Title: Academic Revolution and Regional Innovation: Building University-Industry Relations in the Computer Science Department at Stanford University 1963-1972

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Introduction

There remains little consensus in regional studies on the origins of Silicon Valley or other innovation hubs. Different approaches, reflecting the interdisciplinary nature of the field, have examined the issue from institutional, cultural, and network analysis perspectives. At the same time, historians of science are beginning to construct a more detailed narrative of the development of computer science in the United States, particularly in the divide between academic theory and industrial practice.

Akera has developed a theoretically rigorous synthesis of the field's rise as part of his study on the pluralism of computation in the Cold War era. He develops the notion of an ecology of knowledge to show how the tension between military applications, commercial goals and academic desires shaped the direction of computing. On university campuses, this tension was manifest between the academic staff of the discipline and the service staff of university computational facilities, a conflict that eventually led to their "disintegration."[1]

Looking at the people of computer science, Ensmenger writes that the need for academic legitimacy was a crucial element in the direction of computer science departments, and this concern caused departments to focus on theoretical concepts (especially the algorithm) as a means of building a defined field of inquiry with open problems and clear research directions. He argues that this increasing theoretical basis assisted aca-

[1] Atsushi Akera, Calculating a Natural World, MIT Press, 2008.

demic departments, but led to a widening gap between the science and the applications of computer science.[2]

However, the models developed by these studies are incongruent with the experience at Stanford University. After joining the Mathematics department in 1957, George E. Forsythe, a professor of numerical analysis, worked to quickly develop computer science into its own discipline. Computer science was soon provided its own division within the Mathematics department, allowing Forsythe a level of independence for the burgeoning area of study.

These early years were tough for the Computer Science division. Faculty billets were shared with the Mathematics department, ensuring a constant friction over staff. Furthermore, the development of computer science as a discipline brought its research program away from the work conducted by other mathematicians, generating important discussions on the utility and legitimacy of this new discipline. Eventually, these disagreements would cause Forsythe and the Computer Science division to leave the Mathematics department and create an independent division at the end of 1963.

Despite these issues of academic legitimacy, the division's growth led to the university administration granting full department status on January 1, 1965. However, the financial pressures on the department continued to grow as high inflation and university budget cuts constrained its expansion. Securing fungible funds was challenging, and

[2] Nathan Ensmenger, The Computer Boys Take Over: Computers, Programmers, and the Politics of Technical Expertise, MIT Press, 2010.

the department could not rely exclusively on the Stanford administration and the federal government to provide the funds required to meet student and research demands. Unlike the MIT and Michigan experiences documented by Akera, a relative peace between the service and academic wings was typical at Stanford throughout this period, and the Computation Center actively subsidized the academic Computer Science department.

More importantly, the Computer Science department began to look outside of the university and the federal government for funds. Despite its theoretical character, the department would begin a series of programs to engage industry and develop new and durable revenue sources, in contrast to the picture developed by Ensmenger.

Providing a model to frame this analysis, Etzkovitz and Leydesdorff have developed the theory of the "triple helix" to describe the relations between universities, industry and the government. While the three types of institutions are generally described as being part of a triangle, the triple helix model takes as a basis the differential approaches of the three groups and adds elements of co-evolution (generating the ever-evolving helix).[3] Etzkovitz has further developed these notions in analyzing the development of "entrepreneurial science" at MIT and Stanford.[4]

This paper investigates the role of industry in the Computer Science programs at Stanford, and how the Computer Science department adapted to engage industry. It argues that the Computer Science department created venues of engagement that allowed

[3]Universities and the Global Knowledge Economy: A Triple Helix of University-Industry-Government Relations, Ed. Henry Etzkovitz and Loet Leydesdorff, Pinter, 1997

[4]Henry Etzkovitz, MIT and the Rise of Entrepreneurial Science, Routledge, 2002.

for the circulation of talent that spread crucial ideas between the university and industry. Along the way, these relations provided direct financial benefits to the department, either in the form of money or equipment. Thus, the growth of university-industry relations served several different purposes for each side of the partnerships.

This paper begins by looking at the development of the Computer Science department and the conflict over its academic legitimacy. Then, a brief history of the financial situation of the program's construction of a new building provides a framework for understanding the department's need to secure industry partners. The remainder of the paper analyzes the development of industry grant sources, particularly from IBM, as well as the development of venues to engage industry such as the Honors Co-op program, which provided a means for industry engineers to take classes at Stanford conveniently, and the Computer Forum, a conference for faculty and top industry engineers to meet and discuss research.

Developing Computer Science

George E. Forsythe joined the Stanford University Mathematics department in 1957 as a full professor, joining John Herriot as a numerical analyst. Herriot was among the first of the leaders of computation at Stanford, and the two men immediately began to consider approaches for developing the field of computer science on an educational and intellectual level within the department.

In the years before 1961, there was no official administrative structure for computer science, although Forsythe did formulate a sub-field of sorts within the Mathematics department by 1959. All decisions regarding the academic side of computer science in these years were passed through David Gilbarg, the chair of the department. Gilbarg's interests were in algebraic number theory early in his career, but his work in World War II led him to focus on nonlinear partial differential equations and fluid dynamics for the remainder of his career.

When Forsythe arrived, the differences between the area now defined as computer science and the traditional field of mathematics were relatively few. Mathematics hired Forsythe to add strength in numerical analysis, and he strongly believed in the utility of numerical approaches, which he considered to be the next stage in the development of mathematics. He urged his colleagues that a mathematics education should include at least a basic background in using computation.[5]

The university administration was also enthusiastic about the new field. Albert Bowker, a statistician who was an associate dean in the School of Humanities and Sciences (H&S), discussed the formation of an autonomous division for the field from the very start of its formation within Mathematics.[6] By 1961, the discussion had moved to the issue of logistics, and how such a division would be formed and operated within

[5]Donald E. Knuth, "George Forsythe and the Development of Computer Science," Communications of the ACM, Vol. 15, No. 8 (Aug. 1972), pg. 721-727.

[6]The idea of an autonomous division within Mathematics was a bureaucratic construction. The basic design was to place Forsythe as head of the division with his own budget, but with the chair of Mathematics continuing to hold final administrative authority. The change allowed Stanford to argue that it had an autonomous Computer Science unit.

