Industry-University Cooperation, and the Emergence of Start-Up Companies

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Introduction

For more than 40 years, many U.S. academic and business leaders have urged stronger ties between their institutions in research and graduate education, particularly in fields of science and technology. Although progress has been slow, by now there is persuasive evidence that both universities and businesses realize substantial benefits from participating in cooperative research. Both quality and significance of research are increased; graduate programs leading to M.S. and Ph.D. degrees are strengthened; new technologies are created and bring benefits to industrial partners; and economic development is advanced in society at large.

A recent publication of the U.S. Business-Higher Education Forum expands on the advantages of cooperative activity and identifies specific challenges to constructing partnerships.[1] It suggests proven policies and practices for overcoming the challenges. This publication describes specific recommended practices by universities and businesses for effective engagement in cooperative research activities. It is an excellent document, relevant to engineering, science, and business university programs. It has been widely endorsed by university presidents and corporate CEOs.

Evolution of support for cooperative engineering research

Organized programs for industry-university cooperative research in the U.S. began to grow about 1970. Following is a brief, partial account of subsequent developments. At first, cooperative projects were small and isolated. Only a few faculty members and a few companies participated. Growth was stimulated in 1973 when the National Science Foundation (NSF) initiated its Industry/University Cooperative Research Program.[2] It encouraged creation of university-industry cooperative programs nationwide in a variety of technical fields. The Bayh-Dole Act of 1980 removed a major impediment for cooperation in fields such as pharmaceuticals and biotechnology, in which exclusive licensing of intellectual property is necessary. It transferred to universities rights previously reserved to Federal government agencies.

NSF expanded its commitment to cooperative research in 1985 with establishment of the Engineering Research Centers program. That program provides up to 11 years of NSF funding in partnership with industry. Recently there were 19 centers in operation, each with annual NSF funding averaging $2.5 million. [3,4] Multiple industry partners are members of each ERC center.

In 1981 the University of California established the MICRO program to stimulate cooperative research in microelectronics and computer technology.[5] Formation of the Semiconductor Research Corp.[6] in 1982 was led by major U.S. semiconductor firms with the goal of increasing the level of research effort and the number of graduates prepared to contribute to their industry. All its funding, now about $35 million/year, is expended at universities. In 1996, the University

of California established new cooperative research programs in biotechnology and several other fields.[7] In 1997, the U.S. Semiconductor Industry Association (SIA), in cooperation with members of the U.S. semiconductor equipment, materials, software and services industry, and the U.S. Department of Defense, launched the $60 million MARCO initiative[8] to expand certain long-range applied microelectronics research at U.S. universities.

Last year, the State of California committed $400 million over 4 years to create four new University of California-based *Institutes for Science and Innovation*,[9] focused on bioengineering and medical biotechnology, telecommunications technology, nanotechnology, and societal information systems. The Institutes all require a combination of funds from government and multiple industry partners to support cooperative research.

Note that jointly-funded cooperative programs have received steadily increasing support from universities, industry, federal government, and California state government since 1973. Not one of the programs described above has been terminated. All participants believe these programs are valuable. Yet despite these successes, only a small percentage of U.S. university research is now conducted in cooperation with industry.

Experience reveals some common features among the most successful cooperative programs. Research should be firmly related to scientific foundations, but also highly attentive to application requirements. Collaboration among faculty members, and between university and industry personnel, strengthens the research and the educational experience for all. The most successful programs involve multiple industry partners and continue for 5-10 years or more based on successive shorter commitments. The impact of collaborative research is maximized by open publication of results. Industrial partners derive value from the opportunities to influence research directions, to hire the best graduates, and to be first to market with new products.

Impediments to creation of cooperative programs

Faculty members are a major impediment to further growth of cooperative programs. Those who have spent their entire professional lives as students or employees of academic institutions do not understand the industrial world well enough to build effective cooperative relationships. Successful university-industry partnerships are most likely if they involve faculty members who have worked for a time in an industrial setting, later collaborating with industrial peers who have had personal experience in full-time graduate study at a university. Research collaboration across the boundary between university and industry becomes almost impossible if neither partner has “walked in the shoes” of the other. In the absence of shared experiences, potential partners have difficulty communicating and are reluctant to engage in significant collaborations.

Some people believe that university careers tend to attract “lone wolves,” individuals who prefer working alone (with a few students) to the exclusion of collaborations with colleagues on the faculty or from industry. As science and technology advance, multidisciplinary teamwork within the university and with outside partners is ever more important to significant achievements. Universities are unwise to employ faculty members who resist collaborative activity. Of course, university practices for evaluation, promotion, and advancement of faculty must be refined to give full credit for successful faculty contributions to team achievements. The appropriate overall metric for faculty performance is *impact*: the degree to which a faculty member’s work influences subsequent theoretical and/or practical research and practice in his or her field.

Disagreements over intellectual property policy have impeded many potential university-industry collaborations. In fields such as agriculture, biotechnology, and pharmaceuticals, innovative products require years to bring to market and have a very long economic life. Monopoly positions protected with patents are a critical business asset. It becomes exceedingly difficult to develop university-industry collaborative research involving multiple industry partners.

