

Buying In or Selling Out?

*The Commercialization of the
American Research University*

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not have a first-authored paper demonstrating his or her individual brilliance and originality but has proven to be an invaluable site leader in a large multicenter clinical trial.

Many of the brightest graduates are attracted to industry because they believe that the technological resources and the team approach offer them the opportunity to do their best work. For similar reasons, several leading scientists in academia are exploring the possibility of setting up research institutes outside the university. These are envisioned as nonprofit institutions that embody some of the advantages of the private-sector approach. The country will soon see a number of efforts to devise new ways of doing modern biomedical research through structures that take into account the changes in the way in which modern biomedical science is now practiced. Many of these efforts will take place outside universities. Universities must understand and respond to the tremendous changes that have taken place in biomedical research over the past half-century in order to continue to attract brilliant researchers. The true challenge facing university administrators is to incorporate new administrative structures that facilitate science in the university without compromising its core values.

Conclusion

Driven by scientific discovery and by changes in how science is done, biomedical research relationships between universities and industry have rapidly grown in extent and complexity. Partnerships between universities and private companies have yielded undoubted benefit to our society, in both scientific and economic terms. The relationship is most successful, however, when the two parties acknowledge and respect their distinct missions. For universities, one challenge of the new relationships will be to protect their core values through clear guidelines for individual and institutional conflict of interest. A second challenge will be to learn from the interaction with industry how universities might change their own research culture in beneficial ways.

Chapter 13

Responsible Innovation in the Commercialized University

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IN HIS RECENT *Science, Truth, and Democracy*, philosopher Philip Kitcher (2001) proposes "well-ordered science" as the ideal to which the organization of the research enterprise should aspire. Distinct from government by "vulgar democracy," in well-ordered science a highly informed public, coupled with a public-spirited research community, sets overall research priorities. As a philosopher, Kitcher avoids a detailed comparison of this ideal to the reality of making science policy in the contemporary United States. But he does imply that the reality falls short of the ideal on the counts of both informed public participation and unselfish scientific service. He therefore recognizes the needs, respectively, for "sociological information required to build realistic models" of the construction of "tutored collective preferences" as well as for "a political theory of science that will consider the various ways in which the interests of actors and social institutions" relate to outcomes in well-ordered science (135, 133 n. 8).

It is true that there are shortcomings in both the public and the scientific community. Yet there is room for optimism about the current state of knowledge on the involvement of the public in making technically complex decisions as well as on the capacity of existing scholarship to guide the connection among researchers, institutions, and outcomes in science policy. What we need to preserve science in the commercialized university are university-based Centers for Responsible Innovation (CRIs) that might contribute a particularly important microcosm of science. This chapter addresses three premises about the commercialized university that form the foundation of my call for CRIs.

It also elaborates the tasks that such centers would perform and grounds their operation in recent scholarship in the social studies of science and technology.

The Challenge of the Commercialized Academy

In December 2000 the vice president for academic affairs at Rutgers University, an economist by training, convened an interdisciplinary group of faculty members in the Scarlet Room, a lush conference room in Rutgers's central administrative building. He questioned why the university, with its two law schools, its recently powerful biomedical sciences, its long tradition in environmental research, its nationally regarded philosophy department, and its up-and-coming planning and policy school, had not yet brought these elements together with law, ethics, and policy. He challenged the faculty in attendance to pursue what he called an initiative in law, ethics, and the sciences. The faculty group met only once more. During the second meeting, the vice president requested that participants circulate among themselves proposals for what such an initiative in law, ethics, and the sciences might accomplish. This chapter is the result of that call.

The concerns that drew the Rutgers group together were only narrowly cast as ethics or law. Something more subtle, perhaps, but more profound than the ad hoc collection of patenting genes, privacy in the Internet era, or ethics training for graduate students suffused the Scarlet Room. Rutgers was acknowledging that the primary task of the university—the creation and dissemination of new knowledge—has normative dimensions that the university was not engaging.