H&S. Gilbarg was not actively a part of these conversations despite being chair of the department.[7]

Gilbarg informed the H&S dean, philosopher Philip Rhinelander, of his basic approval. Gilbarg was relatively enthusiastic about the creation of an autonomous division for computer science, arguing that it would provide coherence and would be easier to expand the faculty. Even at this point, just two years after the creation of the sub-field, he observed that there was increasingly a divergence between mathematics and computer science, and that an independent division would fit the diverging nature of the two fields. "The new faculty contemplated for the Division," he wrote, "would not ordinarily be appropriate as members of the Mathematics Department."[8]

Not surprisingly, Gilbarg came down squarely in support of the approach taken by non-numerical mathematicians. "I admit to some qualms concerning the scientific quality of the work in Computer Science – at least compared with that in the traditional scientific disciplines. I refer primarily to the technological rather than fundamental character of much of the work."[9] Nonetheless, his more immediate concerns were pragmatic. Tellingly, one of his conditions was that faculty appointments within the division should require his approval, creating an administrative review that would greatly increase the tension between these two fields in the coming years. However, there was little desire at this point to negotiate these requirements, and the conditions were accepted a few days

[7] All archival materials available from Stanford University Special Collections. Gilbarg to Rhinelander, "Division of Computer Science," 9 Jan. 1961, H&S Files, SC36/89-114/8/"CS: 62-63."

[8] Ibid.

[9] Ibid.

later by Patrick Suppes, a philosopher of science and an associate dean of H&S, leading to the creation of an official division within the Mathematics department.[10]

The heart of the issue is the unique economics of universities. Faculty slots are highly prized, since they are permanent budget outlays to a department and at Stanford, offered the possible benefit of tenure to their recipient. Since Computer Science was a part of Mathematics, the two programs shared faculty slots, and a zero-sum mentality developed over each new slot. In this case, the bureaucratic structure increased this divisiveness because the chair of the Mathematics department was the chief evaluator of faculty nominations from the division. The reviews succeeded when interests aligned, but Forsythe's desire to expand into new areas like artificial intelligence would cause a permanent fracture in the relationship.

The Case of William F. Miller

The divide over the direction of Computer Science after 1963 and its role in the university came up in the tenure decision of William F. Miller, one of the original members of the Computer Science faculty who would later serve as Stanford's provost. Miller was a physicist, receiving his PhD in the field from Purdue in 1956 before joining the Argonne National Laboratory, working on the development of the computer. Given Miller's background in physics, he was nominated in 1964 to fill a joint faculty position

[10] Suppes to Gilbarg, "Division of Computer Science in the Department of Mathematics," 1 Feb. 1961, H&S Files, SC36/89-114/8/"CS: 62-63."

between the Stanford Linear Accelerator Center (SLAC) and Computer Science. Such a joint position logically fit the interdisciplinary Miller, and also allowed the division to expand its faculty for just half of a salary.

His appointment was recommended by the division and by the administration in the School of Humanities and Sciences. Despite this support, the case was not received well by the school's advisory Committee on Appointments and Promotions (A&P). There, the faculty voted unanimously against Miller's appointment. Given its advisory role, the committee's decision was not binding, and the School overruled and appointed Miller full professor of Computer Science later that year.[11]

Chemist Paul Flory was a member of the A&P Committee at the time of the decision. He came to Stanford in 1961, already among the most eminent chemists in the United States. Previously on the faculty of Cornell University, he studied the physical chemistry of macromolecules, developing a theory for analyzing chain molecules quantitatively that would eventually lead to a Nobel Prize in Chemistry in 1974. Flory's stature was recognized at Stanford, where the administration placed him quickly on the A&P Committee.[12]

Flory was deeply concerned about the dean's decision to overrule the committee on Miller. In a three-page letter, Flory explored not only the Miller case but also the wider issues of the role of professional and applied research at a place like Stanford.

[11] Paul Flory to Dean Robert Sears, "Committee on Appointments and Promotions," 29 Jun. 1964, Terman Papers, SC160/3/12/2.

[12] "Paul J. Flory - Autobiography," Nobelprize.org, 22 Jan. 2011, http://nobelprize.org/nobel_prizes/chemistry/laureates/1974/flory-autobio.html

Regarding Miler, Flory wrote that he voted against him because of a lack of scholarly achievement. Commenting on speculation regarding the vote, he said that "The assertion that the Committee underestimated the significance of his contributions to computer science because of the unorthodox media of communication (ditto reports, etc.) in this field lacks credibility."

Given the state of the computer science field at the time, these kinds of reports, despite Flory's stature, may very well have been crucial scholarship, and we see the issue of legitimacy enter into the discussion. In addition, Flory was concerned that a candidate for the joint appointment would need "superhuman capacities" since the job would entail so many different types of activities, and thus he was skeptical if any candidate existed who could fill the position.[13]

These concerns regarding scholarship were certainly not unusual in tenure discussions. However, Flory's arguments on the role of the professions deserves strong analysis. He began his letter by noting that he did not oppose Miller on the grounds that areas of applied science were moving too close to the School of Humanities and Sciences, even though "caution in this regard is imperative." While he argued that "scholarship should certainly take precedence over shades of distinction between the professional and the central disciplines," he continued, "the distinctions must nonetheless be regarded as significant in the academic scene."[14]

[13] Ibid.
[14] Ibid.

After the discussion of the Miller case, Flory unleashes his main argument against the direction that Stanford was taking: "In some way, appointments in 'growing edge enterprises' (my underline) are to be fostered with emphasis on areas of practical concern, because these latter are said to be the well springs of new disciplines. Accepted doctrine backed by a good deal of experience replete with familiar examples teaches the obverse, namely, that areas of practical import spring from advances in the disciplines."[15] He noted that his views are traditional and not keeping with the spirit of the times at Stanford. Flory then crescendoed into his paramount argument:

> No university can hope to mirror all new and promising areas of technology with their manifold proliferations in the present age. In fact, it must constantly guard against the ever present temptation to try to do so in an age of specialization. There are also the closely related pressures to develop enterprises, and these can be lethal to a great university. It is no secret that many of the faculty are gravely concerned over recent tendencies in this direction. It would be a matter of great regret if the School of Humanities and Sciences were to abandon its position as the bulwark of the disciplines in order to take unto itself technologies and professions at what may momentarily appear to be "cutting edges" of "new frontiers."[16]

[15] Of course, this linear model of the progress of theory to applied science has been expanded by a wide range of scholars. See Stokes, Donald "Pasteur's Quadrant" for an encompassing discussion of these models

[16] Ibid.

Flory's argument was the most articulated response to the rise of Computer Science at Stanford, and showed both the importance of legitimacy and the politics of knowledge in the development of computer science.

Building an Academic Home

The department's response to this academic environment was to focus on the development of theoretical advances in the field, particularly in artificial intelligence. There was little desire to develop industry-facing programs, nor to develop applied research programs. However, the financial needs of the department would force a change in perspective on the issue of industry relations, and one of the first examples of the Computer Science department's desire to reach out to industry comes from its attempt to build a new building to house the department's faculty.