By contrast, in other fields including computers, electronics, and software, patents are not the basis for market leadership. Most patentable products and processes have a short economic life. Conformance with industry standards is much more desirable than establishment of proprietary standards. Manufacturing firms seek patents primarily to establish a strong position in cross-licensing negotiations, and for defensive purposes; these considerations are irrelevant to universities. Universities that seek to recover royalties or licensing fees for inventions stemming from collaborative efforts are seen by industry as operating with a "jackpot mentality." Of course, some agricultural and biotechnology patents have produced "jackpots" for inventors and their universities. But there are very few examples of university patents outside those fields that produce significant royalty or licensing income.[10] The record suggests it is a mistake for universities and industry to consider patent rights as a key value to be sought from collaborative research activity in fast-moving fields such as electronics, computers, and software.

An intellectual property policy that has worked well for many faculty members, universities, and industrial partners is to agree that the results of joint activity are placed in the public domain, or otherwise made available to industry partners on a guaranteed royalty-free non-exclusive basis. This satisfies faculty and student needs for prompt publication to advance their careers. It satisfies industry in the sense that firms will not have to pay royalties or license fees, nor risk infringement lawsuits, to exploit the results of joint work. A wise university administration is satisfied when a joint program has impact and the principal participants are satisfied. In fact, the University of California has explicitly authorized this approach to intellectual property arising from cooperative research agreements, as an option available university and industry researchers, in a new trial policy announced last year.[11]

When faculty members and students are engaged in cooperative research with industry (or with start-up companies), there are legitimate concerns about possible conflicts of financial interest and conflicts of personal commitment. Universities must establish clear policies well-understood and respected by all participants to avoid problems in these areas.[12]

Emergence of start-up companies from university research

Startup companies created directly by university faculty and students, based upon research conducted at the university, are only a minor part of the U.S. entrepreneurial record. However, as collaborative research activity has grown, the record of successful new companies emerging from university work has grown too. Looking back over 20 years, now-public companies that began with founding personnel coming directly from California university research programs include Sun Microsystems, Cisco Systems, Cadence Design, Synopsys, Broadcom, Marvell Semiconductor, and Inktomi.

More recently, there are a number of other successful new ventures, none that have yet become public companies. Several were acquired for substantial prices by established companies, including (with their acquirers): OPC Technology (Mentor Graphics), Abrizio (PMC Sierra), Fast Forward (Inktomi), and Timbre Technologies (Tokyo Electron). Promising new ventures that

still are independent include Atheros, Celestry, and Bandwidth9. Faculty and students right out of California universities are founding leaders of all these firms. Additional examples are described elsewhere.[13]

The intellectual climate and business sense stimulated by cooperative research programs is one important factor that enabled successful creation of these new enterprises. Smart, innovative faculty members and students learned much from their industrial partners, most of whom are large, well established corporations that are leaders in their fields. The cooperative programs generally had the charter to look out beyond present solutions and constraints to seek creative new solutions to technical needs. When innovative solutions were found, they were immediately available to their industrial partners.

Why do not industrial partners in cooperative research more often exploit the opportunities suggested by the outcomes of cooperative efforts? The most reasonable explanation is that they confront the classical "innovator's dilemma," so clearly articulated by C. M. Christensen in his 1997 book of that title.[14] Existing companies always are busy incrementally extending existing products and technologies in directions desired by their largest customers. Innovative new products and technologies often require new customers, new manufacturing capability, new sales and marketing efforts, and (at least initially) can be expected to yield only modest revenues and questionable profits when measured on the scale of a large firm. New ventures are founded when existing firms fail to pursue risky new opportunities. In those circumstances, industry partners in cooperative research programs cannot object when university personnel subsequently pursue the new venture path. When new ventures are successful, established firms may react by purchasing a new venture in its entirety, or by becoming a customer for or supplier to it. Our experience is that cooperative partners usually are satisfied with such outcomes.

Other important elements for successful formation of new ventures are not unique to initiatives emerging from the university. Among these elements are a local pool of experienced technologists, managers, and business people that can be hired to fill the gaps in a new firm; venture capital investors to provide funds and to assist in recruiting needed personnel and in identifying and contacting potential customers and suppliers; and the vertically-segmented Silicon Valley business environment that includes many independent firms eager to provide any needed goods or services.

What initiatives can universities undertake to develop entrepreneurial skills in their graduates? Business schools at UC Berkeley and other universities have established programs to encourage entrepreneurial thinking and activity.[15] Successful entrepreneurs are brought to campus to speak in classes or other forums. An annual competition for new student-led business plans is a feature of Berkeley's and other programs.[16] Often the winners receive venture capital funding and become successful enterprises. A recent example is Timbre Technologies, acquired by Tokyo Electron, Ltd. in February 2001. It was the winner of UC Berkeley's competition in 1999.

Conclusion

Graduate education, technological progress, and economic development all can be advanced by formation of cooperative research programs that bring together universities and industry. This can happen when faculty members and universities develop supportive practices for collaborative research and when corporations move beyond secretive internal policies to embrace engagement

with university partners. Proven models exist for successful resolution of all key issues including intellectual property rights, conflicts of interest, and conflicts of commitment.

References

Electronic hyperlinks to all references below and others related may be found in one place: http://radon.eecs.berkeley.edu/~hodges/UnivIndus.html

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