup> It is precisely that reality, the very apparent, even intransigent thingness of these artificial entities that provides the cross-cutting sets of interests, possibilities, and potential sources of resistance for future enrollment efforts. Things may emerge from diverse networks, but that emergence does not occur in a clear field. Reality is variegated and the networks go all the way down.

Stabilized entities resist change. Opposition is all the more significant when the contingent sources of existing arrangements are obscured. Whether we think in terms of the black-boxing of facts and artifacts, the processes of rationalization that transform normal situations into normative conditions (Meyer and Rowan 1977; Zucker 1977), or the routinization of organizational actions (March and Simon 1958), processes that obscure contingency in an air of natural inevitability reduce multiple orders to a single constellation of taken-for granted arrangements (Law 1994). It may well take more than a laboratory to raise a world (Latour 1983; Kleinman 2003) but it is all too easy to equate a world not of ones own making with a world that is not, in fact, made.<sup>4</sup> That equation is

wrong. Actors, objects, interests, and institutions are conditionally constituted and, once stabilized, structure their own and others futures.

Grafting and translation offer alternate views of similar phenomena. Grafting opens possibilities for change within a sector by creating new possibilities for mobility that can shuffle the hierarchies that support fields of power and interest. Translation envisions change as resonance, where forging new linkages (or altering established connections) fundamentally alters the characteristics of all components in a system. Here horizontal relationships reconfigure the meaning and characteristics of existing and emerging actors. The evolution of a distinctively 'entrepreneurial' university partakes of both types of processes. Ever more complex commercial engagements alter both the academic stratification system and the cross-sectoral linkages that make an autonomous, 'ivory-tower' university sensible.

### University Hybridities

Increasing commercialization sparks both vertical and horizontal change. Proprietary approaches to the development and dissemination of scientific and technical findings are increasingly important formal components of the university research mission and commercial success can be leveraged into academic mobility (Owen-Smith 2003). The university is increasingly conceptualized as an 'engine of economic development,' a 'creator and retailer of intellectual property,' and a source of competitive advantage rather than a citadel of science (Feller 1990; Chubin 1994; Slaughter and Rhoades 1996). That conceptual shift repositions the university relative to its constituencies and, by doing so, alters the characteristics of both.

Changes at work in the research university are simultaneously transformations to the institutional arrangements and stratification orders characteristic of ‘the academy’ and to the broader cross-sectoral linkages whose stabilized patterns opened and maintained the possibility of an academic, ivory-tower, university in the first place.<sup>5</sup> The sections that follow offer broad brush empirical support for the simultaneous existence of these dual shifts before turning to a preliminary consideration of where these linked transformations leave the contemporary ‘entrepreneurial’ university.

#### Grafting Separate Systems into a Hybrid Order<sup>6</sup>

If change in commercially engaged universities result from tensions at the interstices of contradictory institutional orders, then the interface between academic and proprietary approaches to research open a window onto transformation. The distinction between these systems is most easily grasped in terms of their characteristic outputs. Patents are the coin of the proprietary realm, while publications are the primary credit in the academician’s ledger. Arie Rip’s (1986) evocative analogy linking patents to fences and academic publications to funnels speaks to the distinctive characteristics of each.

Patents and publications represent alternate institutions that validate and disseminate the outcomes of contemporary research efforts. Both publications and patents are markers of accomplishment and means to disseminate information. Publications, however, are funnels precisely because their success depends on the breadth of future use. Articles represent an author's formal release of control over the uses to which a finding is put.<sup>7</sup> 'Ownership' is largely a matter of peer recognition and priority. Returns to publication accrue in reputation and rewards are intimately linked to others' uses of an author's findings. In short, articles have (and to be successful can have) no

presumption of exclusivity. In contrast, patents are fences in the sense that they demarcate a 'plot' of knowledge legally owned by its inventor. Property ownership conveys a bundle of rights. Excludability (the right to prevent others' use of your property) and appropriability (the right to capture economic returns from the use of your property) are central and their various implications have generated much of the hue and cry that has accompanied academic commercialization.

Patent ownership also establishes priority. Returns to patenting are primarily pecuniary. Ownership is recognized through a bureaucratic process and thus divorced from recognition and the use of inventions by others. While still tethered to fecundity, rewards associated with patenting are a matter of controlling and monitoring others' uses of findings in order to extract a portion of the revenues that come from sale of a product based on the technology (royalty income) or payment for the right to practice a protected invention (licensing fees).

During the Cold war era, academic and proprietary approaches to science and engineering remained (at least rhetorically) separate. Publications were the territory of academics and patents were concentrated in industry. The increasing commercial engagement of universities -- and particularly the huge upswing in academic patenting, which now accounts for five percent of all U.S.-owned patents (National Science Board 2002) -- heralds significant blurring of the institutional boundaries between the academic and commercial spheres.<sup>8</sup> More importantly for an understanding of shifting arrangements within the academy, increased patenting signals the importation of divergent mandates, constituencies, rewards, and practices to the academy.