The department's growth in faculty and students put incredible pressure on the space available to the department. The department's main office space was in Polya Hall, and the division began with 2,610 sq. ft of space in 1961. Over the course of the decade, the office space expanded briefly to as much as 4,200 sq. ft., but would end the decade with only 3,380 sq. ft. in the building. The expansion of the Computation Center eventually cut into the space available to the department. Thus, on-campus space grew about 30% over the course of the decade (compared to a fivefold increase in the size of the budget and students in the department).[17]

The problem is that the Computer Science department had no space of its own on campus, and merely leased space (for free) from the Computation Center's home in Polya Hall. This required faculty to share offices and prevented the department from providing space to graduate students. For instance, in 1967 the Computer Science faculty noted that there were a total of two to four researchers in the department who had worked out of the chair's office over the past few months, and that they were "desperately short of space."[18] In response to the space problem, the university added 12,500 sq. ft. in additional space in the off-campus Powers building, but that space was 15 minutes away by driving, making it inconvenient for academic use.[19]

Forsythe began a lobbying campaign in earnest for the building, working with senior administrators to plan its financing and construction. In 1966, he discussed the issue of raising needed funds for the building, which were estimated at the time at $600,000. Government sources were not likely to support financing of the building, and so Forsythe was encouraged to create a visiting committee of people with interests in computation that would assist the department in setting its direction.[20] Forsythe continued to argue for the building through both official channels and other, more creative

[17]Forsythe to Computer Science Advisory Committee, "Report on Computer Science Department," 19 Oct. 1970, Forsythe Papers, SC98/1/19.

[18]"The Future of Computer Science at Stanford," 8 Feb. 1967, Lederberg Papers, SC186/10/4.

[19]Forsythe to Computer Science Advisory Committee, "Report on Computer Science Department," 19 Oct. 1970, Forsythe Papers, SC98/1/19.

[20]Forsythe to Money-raising file, "Meeting of 18 May 1966." 18 May 1966, H&S Files, SC36/8/"CS: 65-66."

means. For instance, when one professor asks for a visiting professorship, Forsythe responded that “We have the degree of tolerance you need, but you can’t imagine how bad the space situation is here,” and told him that ”I can almost promise you a desk.” Forsythe blind carbon copied the letter to the president, provost and H&S dean.[21] Later, Frederick Terman, the provost of Stanford, would provide assistance in laying out an approach to raising funds for the building, whose costs were quickly increasing. He told Forsythe to break up the building construction into smaller phases, and he suggested that corporations would be willing to donate as little as $25,000 to as much as $800,000 toward a building. He also believed that raising the funds would be tiring and would require a lot of energy for success[22]

The department created the Computer Science Advisory Committee in 1967 to assist it in setting a direction while engaging potential donors in the work of computer science. In developing the committee, Forsythe was told by the administration to place “strong computer scientists” on the committee. However, most of the people desired were alumni, trustees, “people with big money,” and “managers of large corporations like banks.” Even so, Forsythe was told by university administrators that the committee should be focused on the department’s mission, and that it should not be used directly for fundraising.[23] Developing the membership definitely focused on the money aspect: one

[21]Forsythe to Formen S. Acton, 13 Sept. 1967, Sterling Papers, SC216/C1/14.

[22]Forsythe to Building Financing File, “Discussion with Terman, 7 Nov. 1969,” 10 Nov. 1969, Miller Papers, SC208/3/1.

[23]Forsythe to Money-raising file, “Meeting of 18 May 1966,” 18 May 1966, H&S Files, SC36/8/“CS: 65-66.”

example included Ross Perot, who was both interested in computing and had "plenty of money."[24]

Forsythe and the university were relatively successful in their approach, and in 1970, the 15-member committee was composed of six academics, and several wealthy individuals, including the president of Varian Associates, the executive vice president of Bank of America, and the chairman of the Fireman's Fund Insurance Company.[25] Invitations to businessmen were often rejected due to potential conflicts of interest, but others like Fred Merrill of The Fund American Companies believed that the assignment was interesting and "can be of considerable value to our companies."[26]

While the committee may have been created to bring in donors, it also shaped the department's policies and educational program. The committee's primary mission was to advise the university president on all matters related to computer science and computation at Stanford.[27] The committee's activities varied widely, from looking at the undergraduate and graduate programs to analyzing the finances of the Computer Science department. For example, the 1970 meeting included discussions of the time to PhD, the selection of introductory courses, the development of a professional master's

[24]Forsythe to Building-finance file, "Meeting: Miller, Forsythe, Ruetz - 7 Nov. 1969," 11 Nov. 1969, Miller Papers, SC208/3/1.

[25]Forsythe and Miller to the University Computer Facilities Committee members, "Invitation to Computer Science Advisory Committee meeting," 12 Jan. 1970, Lederberg Papers, SC186/4/1.

[26]Letters of rejection from chair of Texas Instruments and President of IBM, along with Merrill are in Sterling Papers, SC216/C1/15.

[27]Robert Lamar, Press Report. Stanford University News Service, 4 Oct. 1967, Forsythe Papers, SC98/1/14.

program and admissions policies.[28] Later that year, Forsythe wrote in his report on "where you have helped us," that "your advice has encouraged us to move in certain directions." Those directions included creating a Computer Engineering master's degree, creating the Computer Forum, restricting the admissions of foreign students, and delaying the creation of an undergraduate major. Beyond this influence though, Forsythe also thanks the committee's assistance in terms of "actual gifts of money."[29] Thus, the committee had fulfilled both its official and unofficial missions: to direct the department and to serve as a source of revenue for major projects.

Industry Funding

DuPont and the Division

Building a new home was an important goal for the Computer Science department, but the continued growth of the base budget for faculty salaries was the primary motivator for Forsythe. One of the greatest challenges faced by the Computer Science division in the early years was securing a stable teaching budget. In the 1963-1964 academic year, the division had a teaching budget of just $48,000. The first external industry grant received by the division came from the DuPont Corporation, a major chemical

[28] Forsythe to CSAC File, "Impressions of advice to the Computer Science Department gained from meeting of 18-20 January 1970," 30 Jan. 1970, Forsythe Papers, SC98/1/18.

[29] Forsythe to Computer Science Advisory Committee, "Report on Computer Science Department," 19 Oct. 1970, Forsythe Papers, SC98/1/19.

corporation with broad interests in engineering education and research in university settings. Beginning in 1963, DuPont donated $18,000 a year to Stanford, and required it to be split between chemistry, biochemistry and undergraduate teaching in engineering. The share received by the Computation Center began at $4,000 in 1963, and increased to $5,000 in 1964.[30]

The DuPont funds were directed toward teaching and represented almost 10% of the Computer Science budget in the early years. The funding was roughly equivalent to the budget for half of a professorship, but with the joint professorships often created, this funding essentially provided another faculty slot for the division. In a typical report on the grant to DuPont, Forsythe stressed both the critical nature of the grant and the importance the division placed on undergraduate teaching, writing that "we know that the future of computing depends on inspiring youngsters."[31] Given the ingratiating nature of such reports, DuPont seems heavily interested in using its funds to develop possible pools of scientific talent.