Invigorating the university's primary task with the necessary normative supplements requires accepting three premises. First, large research universities will continue to be in the business of knowledge-based innovation for at least several generations. Even if students turn to distance learning programs on the Internet and pressures on tenure erode the status of faculty, universities and the people affiliated with them will still create new knowledge and seek to express it in scientific, artistic, and professional forms.

Second, universities will continue to market new knowledge. The commercialized academy has, in various ways, been around for a very long time. Brooks and Randazzese (1998) emphasize the role of the land-grant institutions in the nineteenth century and the rise of engineering education in the early twentieth century in creating links between industry and the academy. The Massachusetts Institute of Technology pioneered entrepreneurial relations with industry in the first half of the twentieth century (Etzkowitz 2002); and in the second half of the century, academic capitalism in many nations fol-

lowed the globalization of research in particular and the economy in general (Slaughter and Leslie 1997). More recently, the Bayh-Dole Act of 1980 has encouraged U.S. universities to become increasingly involved in the commercialization of the new knowledge they produce. In the tenth annual edition of its survey of licensing and other university-based technology transfer practices, the Association of University Technology Managers (2001) provides an overview of the growth of technology transfer activities. Participation in the survey has increased from sixty-six of the top one hundred U.S. research universities to ninety-four, and the total number of respondents increased from 130 to 190 institutions. These respondents report an increase from 6,337 invention disclosures in fiscal year (FY) 1991 to 13,032 disclosures in FY 2000. New U.S. patent applications from these institutions increased from 1,643 to 6,375 over the same period. Licenses and options executed increased from 1,278 to 4,362, and licensing income increased from \$186 million to \$1.26 billion (in current dollars) from FY 1991 to FY 2000. Respondent universities in the United States received \$1.1 billion of the licensing income in FY 2000, a sum equivalent to 50 percent of research expenditures by industry in universities that year and approximately 7 percent of such expenditures by the federal government. As measured by employment and overall economic activity, Bayh-Dole technology transfer is said to have been responsible for approximately 260,000 jobs and \$40 billion in economic activity in the United States in 2000.

Although some research (Mowery et al. 2001) has questioned the necessity and uniqueness of Bayh-Dole's contribution to the boom in universities' intellectual property transactions, such activity has created a tightening aggregation of interests around technology transfer. Etzkowitz and Ledesdorff (2000) call this new political economy the triple helix of university-industry-government relations. The new political economy is fueled not just through licenses with royalties but also through licenses with equity. The Association of University Technology Managers, itself an example of the creation of professional and interest groups around the commercialized academy, reports that licenses with equity shares to universities have increased from 142 in FY 1995 to 372 in FY 2000. Of the 454 start-ups formed in FY 2000, 80 percent are located in the same state as the reporting institution, thus contributing to a critical trend in local and regional economic development. The nonprofit State Science and Technology Institute emerged in 1996 to improve collaborative programs in science and technology for regional economic development, connecting with science and technology commissions or offices in dozens of states and with the Science and Technology Council of the States, affiliated with the National Governors Association. At the federal level, even the National

Science Foundation has supported an intersectoral approach to research through its engineering research centers (see Feller, Ailes, and Roessner 2002 for an evaluation) inaugurated in the 1980s, its more recent Partnerships for Innovation program, and other collaborative endeavors.

Even if the new political economy of academic commercialization were not strong enough for observers to presume its durability, one could argue that it demonstrates through the narrow measures of the market that universities are behaving in a responsible way—that is, in accord with the considered values of the wider community. The promise of research to contribute to economic expansion is rooted in the post-World War II social contract for science (Guston 2000), and fulfilling this promise is a critical element of scientific responsibility. But the economic contribution tells only part of the story of responsible innovation.