The changes that accompany such transitions may be subtle but pervasive, adding novel criteria to the evaluation of universities and their scientists and altering established standards for judging success (Owen-Smith and Powell 2001). At a supra-organizational level, widespread university patenting has opened a new arena for academic competition as an established set of players from one highly stratified competitive field (academic research) enter another (proprietary research). The explicit integration of public and private science orientations in the academic research mission has fractured the established status order that structured possibilities for success in ‘traditional’ academic competitions. By altering the rules of the game to open an alternate route to achievement, research commodification catalyzed the emergence of a hybrid institutional system characterized by positive feedbacks across commercial and academic uses of science (Owen-Smith 2003).

#### *Stratification by Accumulative Advantage*

The academic stratification order certainly represents a constraining structure that is not made by any single scientist or university. In the winner-take-all world of priority races, grant competitions, and reputational rewards success breeds success. Merton (1968) characterized this stratification process in famously biblical terms: “for whosoever has, to him shall be given, and he shall have more abundance.” Within a system governed by the Matthew Effect, where increasing returns to success are driven by peer evaluation based on reputation, chances for mobility are limited and the detrimental effects of transformations may be felt disproportionately at the bottom of existing hierarchies.<sup>9</sup>

Nevertheless, opportunities and resources that enable mobility can arise in institutional channels distinct from the peer-review system that reinforces existing status

differentials. Commercial engagement and particularly patenting -- by virtue of its separation from academic standards of validation, and its potential to return unrestricted income flows to universities and researchers -- offers just such an alternative.<sup>10</sup>

Ownership and marketing of intellectual property (IP) supports efforts to generate blockbuster royalty streams and increases trends toward equity ownership in faculty start-up companies (Association of University Technology Managers 1999). Returns to commercial engagement on campus can catalyze academic success to the extent that resources are folded back into the academic mission.

Such royalty streams are vanishingly small on most campuses and do not approach the costs of R&D on even the most successful (Mowery et al. 2001).<sup>11</sup> Nevertheless, income streams that are not directed to specific projects and uses can offer benefits greater than their magnitude suggests. As Michael Crow, the executive vice provost of Columbia University, noted in a recent article regarding his university's failed attempt to extend the life of a lucrative and fundamental biomedical patent "This is an income stream that is absolutely critical to us. It is the single most important source of free and clear funding. Everything else comes with a string attached" (Babcock 2000). In another interview later the same week, Crow expanded his claim, noting that this free and clear funding stream enables the university to "... do some things none of our other resources allows [sic] us to do" (Pollack 2000).

Other universities evince similar beliefs. Stanford University and the Wisconsin Alumni Research Foundation (WARF) use royalties to fund university-wide fellowship competitions that support faculty and student research. Likewise, Carnegie Mellon University invested more than \$25 Million earned from its equity stake in the web search

firm Lycos into its computer science department, funding multiple endowed chairs and building state-of-the-art research facilities (Florida 1999).

Clearly universities and academic science can benefit from the resources that flow to their proprietary activities. Indeed, in analyses conducted on a nearly 20 year panel (1981-1998) of 89 research intensive universities, I found an increasing pattern of positive linkages across patenting activity and the impact of published articles on campus. Several universities, including Emory, Rutgers, and Columbia saw dramatic increases in their publication impact ratings that accompanied even more impressive growth in the size of their intellectual property portfolios (Owen-Smith 2003). While importing commercial mandates to universities offered some opportunities for mobility in the reputation based world of academic science, such mobility is by no means assured and attempts to leverage resources across academic and commercial efforts can carry dangers of their own.

Consider two well known cases of such attempts: Boston University's controversial engagement with its spin-off firm, Seragen, and Columbia University's attempts to extend the life of their blockbuster patent on a technique for inserting gene fragments into a cell.<sup>12</sup> In 1987, Boston University invested \$25 million of operating income to purchase a majority stake in Seragen, a biotechnology firm started by a BU faculty member. At the time, the purchase price represented a staggering 14% of the university's endowment. In subsequent years BU invested more money, eventually reaching a total of more than \$85 Million. In 1992, under pressure from the Attorney General of Massachusetts, the university agreed to limit its investments in the company. By the end of 1997, BU purchased a unit of the flagging company outright and began

providing the firm with manufacturing, clinical testing and quality assurance services. In 1998, soon after the firm's flagship therapeutic, a treatment for lymphoma, was recommended for approval by an FDA advisory panel, the corporation was purchased by California-based Ligand Pharmaceuticals at a price that represented a more than 90% loss to the university. Shareholder losses were significant and later that year a lawsuit filed against the university and its chancellor alleged self dealing in their management of the firm (R. Rosenberg 1997; Barboza 1998).