The DuPont grant also illustrates one of the major problems with relying on industry partners for revenue:it can often be capricious and disappear with little warning. Frederick Terman placed the grant in the base budget of the department, making it equivalent to H&S teaching funds and other sources of grants as a source of stable funding. Unlike those revenue sources however, the DuPont grant was not automatically renewed each

[30]It is not clear from the archives if the gift was to the Computer Science Division or to the Computation Center; Forsythe's accounting practices likely plays a role in this confusion. Richard Bates to Raymond Bacchetti, "Report to DuPont," 19 Jan. 1965, H&S Files, SC36/8/"CS: 64-65."

[31]Forsythe to Julian W. Hill, 3 Feb. 1965, Terman Papers, SC160/3/12/2.

year. The department's dependence on the grant became clear in the 1966-67 and 1967-68 academic years when DuPont decided against renewing the grant, and did so without warning to the university. According to a member of the secretary's office of Stanford, DuPont assessed its own interests in choosing where to give funding, and did not take requests from institutions. Unlike federal funding mechanisms, there was no established procedure for receiving the grant in the first place. To secure a grant, the secretary wrote that "If some institution in a given year is fortunate enough to fall within the orbit of [the company's interests], then its chances for DuPont support are improved."[32] Computer Science thus had to make up for two years worth of lost revenues with little ability for recourse.

Corporations and the Department

Given the theoretical focus of the Computer Science division, the Computer Science faculty had not developed significant connections to industry. With the creation of the department in 1965 and the further expansion of computing as an industry, the possibility of connections increased tremendously.[33] Within just five years, the department would receive more than a million dollars in direct funding from industry, in addition to creating several bureaucratic venues for engaging industry within Stanford. This sec-

[32]Provost's Office to Russell Worley, "Budget of the Computer Science Department," 25 Sept. 1967, H&S Files, SC36/89-114/"CS: 68-69."

[33]Although it is hard to judge, the increased stature of a department over a division likely played a role in this increase.

tion looks at the largest computing corporations of the time and their relationships with Stanford. Through funding, donated equipment, borrowed talent and other support, the Computer Science department would come to play a mutually advantageous role in the ecology of industrial innovation for these companies.

Corporate Direct Funding

No other corporation played as vital a role to the financial and intellectual development of the Computer Science department as IBM. IBM not only began to think about the possibility of grants early, but the company was also prepared to make very large donations to universities beginning research programs in the burgeoning field. One example comes from early 1962. Albert Bowker, the Dean of the Graduate Division at Stanford, applied for a $100,000 annual grant from IBM that would have been split three ways. Teaching would receive $30,000 a year—almost doubling the current teaching budget at that time. In addition, Bowker requested $30,000 to support research on systems for the the IBM 7090, directing the grant proposal right at the core of IBM's corporate interest. Extending this, he also requested $40,000 for unrestricted research funds, and listed a litany of projects that the money might go to, emphasizing that funds would go to "imaginative and creative applications, not routine ones" and that the funds would be used particularly to start new projects.[34] The grant was not received, but this example shows the level of funding possibly available to a research area that had yet to

[34] Letter from Bowker to C. R. De Carlo, 2 Mar. 1962, H&S Files, SC36/89-114/8/"CS: 62-63."

develop into an independent academic division of Stanford.

The university, though, would continue to pursue grant opportunities from IBM, and those efforts proved successful in 1967 when the company approved a $1 million grant to be paid out over four years. The size of this grant was extraordinary given the size of other revenue sources for the Computer Science department at the time, and perhaps unsurprisingly, the talks surrounding the grant were described as a "somewhat unusual negotiation."[35] Thomas J. Watson, Jr. the chairman of the company's board, wrote Stanford's president J.E. Wallace Sterling with the decision. IBM's rationale for providing such a large amount of funding included the desire to support additional research in systems and advanced computing applications, and Watson added also that "our people in the IBM Scientific Center in Palo Alto look forward to continuing their close technical liaison with your people."[36] This desire to connect theoretical researchers in the academy to the technical personnel in nearby industrial labs was a constant feature of Stanford's relationship with industry.

President Sterling emphasized in his acknowledgement of the grant that the funding would be used to connect the Computer Science department with other departments across the university,a goal of interdisciplinary research that was typical of IBM's approach.[37] This teaching grant was not the only major source of funding from the

[35]Frank Newman to John Herriot, "IBM Grant," 18 May 1967, H&S Files, SC36/8/89-114/"CS: 66-67."

[36]T. J. Watson, Jr. to J. E. Wallace Sterling, 9 May, 1967, H&S Files, SC36/8/89-114/"CS: 66-67."

[37]J.E. Wallace Sterling to T. J. Watson, Jr., 23 May 1967, H&S Files, SC36/8/89-114/"CS: 66-67."

company with interdisciplinary research as its goal. IBM also influenced the department through funding new research programs. Stanford Law School developed a Law-Computer Fellows program that would explore how computers might affect the legal environment, and the costs of that program were underwritten by a $255,000 grant by the company.[38]

Evidence suggests that IBM hoped to enhance its own competitiveness by influencing Stanford's research and services, and thus, the company's intentions were not entirely pure. The desire to protect core corporate interests was a major motivation of the funding and relationship-building the company conducted. One example of this desire comes from the early history of the Computation Center. In late 1963, Forsythe received a letter from a manager at the Service Bureau Corp. a commercial computation center fully owned by IBM. The company was concerned that Stanford was potentially offering its computation resources to commercial clients, and the company felt that it could not compete with the low prices and excellent service offered by Stanford.[39] Forsythe told the company that Stanford's Computation Center was not engaged in commercial computation, and felt that the company's request to desist was a little out-of-place.[40]

IBM's enormous funding was a massive boon to Stanford, and indeed, it is unlikely that the department could have achieved its growth in student enrollment without this significant source of external revenue. As seen with the DuPont example though, creat-

[38]T. J. Watson, Jr. to J.E. Wallace Sterling, 3 Sept. 1968, Miller Papers, SC208/3/29.

[39]W. A. Wasson to Forsythe, 18 Oct. 1963, Sterling Papers, SC216/1/1/27.

[40]Forsythe to IBM File, "Visit from Warren Wasson," 10 Oct. 1963, Sterling Papers, SC216/1/1/27.

ing a balanced array of revenue sources was crucial for income stability, and Stanford pursued funding from other corporations as well.