Third, another premise that dawned on the Rutgers group is that the enterprise of knowledge-based innovation has normative dimensions that science policy confronts only marginally or in ad hoc ways. Such normative consequences begin with the costs, in addition to the benefits, of technology transfer and other university-industry interactions. On campuses, market values intrude on the scholarly enterprise by creating opportunities for conflicts of interest and commitment among faculty and students, changing norms of scholarly communication and materials transfer, turning students into consumers, and potentially devaluing learning for its own sake (Slaughter 2001). In chapter 11, Sheldon Krinsky reminds us that there are both local and broader public consequences to commercialization when universities and their faculties become interested participants in technical decisions and controversies rather than disinterested observers. The ideal of what Joel Primack and Frank Von Hippel (1974) call public science has been almost completely lost: more than two-thirds of national research and development spending in the United States comes from private interests, and a significant fraction of the remaining one-third of public money is potentially compromised by interests in commercialization or by mingling with private funds.

In addition to behaving responsibly with respect to economically relevant research through the creation of offices of technology transfer, universities began a decade earlier to behave responsibly with respect to human and animal research subjects by creating institutional review boards (IRBs). These activities, however, clearly need improvement, as demonstrated by Jesse Gelsinger's tragic death during a genetic therapy trial at the University of Pennsylvania. In this case, the director of the research institute housing the research held financial interests in a firm, founded by one researcher, which helped finance the institute (Sacks 2000).

Technology transfer and IRBs show that universities can adopt a responsible position when the opportunity arrives. Yet the protection of research subjects and the contribution of university-based research to the economy do not exhaust the scope of the ethical, legal, and social implications of innovation. The societal value of knowledge creation cannot be measured merely by licensing income, and the ethical duties of research are not entirely discharged by obtaining informed consent. Derek Bok (1982) realized this two decades ago when he delved into the social responsibilities of the modern university. Bok wondered, in a world remade by knowledge-based innovation, "should academic freedom extend to university laboratories that could produce discoveries of awesome power and destructive force?" There are many grades of distinction between academic freedom and intellectual servitude, just as there are many critical societal effects short of "awesome power and destructive force." The point, familiar to students of science and technology, is simply that knowledge-based innovation helps create many patterns of society to which people must respond, usually without having had any choice in those patterns—whether through design, accident, or neglect (Winner 1977).

Unfortunately, little is known about how these patterns are created. There is a role for knowledge creation and dissemination around the normative dimensions of knowledge creation itself, and universities therefore have a role in this reflexive enterprise. New ways must be found to manage the ethical, legal, and social implications of research that aspires to help people pursue more uplifting lives in more just societies.

Universities' examination of the ethical, legal, and social implications of the knowledge-based innovations they principally pursue is particularly critical given the unbalanced evaluation of costs and benefits to which Bok refers in chapter 3. If it is hard to say no to the incremental commercialization of universities because each new bit is not entirely unprecedented and because the negative consequences of each new increment cannot be as clearly discerned as the positive ones, then at least universities can say yes to the reflexive study of the interaction of innovation and society.

The Roles of the Center for Responsible Innovation

To house the self-scrutiny of the ethical, legal, and social implications of knowledge creation, universities should create centers for responsible innovation (CRIs). CRIs would accomplish this reflexive pursuit in parallel with the universities' traditional missions of teaching, research, and service.

CRIs would function primarily as brokers of interdisciplinary teaching and learning opportunities and educational resources. One obvious area would be

supporting departments in their federally mandated and independent efforts to integrate ethics and responsibility issues into their curricula. The National Institutes of Health require that institutions applying for biomedical training grants provide trainees with course work in scientific responsibility. More recently, the Office of Research Integrity (2000) of the U.S. Public Health Service has announced a policy to require similar training in the responsible conduct of research for all grant applicants, although Congress has suspended the policy pending what it considers more appropriate procedures in promulgating it (Brainard 2001). Similarly, the Accrediting Board for Engineering and Technology (2000) requires ethics training in its recent accreditation criteria for undergraduate engineering degrees. CRIs would help such relevant courses find faculty or professional expertise and course material.

CRIs would also propose, plan, promote, or implement novel educational programs. Such programs might include helping to create or support undergraduate course work; minors or majors in science, technology, and society; or graduate programs in science and technology studies. They could also include graduate programs that cross-train, for example, natural scientists and engineers in business, policy, law, and the humanities. At Rutgers, one program combines a master's degree in biomedical sciences with a master's degree in business administration. The Massachusetts Institute of Technology's technology and policy program combines a master's degree in science with course work in public policy and an interdisciplinary thesis.