Columbia University's patent extension case was similarly controversial. In 1983 a patent on what was to become one of the fundamental techniques underpinning drug development efforts in biotechnology was issued to the university. The 'Axel patent,' named for its senior inventor, covers a process known as cotransformation, which has been used to develop some of the most successful biotechnology drugs.<sup>13</sup> Columbia has broadly licensed the patent in return for a royalty of 1% of the sales of all drugs developed using the process. Royalty income on this patent has been estimated at \$280 million dollars and has kept Columbia among the top universities in terms of licensing income for the last decade. But patents expire and the loss of ownership rights also removes the royalty stream that Michael Crow so clearly associated with increased research capacity and flexibility.<sup>14</sup>

In an attempt to avoid this loss, Columbia persuaded a United States Senator – New Hampshire Republican Judd Gregg – to sponsor an amendment to an agricultural spending bill that would extend the life of the patent.<sup>15</sup> The amendment drew upon and extended the logic of the 1984 Hatch-Waxman act, which enables firms to apply for extensions to patented therapeutics as recompense for delays in the often lengthy FDA



approval process. An extension of Columbia's process patent would significantly extend the reach of the 1984 act and thus met with significant resistance from industry lobbyists, patient groups, and Senators. The attempt at extension eventually failed under a barrage of media criticism and attention (Babcock 2000; Pollack 2000; Marshall 2003).<sup>16</sup>

While there are clear benefits to parlaying commercial efforts into academic achievement, the Seragen case and the Axel patent offer cautionary notes while highlighting the extent to which grafting opens a limited window for innovation. Responses to that window by established players help a new system of stratification and constraint cohere. In one case, a university aggressively attempted to climb the public science hierarchy by gambling a significant portion of its endowment on the fortunes of a firm, in the process drawing attention from state regulators and undertaking some decidedly un-university like actions such as leasing manufacturing services to a struggling corporation. At the other end of the continuum, an established, Ivy-league university that had parlayed a blockbuster patent into increasing research capacity and flexibility faced the loss of that royalty stream and in response pursued multiple controversial efforts to extend its ownership rights prompting charges of unfair and illegitimate efforts to extend monopoly rights; a charge that on its face suggests distinctively un-university like behavior.<sup>17</sup>

Both cases reflect the benefits and pitfalls of leveraging resources across institutional regimes. A failed gamble damaged the legitimacy of a striving organization while a commercial success helped another campus climb the status ladder at the cost of wedding success to continued income flows. This catch-22 placed the university a

position uncomfortably similar to its pharmaceutical and biotechnology clients whose uncertain longevity depends upon generating a series of risky blockbusters.

These cases are not isolated instances but instead represent multiple facets of university responses to a systematically changing institutional environment; an environment that is simultaneously constraining and a collective outcome of actions and approaches to technology licensing in the wake of the 1980 Bayh-Dole act. In essence, importing commercial logics to core mission of the academy opened a window for innovative action and increased possibilities for mobility before that very action crystallized a structure that constrains future opportunities and places new limits on successful and striving universities alike. While collapsing once separate regimes into a single organizational mission allows resources to be leveraged across realms, the practical fungibility of resources and strategies is temporally limited. The status order that structures opportunities and outcomes in the contemporary academy represents a hybrid that merges basic and proprietary logics, allowing advantage to cumulate within and across realms.

The process at work here is one of grafting. Institutional arrangements that were (at least titularly) separate were brought together. Their interface created contradictions that opened a space for novelty as participants struggled to parse and react to their changing environment. That window opened only temporarily, though, because early entrants created a model that constrained their future moves and limited opportunities for innovation by latecomers who now faced a stratification system characterized by cumulative advantage across commercial and academic regimes. A grafting process transformed the characteristic and expected practices of universities. As a result, it is

increasingly necessary to achieve in both commercial and academic activities in order to succeed at either *and* attempts to accomplish in both realms are routinely accompanied by broader and more explicit extensions from the university into other parts of society.<sup>18</sup> In an era when commercial successes and peccadilloes are trumpeted in the media and when many governors seek to parlay academic capacity into high technology muscle, both intra-academy status competitions and trans-campus constituencies feel the impacts of commercialization. In short, social constraints upon action that resulted from grafting also translate across extensive networks.

#### Blurring Boundaries and University Networks

A language of extension and translation is central in stories of two universities struggling to achieve and maintain stature under an institutional order that blends basic and commercial science. The rules for inter-university competition have changed and the networks that constitute and support ivory towers have shifted. Commercialization has changed the rules of the game and those changes have altered the university's relationships to key constituents. Such alterations create a new sort of academic actor. In what follows I trace a few of the translations that allow commercial engagements to alter the very characteristics of contemporary universities.

#### *Shifting Terrains for Academic R&D*

Increasing academic commercialization has done more than shift the ways universities go about their traditional business. It has also transfigured relationships that reach across established divisions in society. Especially in arenas – such as the life sciences, optics, nanotechnology and computational chemistry -- where technological advances, research requirements, and novel opportunities blur the academic and the

commercial, university research has become a component of commercial application while industrial muscle offers a key to fundamental discoveries. The shifting relationship between industrial and academic R&D efforts may lessen university scientists' ability to blaze new trails for industry (Woodenhouse, this volume) while increasing the likelihood that commercial discoveries will shape academic research trajectories (N. Rosenberg 2000).