One source of revenue Stanford used was its extensive network of engineering alumni. The quintessential pair was William Hewlett and David Packard, who had long and deep relationships with Stanford beginning with their undergraduate education in the 1930s. Hewlett-Packard (HP) would take an early and enduring interest in computing, becoming one of the early industrial leaders of the field. The Computer Science faculty were well aware of the importance of the relationship between the department and the company, and established an HP liaison committee —the only company to have a standing committee of the department by 1975.[41]

While HP's gifts were generally in the form of computers, David Packard also had an on-going personal relationship with the department as the board of trustees representative on the Computer Science Advisory Committee. Packard himself would donate a significant amount of funds to the department's projects, including a $50,000 gift in 1969.[42] A member of the committee felt that the donation to computer science education stemmed directly from the work that Packard did with the committee, giving the issues facing the department increased visibility (and simultaneously representing one of the larger successes of the main goal of the committee).[43]

[41] See "Computer Science Department Committee Memberships 1974-1975," Lederberg Papers, SC186/5/2.

[42] Robert Langle to Robert Vandagriff, "Investment of Funds," 21 Nov. 1969, H&S Files, SC36/89-114/8/"CS: 69-70."

[43] F. J. Weyl to Forsythe, 20 Mar. 1969, Forsythe Papers, SC98/1/17.

Donated Equipment

Outside of the personal relationship between Packard and the department, HP itself provided significant resources into the department, following a similar corporate investment strategy to IBM. HP, like other computing companies, faced an incredible shortage of recruits for its business. The company donated an HP2116A computer for student use and helped to fund a departmental research assistantship that would focus on developing software for the new machine.[44] HP was quite up-front with its intentions for the donation. Forsythe wrote that HP "may later try to market it, and would like some experience with its use," and he does not believe that "they expect production programming, but really hope to get some experience, criticism, and some intangible award."[45] Computer Science faculty were also encouraged to make trips to HP to comment on the technology and research programs, creating a circulation of scholars.[46]

However, donations of equipment were sometimes controversial when attached to closely to corporate research agendas. This was particularly the case of joint research programs, where the worlds of basic and applied science appeared to most closely meet. One notable example of this type of controversy was in the summer of 1970, when the Standard Computer Corporation developed a potential joint research project with the university. As part of the agreement, the company would donate more than $1.1 million in equipment to the Computer Science department, with both sides offering personnel

[44] John Herriot to WF Cavier, 5 Oct. 1966, Miller Papers, SC208/2/14.
[45] Forsythe to HP File, 19 Apr. 1966, Miller Papers, SC208/2/14.
[46] Bernard M. Oliver to W.F. Miller, 12 Nov. 1968, Miller Papers, SC208/2/14.

to explore research on the equipment.[47] The goal for the company was to develop computer science as a field, and more importantly, to "promote the development of software and other computer science tools usable with Standard's computer systems and taking particular advantage of the microprogramming capabilities as are now being manufactured by Standard."[48]

At the heart of the faculty's concern was whether Stanford should accept research proposals from industry. Complicating the issue were faculty who actively desired to work on the equipment, and thus the definition of faculty interest was blurry. Nonetheless, the university administration emphasized the need for university research to come "fundamentally from faculty interest —not in response to a [research project] quote."[49] In the end, despite strong support from some Computer Science faculty, the university rejected the entire offer and moved away from direct computation research on behalf of a corporation.[50]

Circulating Talent

IBM's influence and shaping of the Computer Science department did not stop at just funding, but also took place through person-to-person interaction facilitated by the

[47] Sidney Drell to Howard Hooper, "Proposed Joint Study Agreement between Standard Computer Corporation and Stanford University," 6 Aug. 1970, Miller Papers, SC208/1/31.

[48] "Agreement concerning joint research and study program," 1970, Miller Papers, SC208/1/31.

[49] Niels J. Reimers to John F. Olson, 28 July 1970, Miller Papers, SC208/1/31.

[50] Perhaps no other event indicates that the department had reached financial security by 1970. Today, it seems unlikely that a university would turn down an equivalent $6.1 million gift. See Daniel S. Greenberg, Science for Sale: The Perils, Rewards, and Delusions of Campus Capitalism, University Of Chicago Press, 2007.

company. An early example of this kind of interaction was the development of a position for Arthur Samuel, described as one of the "vigorous leaders in research on artificial intelligence."[51] Samuel was retiring from IBM and interested in continuing his research on machine learning at a variety of institutions, including MIT and Stanford. Forsythe developed a unique arrangement to persuade him to join the department, including additional consulting days per week and a reduced course schedule.[52] Unlike some of the university's decisions, Stanford handled the negotiations rapidly, and Forsythe offered Samuel the position of senior research computer scientist just four days later with funding from three separate grants.[53]

Samuel would play an important role in the department's artificial intelligence projects, but also helped to shape the department's relationship to industry. He gave a presentation about the Computer Forum to the Computer Science Advisory Committee, the department's visiting board of advisers, and he encouraged the Computer Science faculty to reach out to the research and operating departments and avoiding the corporate staff when finding contacts for the forum.[54] The interaction between the department and IBM also included active staff. For example, Ted Rivlin, an active research scientist at IBM, was provided a visiting professorship paid jointly by Stanford and the company.[55]

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[51]Forsythe to Hubert Heffner, "Employment of Arthur Samuel," 4 Feb. 1966, H&S Files, SC36/89-114/8/"CS: 66-67."

[52]Ibid.

[53]Forsythe to Arthur Samuel, 8 Feb. 1966, H&S Files, SC36/89-114/8/"CS: 66-67."

[54]Forsythe to File, "My notes on the Computer Science Advisory Committee meeting of 6-8 October 1968," 25 Oct. 1968, Forsythe Papers, SC98/1/16

[55]Forsythe to CSD Faculty, "Visitors, faculty appointments, and new courses," 18 July 1969, Miller Papers, SC208/3/17.

Outside of IBM and HP's donated equipment, Forsythe attempted to create an environment of cross-pollination between the Computer Science department and industry. The goal was both to increase the quality of the research program and to engage potential donors in the mission of the department. Bell Laboratories played a significant role in creating this sort of academic-industry circulation. The company helped to subsidize the costs of having its researchers join Stanford as visiting faculty, allowing the department to expand the number of faculty slots for minimal cost while providing some of the company's top engineers with an intellectually stimulating environment.[56]

Other notable researchers like Richard Hamming, who helped to form the field of coding theory, requested sabbaticals from Bell Labs to go to Stanford. In fact, Forsythe was told by Bell's leadership that the department needed to do more to attract its researchers, saying that the school's peers were more aggressive in securing visiting professors.[57] At least at Bell, the movement of researchers was generally initiated by the people themselves, and not by corporate leaders. Forsythe was told that Bell does not "ration" personnel to universities, but rather its researchers request leave from their superiors who will consider the request.[58]

[56]Forsythe to Sears file, 'Conference with Royden 4 June 1965," 10 Jun. 1965, H&S Files, SC36/8/"CS: 65-66."