The primary research contributions of such a center would involve engaging in externally funded cooperative research on the ethical, legal, and social implications of other research on campus. Ethical, legal, and social implications research (known by the acronym ELSI) has expanded over the past decade, funded by 3 to 5 percent set-asides from large federal programs such as human genome, information technology, and nanotechnology initiatives. Although successful in funding a significant amount of research (the human genome ELSI program at the National Institutes of Health and the U.S. Department of Energy has funded more than \$150 million of work since FY 1990), ELSI seems to have been more successful in diverting calls for other innovations in ethics and responsible research than in informing the science policy process or encouraging broader and more sophisticated political considerations of issues such as genetic privacy and discrimination (Kitcher 2001). In a detailed study of the human genome ELSI program, Lauren McCain (2002) concludes that "the ELSI experience so far does not support an early contention . . . that public science projects can sufficiently monitor and address their own social impacts. ELSI-type programs are unlikely to help shape public research agendas" (12).

Such expectations for ELSI research, however, may be too high because ELSI work concentrates on innovations after they emerge from the laboratory; it has had few, if any, institutional links back to setting research priorities and other science policy tasks. In contrast, research conducted or encouraged by CRIs could resemble real-time technology assessment, which combines historical research, public opinion and communication, traditional technology assessment, and interactions between the public and active researchers (Guston and Sarewitz 2001). This ensemble of research attempts to encourage responsible knowledge-based innovation by understanding historical precedents for similar innovations; providing links for communication and education among researchers, potential consumers, and the public; and allowing the possibility of public intervention in the innovation process before the innovation is introduced as a market product. Particularly interesting would be interdisciplinary collaborations coordinated by CRIs on knowledge-based innovations with potentially important effects on local communities around universities.

CRIs would also be involved in more traditional scholarly pursuits, such as organizing symposia of university and outside faculty for high-profile intellectual and public events and pursuing an aggressive publishing agenda from them. They would provide advice, assistance, and seed funds for faculty and students commencing externally funded projects that might benefit from ideas in responsible innovation. Specifically, they might assist natural scientists and engineers applying for National Science Foundation grants to articulate responses to the foundation's criterion 2: the broader social merit of the proposed research. Although the foundation does not have a good track record in using criterion 2 to make funding decisions (Mervis 2001), part of the problem may be that applicants do not understand how to frame responses to criterion 2 issues. But political and administrative pressure to use those issues will not subside. CRIs would thus help correct the foundation's mistaken assumption that technically competent researchers also are proficient in discussing the social implications of their work.

In their primary service role, CRIs would reach out beyond the university to local, state, and national decision makers and to the public. This role would, of course, require close collaboration with university communication and government-affairs offices. State legislators and their staff often believe that universities, particularly public ones, should be more helpful to the legislature as informational sources (Jones, Guston, and Branscomb 1996). CRIs would offer informational programs for public officials grounded in research at the university and would collaborate with a university's Washington office on such programs for national decision makers. They would also collaborate

with IRBs, offices of technology transfer, and other elements of university administration on local projects of mutual interest. CRIs would pursue a strategy for dissemination that includes nonacademic outlets, such as editorials and cable television, to reach the broadest possible audience.

Interaction with the public mediated by CRIs should not be exclusively one way. CRIs must also be conduits to the university, relaying public concerns and lay perspectives. Not only university officials but also teaching faculty and researchers must hear these voices. There are a variety of models for facilitating such expert-lay interaction, including the consensus conferences pioneered by the Danish Board of Technology and recently imported to the United States and other countries (Joss and Durant 1995, Guston 1999a, Hörnig 1999); scenario development workshops in which experts and lay participants reflect on coherent descriptions of envisioned technological futures (Andersen and Jaeger 1999, Sclove 1999); focus groups (Dürenberger, Kasrenholz, and Behringer 1999); and participatory research and design such as that conducted by community-based research centers and "science shops" (Study and Conference on Improving Public Access to Science 2001).