In a recent editorial in the journal *Science*, Donald Kennedy<sup>19</sup> characterizes the contemporary world of life science research as a convergence of two distinct trends, the post-war engine of investigator initiated and federally funded basic research and the development of “industrial strength basic science,” which is “[d]one in mixed or commercial settings, usually by large teams with impressive infrastructure support” (Kennedy 2003). The convergence of these two trends in the life sciences is most clearly visible in the recently completed Human Genome Project which pitted a widely dispersed academic consortium spearheaded by the NIH’s Francis Collins against a more focused for-profit team under the direction of Celera Genomics founder Craig Venter in a race to sequence the complete human genome. Arguably, the speed and technological innovations at the heart of the successful project owe much to the intense rivalry between these ‘teams.’ While these trends are most pronounced in the life sciences broad trends apparent in bibliometric analyses of patents and publications suggest that similar patterns appear across science and engineering fields.

In an era when both the frequency and size of scientific collaborations has increased dramatically, the center of gravity of the knowledge economy has shifted toward universities and non-profit research centers and away from the corporate R&D

laboratories that once dominated the U.S. R&D system (Hicks et al. 2001). Industrial R&D funds poured into U.S. research universities at unprecedented rates over the last decade and the academy undertook an increasing share of American R&D activity (National Science Board 2002). At the same time, patented science moved closer to academic concerns as evidenced by a more than doubled incidence of citations to academic articles in industrial patents (National Science Board 2002).

Universities provide an anchor for collaborative endeavors in an increasingly collaborative, multidisciplinary, and trans-sectoral research ecology. Consider Figure 1, created from the National Science Board's 2002 Science and Engineering Indicators, which describes the percentage of collaborative articles that involve organizations from multiple sectors.

[Figure 1 Here]

Figure 1 highlights patterns of inter-organizational collaboration<sup>20</sup> in terms of the sectors, to which collaborating organizations belong. In the network image presented here, the size of a sector's node is proportional to the percentage of collaborative articles produced solely at organizations in the sector – for instance a paper with authors from two or more firms would contribute to the size of the node labeled 'industry' but not to any of the arrows. Arrows represent the proportion of collaborative pieces that involve other sectors. The size and grayscale tone of the arrows are proportional to the magnitude of the collaboration.<sup>21</sup> Figure 1's clear message is that the academy is both the most internally reliant sector (its node is the largest) and the central partner in a world of defined by inter-sectoral collaboration. Across all fields, in 1999, the academy is the largest performer and the anchor for collaborative basic research.

Academe's role in the convergence of public and proprietary research may result from shifts in the character of science and from an institutional order that increasingly necessitates new strategies for simultaneously navigating both academic and commercial worlds. The university's centrality is comforting. Far from being destroyed by commercialization the academy has become an obligatory passage point for research that spans basic and commercial concerns. This centrality makes the transformations at work in the academy issues of broad societal import while offering opportunities for a refigured academy to cement a new type of place in the pursuit of science.

### *Reaching beyond R&D*

If theoretical work on enrollment and translation suggests anything, it is this: the cast of performers necessary to coax a new and stable entity or artifact into being is staggeringly diverse and often divisive. Similarly, the academy's research centrality rests on connections that extend into the federal government, the international policy arena, activist groups, the news media, farther than the eye can see.<sup>22</sup> The emergence and constitution of an entrepreneurial academy and the associated convergence of two disparate models for R&D did not occur in a vacuum and their effects have sparked tensions between the university and its industrial partners.<sup>23</sup>

Columbia's attempts to extend the life of its valuable patent and recent conflicts between the Wisconsin Alumni Research Foundation (WARF) and Geron, a California biotechnology firm, over the distribution of rights to recently isolated lines of Human Embryonic Stem Cells demonstrate why conflicts over access, exclusivity, and the right to profit from scientific discoveries generate concern about the university's ability to maintain its distinctive features in the face of increasing commercial involvement.<sup>24</sup> But

the university is not a passive object buffered by stronger and savvier commercial partners. Patent fences give universities unprecedented leverage in the decisions of for-profit collaborators and clients. Using such leverage requires that academic institutions conceive of IP as more than an alternative source of revenue. A broad conception of the ways that private rights can be turned to the service of public needs can and should inform policies and practices for the management of academic intellectual property.

Consider the case of anti-retroviral theories for HIV/AIDS. These cocktails of drugs significantly increase survival rates among infected individuals. Universities have played a central role in the development of many of these therapeutics with Yale, Minnesota, Emory, and Duke each holding patent rights to aspects of important retroviral drugs (Kapczynski et al. 2003). The central role university science played in developing these drugs offers some support for the claim that real public benefits can accompany efforts to commercialize academic research. Such commercialization efforts also offer new power and possibilities to universities, which can turn ownership to strategic efforts to ensure broad access to expensive but essential therapies.