[57]Forsythe to Tenure Faculty, "Bell Laboratories as a source of colleagues," 7 Feb. 1969, Forsythe Papers, SC98/14/10.

[58]Ibid.

Other Connections

These industry connections also facilitated the recruitment of students, as well as providing them with interesting opportunities. Texas Instruments gave a presentation of its company's research in late 1969 and held a series of exchanges with faculty and researchers at the Computation Center, AI Lab and SLAC. In addition, the visiting representatives also interviewed students, providing a convenient means for securing employment.[59] IBM also desired to create connections with students. In addition to developing relationships through the Computer Forum, IBM offered such gifts to students as tickets to the American Ballet Company.[60]

IBM was not just interested in recruitment, but also desired to develop the nascent field of computer science. An example of this kind of approach was the development of an "IBM Postdoctoral Fellowship" in 1971. William F. Miller, a professor in the department, received a note from the IBM San Jose Laboratory stating that the lab was trying to contribute to a " 'science' of computers" and that the lab wanted to support the creation of a postdoctoral position that would help to develop this area.[61] Supporting students through these postdoctoral grants thus provided access to up-and-coming researchers for recruitment while also expanding the "core" of computer science.[62]

Developing these connections with industry often required high-level support from

[59] "Texas Instruments Presentation," 12 Dec. 1969, Miller Papers, SC208/1/6.

[60] Steven A. Baffrey to W.F. Miller, 19 Jun. 1970, Miller Papers, SC208/2/11.

[61] A. H. Eschenfelder to William F. Miller, 1 Mar. 1971, Miller Papers, SC208/2/11.

[62] Forsythe to Dantzig, Feigenbaum, Floyd, Knuth, McCluskey and McCarthy, "IBM Postdoctoral Fellowship," 15 Mar. 1971, Miller Papers, SC208/2/11.

the Stanford administration, and the department often received it. The president played an important role in developing these relationships. When Cuthbert Hurd wanted to discuss the far reaching implications of Computer Science, Heffner wrote to President Sterling's aide that "Incidentally, Hurd is potentially a major donor to computer activities at Stanford."[63] Hurd would eventually get his meeting with the president, and later would chair the Computer Science Advisory Committee. In the other direction, Sterling reached out to industry. When the Burroughs Corporation, a major manufacturer of computers, began an expansion on the West Coast, Sterling introduced himself and almost immediately requested "the financial support" of the company to benefit the university.[64]

Throughout this discussion, we see the tremendous impact of a handful of companies on shaping the development of the Computer Science department. Whether in terms of academic programs, such as the Computer-Law Fellows program sponsored by IBM, or the circulation of experts between industry and academia such as from Bell Labs, the department's direction was heavily shaped by the desire to engage industry and support work of mutual interest.

[63]Heffner to F. O. Glover, 13 Feb. 1967, Sterling Papers, SC216/C1/15.

[64]J.E. Wallace Sterling to Ray W. Macdonald, 8 Jan. 1968, Sterling Papers, SC216/C1/14.

Developing Venues for Industry

While Stanford tended to have formal arrangements only with the largest corporations, the Computer Science department created two venues of engagement that provided alternative means for other companies to interact with the department. First, the Honors Co-Op program was a special master's program that allowed employees of local companies to take computer classes in a convenient, ad-hoc fashion. Second, and most critically to the development of the department, the Computer Forum was created to provide a conference to showcase the latest work of the Computer Science faculty to top industry scientists. Both programs provided significant funding to the department and were crucial to the financial stability of the department.

The Honors Co-Op Program

The speedy development of computer science in the 1960s created an acute manpower shortage of academic computer scientists and programmers. For companies that required such talent, there are a couple of different approaches they can use to solve this problem. One approach was to create better relationships with computer science departments, whereby a company would get access to new graduates ahead of the competition. Another approach was upgrading the skills of existing company employees, some of whom may have an educational background close to computer science. While companies in the industry desired to increase the number of employees trained in the field, most could not afford to lose employees for one to two years to a master's program, either in terms of tuition or the opportunity cost of lost productivity.

Stanford developed a program to address this issue known as the Honors Co-op program. Modeled after similar programs in Stanford engineering (particularly electrical engineering), the program allowed employees of industrial affiliates to take classes part-time, generally one or two at a time while paying a higher level of tuition than typical for the administrative convenience.[65] The program first appeared in 1963, and in its first year it taught sixteen students from industry for a total of 185 units.[66] Income that year totaled $3,258, or about $17.61 a unit.[67] The program expanded quickly, more than doubling revenue in the next academic year to $7,260, an amount that could pay for the department's share of a joint faculty member.[68]

Conflicting priorities over the direction of education in the department, however, soon caused the program to stall. At the very first faculty meeting of the new Computer Science Department in January 1965, Forsythe asked whether students who were not making degree progress in the Honors Co-Op program should continue to be allowed to register for classes.[69] Due to the lack of faculty, there was a desire by members of the

[65] Forsythe, "State and Plans of the Computer Science Department: A report to the Computer Science Advisory Committee," 7 Oct. 1968, Forsythe Papers, SC98/1/16.

[66] Royden to McGhie, "Honors Co-Op Funds for Computer Science," 17 Oct. 1963, H&S Files, SC36/89-114/8/"CS:63-64."

[67] L.F. McGhie to Royden, "Honors Cooperative Funds for Computer Sciences," 30 Oct. 1963, H&S Files, SC36/89-114/8/"CS:63-64."

[68] Robert Langle to Forsythe, "Status of CSD Honors Cooperative Fund," 29 Oct. 1965, H&S Files, SC36/89-114/8/"CS:65-66."

[69] Forsythe to File, "Meeting 5 January 1965," 19 Jan. 1965, Forsythe Papers, SC98/15/1.

department to focus more attention on doctoral candidates, which provided the visibility and prestige that the department desired. However, the university administration wanted the additional revenue that the Honors Co-op program provided, particularly because the Computer Science budget was so dependent on soft money provided by the university. The potential growth of the income was considered "spectacular" and the income was used to pay for a variety of expenses, such as the department's secretary.[70]

With control of the admissions policies though, the department's faculty won over the university administration, and the department soon throttled the number of graduates into the Honors Co-op program.[71] However, the administration was not responsive to the changing admissions profile, and started to budget the Honors Co-op program's income directly into the budget base of the department. This issue reached a climax in 1968 when the lack of income became apparent, and the department's budget faced cuts. Forsythe was unhappy at the prospect of cuts, writing in his notes that "no one ever asked us to keep our HCP program going strong; there has never been the slightest intimation that our budget depended on it."[72] When Forsythe discussed the matter with the Computer Science Advisory Committee that year, he asked whether throttling admissions had been a "mistake."[73] Repeating earlier arguments, he was told by Albert

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[70]Royden to Terman, "Missing salary for Diana Saunders," 21 June 1965, Terman Papers, SC160/3/12/2.