As this list of potential functions suggests, a CRI will not be an organization that does unique things, although some of its tasks will be new in particular institutions. Rather, its novelty will lie in its mission of institutionalizing responsible innovation at research universities and assembling activities in pursuit of this mission. If we remain committed to the idea of the synergy between research and teaching, then this commitment should extend to the university's endeavors to behave responsibly. Failure to institutionalize such an ensemble of activities is not just the failure to pursue responsibility more actively but also the failure to pursue efficiently the mission of the university.

Through CRIs, universities would construct ongoing projects and relationships to help assure members of their own communities, leaders from the public and private sectors, and the public at large that institutions are engaged in responsible innovation, despite continuing commercial ties. CRIs would require some commitment of faculty and staff resources, but they may very well raise a significant share of their own funds from sources such as ELSI programs in the genome, information technology, and nanotechnology initiatives; the Program in Societal Dimensions of Engineering, Science, and Technology at the National Science Foundation; local and regional foundations concerned with the immediate implications of university research; and local corporate givers pursuing an enlightened approach to innovation. The first CRI pioneer would capture headlines and, better, imaginations because such an institution would be novel not just in the United States but perhaps the world. In an increasingly competitive environment, a university with a CRI

would be able to position itself at the vanguard of both intellectual creativity and social responsibility.

Will CRIs Succeed?

Having considered the warrant for and functions of CRIs, let us return to Kitcher's concerns about the science policy system more generally. Given that CRIs seek to involve the public in potentially critical roles in knowledge-based innovation, can we have any confidence that they will succeed?

During the past decade, familiarity with and expertise in mechanisms for the participation of the public in various technical decisions has increased tremendously. In science and technology policy circles, perhaps the most notable achievement has been the spread of Danish-style consensus conferences, or citizens' panels, from the smaller nations of northern Europe to larger nations, including the United States and Japan. Governmental bodies, universities, and private groups have implemented such citizens' panels as well as other participatory mechanisms, including scenario workshops, focus groups, and community-based research centers (or "science shops"). With the increase in participatory activities has come increased attention in the science policy literature. Joss (1999) and Chopyak and Levesque (2001), in particular, provide useful summaries of the variety of mechanisms in use, their apparent strengths and weaknesses, and evaluations of their experiences. The literature reveals that such participatory mechanisms have demonstrated, at least under closely supervised and mediated situations, that members of the public can interact helpfully with experts to assess technical controversies and policies, develop plans for technological futures, and design and conduct certain technical inquiries alongside traditional researchers. From these experiences, it is plausible, even likely, that a well-prepared CRI could succeed in engaging the public and communities around universities in substantive activities with university researchers. If created on a number of university campuses, they would thus constitute a distributed capacity for technology assessments, which some observers (such as Sarewitz 1996) have called for.

Since the 1990s, scholars have also made considerable progress in understanding how the institutions of science policy operate between politics and science to produce societal outcomes. Instead of focusing on the "estates" of science, the professions, administration, and politics that have historically characterized the "spectrum from truth to power" (Price 1965, *passim*), they examine the institutions that manage transactions across these boundaries, which they do not see as static (although Price did). This "important strand of current scholarship about science and society" (Sonnert and Holton 2002,

16) has yielded a description of boundary organizations (Guston 2000, 2001). Examples include offices of technology transfer (Guston 1999b); the Health Effects Institute (Keating 2001); agricultural extension (Cash 2001); the International Research Institute for Climate Prediction (Agrawala, Broad, and Guston 2001); and the Subsidiary Body for Scientific and Technological Advice to the United Nations Framework Convention on Climate Change (Miller 2001). Critical to the success of boundary organizations is their ability to manage the cooperation between scientists and nonscientists in the pursuit of ends of mutual interest—what Guston (2000) calls collaborative assurance. CRIs might engage in collaborative assurance—for example, by providing services to natural science and engineering units (by assisting with ethics curricula, grant applications, and information dissemination to the public and decision makers) while also serving society by helping attune scientists and engineers to societal needs. Although no person may serve two masters, boundary organizations like CRIs can serve both science and society by helping each to achieve the teaching, research, and service goals they want to reach responsibly.