Yale University holds a key patent on stavudine, a commonly used anti-retroviral drug exclusively licensed to the pharmaceutical firm Bristol Myers Squibb (which markets it under the brand name Zerit). In early 2001, Doctors Without Borders -- a non-profit group dedicated to providing medical assistance to the populations of underdeveloped areas -- requested that Yale allow them to distribute generic versions of the drug in South Africa where the yearly cost of medication far exceeds the ability of most patients to pay. Yale refused citing an existing contract with Bristol-Myers. John Soderstrom, Managing Director of Yale's office of Cooperative research, framed the

issue in a letter: “Although Yale is indeed the patent holder. Yale has granted an exclusive license to Bristol-Myers Squibb, under the terms of which only that entity may respond to a request.” (McNeil 2001). Alison Richard, then Provost of the university, put the issue more colloquially in an interview with the Yale Daily News: “It’s not ours to give away. We are hopeful that Bristol-Myers Squibb is going to do their best to make this work out.” (Adrangi 2001).

Perhaps predictably, this interaction drew a huge amount of attention and sparked a storm of protest including an important campaign launched by a Yale law student and supported by the compound’s inventor, then an Emeritus Professor (Borger 2001).<sup>25</sup> Among the responses was a letter from Doctors Without Borders suggesting that Yale’s response was in violation of its own policy on intellectual property licensing. The relevant section of that policy reads as follows (my italics):

*The objective of the University is to assure the development of its technology in furtherance of its own educational mission and for the benefit of society in general. Therefore, as a general policy, the University will set the terms of its licenses so as to further the achievement of this objective. Exclusive licenses will be granted if it appears to the Office of Cooperative Research that this is the most effective way of ensuring development to the point that the public will benefit. Any exclusive license agreement will be so drawn as to protect against failure of the licensee to carry out effective development and marketing within a specified time period.*<sup>26</sup>



After intensive talks between Yale and Bristol-Myers, the company announced that it would not enforce its patent rights in South Africa, paving the way for the manufacture and distribution of generic drug versions of the drug at a cost some 30 times less than the price of Zerit (Kapczynski et al. 2003).

This outcome was hailed as ‘historic’ and largely resulted from the combination of internal and external pressures on Yale; pressures which may have been much less effective if applied directly against Bristol-Myers. Here an intellectual property owner formally and publicly committed to effective use and societal benefit offers a fulcrum for activists to successfully exert pressure on a corporate giant. That pressure depended both on Yale’s concern with its public profile and upon its ownership of a fundamental and valuable piece of property. Somewhat paradoxically, Bristol-Myers final decision may have hinged on the combination of Yale’s open, academic character and its proprietary rights.

As Toby Kasper, the head of the Doctors Without Borders Unit responsible for the initial request noted “A company has never given up its patent for a drug like this. Universities make a lot of money on these patents, so they’re hesitant to give up their right. But Yale acted out of fear of public relations and fear of a student uprising. Besides, AIDS is a graveyard for corporate P.R., and it’s an area that could cause potential harm to a university’s P.R.” (Lindsay 2001). Yale’s brief press release in response to the announcement highlighted the university’s role in the decision “Yale worked diligently to remove any obstacles created by its license agreement with BMS [Bristol-Myers Squibb]. We are gratified that our efforts paved the way for the significant action announced by BMS today. We will continue to encourage all pharmaceutical

companies to make their AIDS drugs affordable and widely available in Africa.”<sup>27</sup>

Perhaps more importantly, Yale has taken the opportunity to begin developing best practices for assuring broad access to essential medicines based on university innovations.

In what may turn out to be a prescient statement of things to come, a recent report from that effort notes that the upstream character of university research offers the possibility for academic institutions to exert ‘early leverage’ in development and marketing. Another of that report’s ‘key points’ implicitly references blurring boundaries between academic research and commercial development and between academe and civil society: “ The issue of access cannot be separated from that of innovation and universities must consider the impact of best strategies on both” (Merson 2002: 1).

Clearly, Yale is not an unambiguous hero. The university’s patent rights and licensing agreements could have prevented broad distribution of an important drug to patients in need. Yet those very rights may also have provided the necessary leverage to accomplish a transformation in corporate policy. This story turned out well. Its outcome has sparked a number of other attempts to use university patent rights to exert pressures for broader worldwide access to medication (Lindsay 2001). Here we see one way that the shifting focus of university competition and the convergence of multiple models of science might open new opportunities for academic institutions to exert influence on a broader field. An extensive hybrid, the entrepreneurial university anchors a science whose organizational division of labor spans diverse sectors. The contemporary research university is thus a constrained actor and a passage point, a position fraught with opportunity and danger.

## Entrepreneurial Universities as Dual Hybrids

Changes at work in contemporary American universities have fundamentally altered the rules of the game for academic science and engineering. Opportunities for mobility along novel paths were opened through a process of grafting and then re-calcified into a new order that mixes commercial and academic logics. Through this process, one characteristic set of constraints was contingently transformed into another with significant consequences for striving and successful institutions alike.