[71]Forsythe, "State and Plans of the Computer Science Department: A report to the Computer Science Advisory Committee," 7 Oct. 1968, Forsythe Papers, SC98/1/16.

[72]Forsythe to Royden file, "Meeting of 28 October 1968," 28 Oct. 1968, H&S Files, SC36/8/89-114/"CS: 68-69."

[73]Forsythe, "State and Plans of the Computer Science Department: A report to the Computer Science Advisory Committee," 7 Oct. 1968, Forsythe Papers, SC98/1/16.

Bowker, the dean of H&S, that the program should be kept for the revenue.[74]

The Computer Science faculty were more receptive to Bowker's argument this time, as the need for revenue became particularly acute in the late 1960s and early 1970s. The department began actively building up the program once again. First, the department developed a closed-circuit television system that would allow for the taping of classes that could be watched by employees at their convenience, allowing the program to adapt to work schedules better.[75]

More importantly, the department began to develop an interdisciplinary master's program in Computer Engineering. The program was designed for Honors Co-op students, and there was even discussion of limiting the program to only those students.[76] Intellectually, the need grew out of the growing split between the fields of computer science and that of software engineering, "even though," as Forsythe wrote, "an aspect of computer science is concerned with software."[77] The approach began to increase the co-op funds, which reached around $8,000 in 1970 and were expected to increase in the coming years.[78]

[74] Forsythe to File, "My notes on the Computer Science Advisory Committee meeting of 6-8 October 1968," 25 Oct. 1968, Forsythe Papers, SC98/1/16.

[75] Forsythe to Computer Science Advisory Committee, "Report on Computer Science Department," 19 Oct. 1970, Forsythe Papers, SC98/1/19.

[76] G.H. Golub and E.J. McCluskey, "Degree of Master of Science in Computer Engineering: A Proposal," 19 Jan. 1970, Forsythe Papers, SC98/1/18.

[77] Forsythe to Software Engineering file, "Perlis's Remarks in Boston," 19 May 1969, Forsythe Papers, SC98/14/9.

[78] Forsythe to Computer Science Advisory Committee, "Report on Computer Science Department," 19 Jan. 1970, Forsythe Papers, SC98/1/18.

The Computer Forum

Perhaps no element of the Stanford Computer Science department more embodies the the development of networks between academia and industry than the Computer Forum, a membership-based conference that provided a common environment between industry scientists and the department's faculty members. Through these conferences, industry provided insight to the members of the department on the issues facing their companies, and Computer Science faculty updated industry partners with new information on the forefront of their research. Along the way, faculty became more involved in the work of individual companies, in some cases forging consulting ties with them, and in other cases simply developing an open line of conversation.

The development of the program began in late 1968, mostly as a response to the difficult budget situation faced by the department as well as Stanford. The department needed to increase the amount of "hard money" it secured, and one avenue for doing so was increasing money from industry. The Honors Co-op program covered the educational needs of industry, but there was increasing desire to share the theoretical insights gained by the department's faculty with industrial partners. The Computer Forum was variously described in brochures as a "Stanford-industry-business program" and was successful quite early in attracting industry members. Part of the support came from members of the Computer Science Advisory Committee, which created a subcommittee to follow the development of the forum chaired by David Packard, himself one of the most important industrialists of the era.[79]

The development of the Computer Forum was slow in the initial months, blamed on the lack of a strong leader to implement a vision for the program.[80] Forsythe agreed to the program in early 1968, but feared that the program would fall into the trap faced by a similar program at MIT, by which "non-professional" faculty (by which he meant faculty without an understanding of industrial goals) headed it "from the start."[81] These fears seemed to have delayed implementation of the program, but by the the end of 1968, a handful of qualified people took the leadership. Among them was Ed McCluskey, who was jointly appointed between Electrical Engineering and Computer Science and helped to develop the program as a joint operation between those two departments. In addition, William F. Miller assisted in building organizational support. However, a large influence came from Arthur Samuel, the retired IBM researcher who had recently joined the department as a senior research computer scientist.[82] Stanford's earlier development of connections to industry thus proved to be a critical element in Computer Science's further success in attracting partners to the department. One of the major successes in launching the program was building a faculty team with natural connections to industry, and all three individuals had them.

One of the major insights of the program was focusing on technical-level relation-

[79]Forsythe to File, "My notes on the Computer Science Advisory Committee meeting of 6-8 October 1968," 25 Oct. 1968, Forsythe Papers, SC98/1/16.

[80]Forsythe, "Notes on Lunch with Linvill," 25 Feb. 1969, Forsythe Papers, SC98/2/38c.

[81]Forsythe to Affiliates File, "CSD-EE Affiliates Program," 14 Mar. 1968, Forsythe Papers, SC98/14/15.

[82]Forsythe, "Notes on conversation," 10 Jan. 1969, Forsythe Papers, SC98/2/38c.

ships. This emphasis was communicated strongly by the university, such as when President Kenneth Pitzer, a noted chemist, began outreach to Fairchild Semiconductor: "our Computer Forum is intended to encourage a working relationship between peers in the laboratories of the industrial participants and of Stanford participants; it is not intended to be a corporate-level relationship."[83] Stanford's promotional brochure further explained the best kind of representative from corporate affiliates: "These people should have a broad view of the company's interests, but should be close enough to the technical work to benefit and contribute to the technical meetings and informal discussions."[84] By limiting the scope of the type of person who should come to the forum, Stanford created a venue that focused on fundamental research issues, which was more valuable to the department than an executive meet-and-greet.

The first meeting of the Forum was held in May 1969, and it was attended by representatives from seven companies who together paid $16,000 in dues for a one-year membership.[85] Forsythe noted that the amount of money was "already playing an indispensable role" in the department's budget, and the desire was to increase the amount to $24,000 by 1971.[86] Expenses for the meeting were remarkably small: the fourth annual meeting cost less than $1,000 to execute.[87] The success of the first meeting encouraged

[83]Pitzer to Kay Magleby, 25 Nov. 1969, Lyman Papers, SC215/1/"CS: 68-71."

[84]Brochure: "The Stanford Computer Forum," Undated, Feigenbaum Files, SC340/13/26.