Creating new institutions, even those about which one might have some confidence based in theory and practice, entails some risk. One potential risk of creating CRIs is that they may end up institutionalizing criticism of science. The honest response to such a concern is that CRIs will indeed institutionalize science criticism, but it will be criticism in the sense of constructive engagement with the quality and contribution of the scientific enterprise. Such criticism, which would be along the lines of art or food criticism (Chubin 1994), is exactly what such a center should be after and precisely what the commercialized university needs. The acceptance of ELSI programs within the ranks of scientists suggests that informed criticism can find an institutional home close to the research it engages in. Moreover, there are other, albeit modest, proofs that aspects of this enterprise can succeed. For example, nanotechnology researchers at Arizona State University have collaborated with Columbia University's Center for Science, Policy, and Outcomes to propose a real-time technology assessment agenda and to cross-train Arizona State's graduate students in nanoscience and engineering in science policy under an integrative graduate education and research traineeship grant from the National Science Foundation.

A second possible criticism is that CRIs would contribute to what might be called the "ELSI-fication of the social sciences." That is, the important role of the social sciences in examining the implications of the natural sciences may be taken as the only or the primary role for the social sciences. John Steelman, one of the architects of the modern research establishment in the Truman administration and himself an economist, argued that "competent so-

cial scientists should work hand in hand with the natural scientists, so that [societal] problems may be solved as they arise, and so that many of them may not arise in the first instance" (Guston and Sarewitz 2001, 95). More recently, sociologist William Julius Wilson (2002) has argued that the social sciences must respond to the "impetus to address policy-relevant issues . . . that grow out of the struggles of nation states to adapt to the impact of rapid technological and economic changes on individuals, families, communities, institutions, and the society at large" (1).

Without predicting the likelihood of demands for greater relevance from social science research, ELSI-like work forms a significant but not overwhelming share of available federal social science research dollars. Since 1991, the National Institutes for Health have spent slightly more than \$130 million in ELSI funds, including an estimated \$21.5 million for FY 2002. The Department of Energy has spent nearly \$25 million during the same period on genome-related ELSI research, including an estimated \$2.8 million in FY 2002.¹ National Science Foundation spending on the social and economic sciences totals more than \$70 million per year (American Association for the Advancement of Science 2002, 144); and of this sum, spending on the Program in Societal Dimensions of Engineering, Science, and Technology, the foundation's closest cognate program to ELSI, is close to \$2 million per year.

Given that genome-related ELSI funding is nearly an order of magnitude greater than the National Science Foundation's Program in Societal Dimensions, a more likely result than the ELSI-fication of the federal social science portfolio is that research on the ethical, legal, and societal aspects of innovation will be overwhelmed by particular innovations that the federal government has already identified and cultivated for support. With significant ELSI-like funds coming only after the federal government has committed to a multiyear, multibillion-dollar investment, the results of such research may be enlightening but have a decreasing chance of influencing the policy environment or the trajectory of the innovation. The risk of ELSI-fication seems less than the risk that only specific technologies will be scrutinized, and then only after they have already been imparted with great momentum. The need for decentralized, university-based CRIs therefore becomes even more apparent.

Conclusion

Universities should make a demonstrated commitment to responsible innovation in the face of the challenges wrought by the commercialization of the academy. Such a commitment is warranted because universities will continue to be in the business of knowledge-based innovation for the foreseeable future.

The commercialization of knowledge-based innovations has been, is, and will continue to be integral to some aspects of the university; but "doing no harm" and "contributing to the economy" do not exhaust the normative demands on the research enterprise. University-based CRIs can help satisfy these additional demands, even while helping members of the university community achieve their substantive goals for teaching, research, and service. Grounded in recent scholarship in public participation and the design of science policy boundary organizations, they can draw university research, the values of communities, and the needs of decision makers closer in fruitful ways. CRIs can help create microcosms of well-ordered science, one university at a time.

Note

1. Data were provided by Howard Silver and Angela Sharpe, personal communication (Washington, D.C.: Consortium of Social Science Associations), June 2002.

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