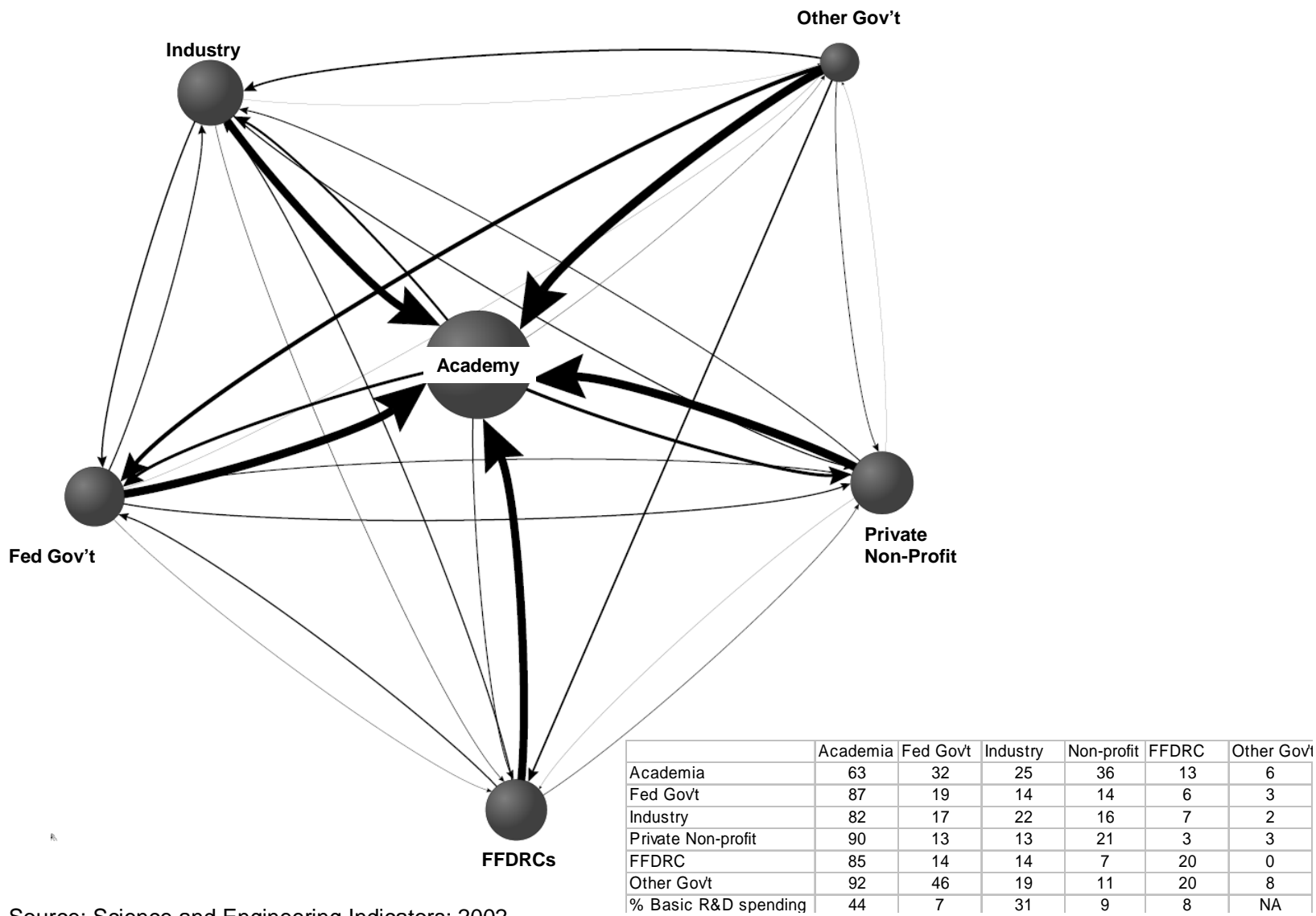
Changes in the institutional order and stratification system of the academy have broader implications for contemporary society precisely because they cannot be understood in isolation. The emergence of a hybrid, entrepreneurial university is a relational accomplishment. The characteristics and attributes of contemporary research universities are being shaped by connections that reach across regimes and sectors. As universities adapt to the dictates of the new academic game they helped to create, such points of contact enable changes on campus to resonate through structures adjacent and distant, thus reconfiguring not only the university but also the outlines and features of contemporary society.

The two forms of hybridization I describe are inseparable. Grafting depends upon a stabilized and taken-for-granted system of relations that constitutes separate but potentially collapsible regimes. When such separated regimes collide the very sets of relationships they depend upon are revealed to be contingent. Contradiction opens opportunities for once tightly constrained actors to forge novel connections in response to newly salient ambiguities.