[85]The companies were Bank of America, General Electric, General Motors, Hewlett-Packard, IBM, RCA and Xerox. There was a single flat fee for each organization. Forsythe to Computer Science Advisory Committee, "Report on Computer Science Department," 19 Jan. 1970, Forsythe Papers, SC98/1/18.

[86]Ibid.

[87]Sally Burns to Computer Forum Committee, "Expenses Incurred for the Fourth Annual Meeting," 9 Mar. 1972, Feigenbaum Papers, SC340/13/15.

other faculty members to begin recruiting industry partners, such as Gene Golub, the numerical analyst.[88]

From this beginning, the program grew rapidly with the strong involvement of the Computer Science faculty. Dozens of potential companies were contacted, and lists were maintained of other potential companies (with particular attention paid to companies that were corporate sponsors of the ACM).[89] The department expected the forum to increase from the initial seven members to fifteen, and later, to twenty members in their promotional brochures.[90] However, the quickly increasing number of companies that joined the forum did not mean that some members did not leave. Bank of America would leave after the fourth annual meeting since they felt that the lack of a joint program between the department and the business school was not serving their needs.[91] Nonetheless, the program proved quite capable of attracting new members (perhaps assisted by the department's policy of offering a "finding fee" to faculty who brought new members to the forum).[92] By the end of the decade, there were 23 members, and the department agreed to increase annual membership fees to $9,000— a total of about $207,000 of revenue from the program every academic year. In addition, the initial

[88]Forsythe to Senior Faculty File, "Notes on meeting of 2 Feb. 1970," 3 Feb. 1970, Miller Papers, SC208/2/13.

[89]Examples: Forsythe to Senior Faculty File, "Notes on meeting of 2 Feb. 1970," 3 Feb. 1970, Miller Papers, SC208/2/13; Sally Burns to Computer Forum Committee, "Minutes of Meeting of 21 Oct. 1970," 22 Oct. 1970, Miller Papers, SC208/2/12.

[90]Brochure: "The Stanford Computer Forum," Feigenbaum Files, SC340/13/26; Brochure: "The Stanford Computer Forum," Miller Papers, SC208/2/12.

[91]Sally Burns to Computer Forum Committee, "Minutes of meeting of Feb. 18, 1972," 13 Mar. 1972, Feigenbaum Papers, SC340/13/15.

[92]Floyd to Computer Forum File, 28 Oct. 1975, Feigenbaum Papers, SC340/13/17.

membership was extended to a minimum of five years —providing a rare source of stable income to the department.[93]

The success of the program cannot be judged just in terms of revenue, but must include the creation of new connections between the department and industry. At the heart of the program's goals was to generate a conversation between industry and academia and provide a structured informal conversation for exchanging ideas. The department argued that the program would provide "relaxed contacts with faculty and graduate students" and "the opportunity to hold informal discussions with faculty members and to influence trends in computer education" for industrial members, and reciprocally, Stanford would receive insight into pressing business problems.[94] This goal was translated into action: for example, the forum meeting in February 1971 included five panel discussions chaired by faculty, but also space for individual appointments and a beer party.[95] Faculty were heavily encouraged to attend both technical and social events.[96]

These individual contacts with faculty and graduate students proved useful to companies. Faculty were encouraged to visit companies at their engineering laboratories, a part of the benefit of membership in the forum.[97] One example comes from the fourth annual meeting in February 1972, where Robert Floyd was asked to begin a consult-

[93]Betty Scott to Computer Forum Committee, "Meeting of Oct. 31, 1974," 11 Nov. 1974, Feigenbaum Papers, SC340/13/16.

[94]Brochure: "The Stanford Computer Forum," Feigenbaum Files, SC340/13/26.

[95]Forsythe to Meetings file, "Meeting of 11 Jan. 1971," 13 Jan. 1971, Miller Papers, SC208/2/11.

[96]John F. Wakerley to Computer Science Faculty, "Stanford Computer Forum Meeting," 24 Jan. 1975, Feigenbaum Papers, SC340/13/26.

[97]Ed McCluskey to CS/DSL Faculties, "Reimbursements for faculty visits to Forum companies," 13 Jan. 1978, Feigenbaum Papers, SC340/13/15.

ing relationship with Xerox after the company's representative had a fruitful talk with him at the Forum.[98] Companies also benefited from interacting with graduate students. February was an ideal time for the meeting, as graduate students were ready to begin finding employment in industry. Given the serious lack of candidates for positions, early access to graduates was likely a significant factor in the development of the Computer Forum.[99]

The Computer Forum brought industry into close and regular contact with the faculty of Stanford. The program provided significant and stable revenue to the department, allowing it to expand its teaching mission, while also providing important benefits to industry in the form of intellectual connections. The networks that developed between the two were strong, and helped to cement Stanford's reputation in the computing world.

Conclusion and Policy Implications

Necessity was critical for creating an environment conducive to attracting industry. The faculty's hesitation with the Honors Co-Op program in the mid-1960s is just one example of this phenomenon. If these debates are any indication, a better funded department would most likely have focused more heavily on the development of doctoral candidates. However, the department had little choice, and it is to its credit that the faculty not only adapted to this reality but also built programs that were well in-line with

[98] Peter J. Warter to E. J. McCluskey. 15 Feb. 1972. Feigenbaum Papers, SC340/13/15

[99] Forsythe to W.F. Miller, 29 Oct. 1969, Miller Papers, SC208/2/13.

its goals. It is this strong entrepreneurial culture and the desire to pursue all possible avenues to success that ultimately created a strong Computer Science department.

This analysis points to several important policy implications. One of the counterintuitive findings is that a scarcity of resources led the Computer Science department to seize alternative opportunities, and particularly to develop relations with industry. This theme has implications for federal government and philanthropic research grants, particularly those aimed at developing new programs. Simply increasing funds will not necessarily create a better academic culture.

Second, the department's focus on theoretical developments was a strength in its pitch to potential industry partners. Computer Science is perhaps a unique field in its ability to mix the practical and theoretical. Nonetheless, the focus of the department did not harm its outreach, as the Computer Forum grew substantially in little time. Efforts to encourage applied research with the goal of developing industry ties look weaker within this narrative.

Further research must be made at the university level to understand the politics of knowledge that existed at different institutions. This study provides an archival-based history of the developments at Stanford, but this information must be put into a comparative framework to analyze the varying experiences of universities including MIT, Harvard, Stanford, Carnegie Mellon and the University of Michigan. Along this line, additional analysis is required of how these departments evolved, and why universities specialized in particular areas. Such research can make an important contribution to the developing theory of the Triple Helix framework as well as assist policymakers in developing an understanding of why different departments enthusiastically or hesitantly engage with industry partners.