Such moves reverberate and thus alter not only the distribution of resources and opportunities within a field but also the webs of translation and enrollment that are the wellsprings of stable social ontologies. The opportunities and dangers inherent in university research commercialization stem from the same source. Reordering and refiguring hybridizations jointly remove any possibility that the university's uniqueness and social efficacy require its separation from the world. Recognizing its embeddedness in and essential contribution to the making of a world beyond its grasp opens opportunities for new types of leverage and action on the part of universities. Careful attention to the systematic effects of actions and concern with the unintended consequences of ad hoc responses to contingent circumstances is necessary, but in this instance, I contend, collapsing distinctions and sticky imbroglios also offer opportunities for innovation and widespread reconfiguration of the order to which we have become accustomed.



Figure 1: Percentage of Collaborative Articles Involving Other Sectors, All Fields, 1999.



Source: Science and Engineering Indicators: 2002

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<sup>1</sup> Rhetoric relating university research to national economic competitiveness is also commonplace in rationales offered for federal research funding (Slaughter and Rhoades 1996) and in academic analyses of national innovation systems (Mowery 1992).

<sup>2</sup> Such discussions are often framed in terms of exemplary cases such as the contested tenure case of a Berkeley ecologist. Ignacio Chapela's controversial research on the spread of genetically modified corn strains into natural maize populations in Mexico and his outspoken resistance to the recently concluded deal linking Berkeley's prestigious plant science department to pharmaceutical giant Novartis have been offered as explanations for his unexpected denial (Dalton 2003).

<sup>3</sup> It should come as no surprise that the entrepreneurial university represents neither the first nor the only academic hybrid. Among the more notable prior examples are the land grant universities that emerged around the turn of the last century (Geiger 1986), and post-war era research labs that supported both a dominant discipline and the policy nexus that generated the largely taken-for-granted ground for the figure of academic commercialization (Leslie 1993; Lowen 1997).

<sup>4</sup> In a recent examination of an academic biology laboratory doing simultaneously academic and commercial research, Daniel Kleinman frames the issue as follows

Although it is undoubtedly true that laboratories and scientists play a role in shaping the world, my aim has been to show what I see as a more important and significant trend: how the work done by scientists and the world they inhabit is shaped by the world they

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inhabit is shaped in significant ways by the larger (social) environment in which the practice of science is undertaken (Kleinman 2003: 157).

While I concur wholeheartedly with the sentiment expressed here, I am less interested in engaging with the ongoing discussion about the relative primacy and distinctiveness of the social and the technical. I contend that both are relational accomplishments that are naturalized through roughly analogous processes that obscure their contingent character.

<sup>5</sup> Numerous historical analyses of the American university remind us that the now taken-for-granted character of academic research and development efforts was, indeed, an accomplishment (Guston and Keniston 1994; Kleinman 1995).

<sup>6</sup> This section relies upon a recent article (Owen-Smith 2003).

<sup>7</sup> This is not to say that articles convey all of the information necessary to actually accomplish a replication (let alone a novel extension) of a given finding.

<sup>8</sup> It is precisely this trans-sectoral blurring that is the focus of the following section on hybridity through extension.

<sup>9</sup> Reputation offers a particularly clear mechanism for the cumulative advantage in life and physical science fields where both article and granting agency peer review processes are single blind.

<sup>10</sup> Commercial endeavors are by no means the only such loopholes. Indeed, academic earmarks – direct congressional appropriations for universities and colleges – have grown dramatically, from \$11 million in 1980 to nearly \$1.7 Billion in 2001 (National Science Board 2002). These funds, which also bypass peer review (and thus have come under increasing fire) have been defended as a means for less successful universities to gain resources necessary for success in academic competitions. The Chancellor of Boston University, John Silber described such earmarks as a means to “force your way into” the “old boy network” that is the academic peer review system. The monies BU garnered through lobbying efforts Silber contends allowed the university to bootstrap its way into a higher position in the academic status order: “Our peer-reviewed grants and contracts have increased with every passing year. It is a result of having been able to put together the facilities to bring in the outstanding scientists who bring in those peer-reviewed grants” (Schlesinger 2001). While it is beyond the scope of this paper, increases in university lobbying efforts and

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the antecedents and consequences of lobbying efforts offer fruitful areas of study for a political sociology of science.

<sup>11</sup> Of the 142 US universities surveyed by the Association for University Technology Managers, only 19 report gross licensing income in excess of \$10 million. Almost half (70) report income less than \$1 Million and none approach the \$100 Million mark. All told these institutions earned slightly more than \$ 1.3 Billion in royalties, slightly more than 7% of the \$18+ Billion they spent on federally funded R&D (Association of University Technology Managers 2000)

<sup>12</sup> US patent Number 4,399,216.

<sup>13</sup> Among the more well known are Amgen's anemia drug, Epogen, and Immunex's successful treatment for Rheumatoid Arthritis, Enbrel.

<sup>14</sup> Issued in 1983, the Axel patent had a life of 17 years and was set to expire in August, 2000. More recently issued patents can extend protection for 20 years from the date of application.

<sup>15</sup> The proposed extension of 14-18 months was estimated to be worth approximately \$150 Million in additional royalties.

<sup>16</sup> The saga continues into 2003. Columbia filed a second patent on the Axel process in 1995 and that patent (USPTO # 6,455,275) issued in September of 2002, offering the university the possibility of a further 17 years of royalty income. Claiming that the new patent was not substantially different from the 1983 original and that it represents Columbia's "illegitimate effort to extend its patent monopoly" two Boston area biotechnology firms, Genzyme and the Abbott Bioresearch Center filed a lawsuit asking that the new patent be invalidated. Similar suits had already been filed in two other federal courts (a suit by Amgen was filed in Los Angeles and another by Genentech in San Francisco).

<sup>17</sup> Patents, by definition, offer limited monopoly rights and the question of how (and whether it is possible to) replace royalty streams from lucrative blockbuster patents is becoming an important one. In addition to the Axel patent, another fundamental and exceptionally valuable process patent (the Cohen-Boyer gene splicing patent) recently expired significantly reducing royalty streams at Stanford and the UCSF.

<sup>18</sup> In part as a consequence of the actions described in this section, Columbia University and Boston University topped the list of spending on lobbyists in 2000 (data retrieved from [opensecrets.org](http://www.opensecrets.org) <http://www.opensecrets.org/lobbyists/indusclient.asp?code=W04&year=2000&txtSort=A> 01/06/03). Both

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universities rely largely on the services of Cassidy and Associates, the most prominent educational lobbying firm. Interestingly, Gerald Cassidy the founder chairman and CEO of the lobbying firm was recently named to Boston University's Board of Trustees (Deveney 2003).

<sup>19</sup> The journal's editor and past Provost of Stanford University.

<sup>20</sup> At least those that result in published scientific articles in journals indexed by the Institute for Scientific Information.

<sup>21</sup> Several caveats are in order. This image was created in Pajek using data presented in the table embedded in figure one. The data are asymmetric (meaning that industrial publications can more often draw on academic collaborators than vice versa) and the main diagonal represents the proportion of collaborative work undertaken within a sector. The largest node, representing the academy, reflects the fact that some 63 percent of all academic articles involving more than one organization involve only universities. FFDRCs are Federally Funded Research and Development Centers. Data sum to more than 100% because of the counting methodology used to sum sector publications. Each institutional author was assigned a whole count of a publication.

<sup>22</sup> Many of the arguments presented here resonate with two other approaches to thinking about shifting networks constitutive of contemporary science and transformations underway in the academy (Gibbons et. al. 1994; Etzkowitz and Leydesdorff 1998).

<sup>23</sup> It should not be forgotten that a transformation in the academy necessarily resonates through associated fields in industry. While this fact has been widely recognizes several scholars have suggested that it is industry that is more corrosive to distinctively academic approaches (Slaughter & Leslie 1997). While there is convergence across the worlds of the academy and industry, such transitions are 'asymmetric' and favor firms at the potential expense of universities (Kleinman and Vallas 2001).

<sup>24</sup> This challenge is becoming more pressing as a recent federal court decision (Madey v. Duke) essentially swept away the traditional concept of a research exemption for academic use of intellectual property on the grounds that research represents a central business interest of universities and the acknowledgement that those interests increasingly cross into the commercial realm (Eisenberg 2003). The Madey decision has accelerated concerns that widespread patenting of research tools will have a chilling effect on academic research as scientists (whether engaged in commercially valuable projects or not) are confronted by an

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increasing need to license tools and materials (at significant expense of effort and resources) from multiple sources.

<sup>25</sup> Dr. William Prusoff expressed strong support for the student campaign to relax Yale's patent rights in South Africa: "I'd certainly join the students in that. I wish they would either supply the drug for free or allow India or Brazil to produce it cheaply for under-developed countries, But the problem is, the big drug houses are not altruistic organizations. Their only purpose is to make money" (McNeil 2001). Interestingly, stavudine is not the first retroviral developed by Prusoff. The first, idoxuridine, he synthesized during the 1950s also at Yale. That compound, the first retroviral to receive FDA approval, is still in use for treating eye infections resulting from the herpes simplex virus. Prusoff reminisces about a very different time in the history of University-Industry relations: "My chairman at the time wanted to patent the drug, and Yale's lawyers wanted nothing to do with patents. It was beneath the dignity of the university to do something for money. So four or five took the thing up and put it on the market – and there's no patent, anyone who wants to produce it can produce it. Those were the days" (Zuger 2001).

<sup>26</sup> The policy was last revised in 1998 and so was in force at the time of the request. It was retrieved from [http://www.yale.edu/ocr/invent\\_policies/patents.html](http://www.yale.edu/ocr/invent_policies/patents.html) on 01/09/04.

<sup>27</sup> Yale News Release, 03/14/01. Retrieved from <http://www.yale.edu/opa/newsr/01-03-14-03.all.html> 01/09/04.