Appendix A
SRI's Visibility Problem

For several reasons SRI has had a bit of a visibility problem over the years. First, and most importantly, contract research by its very nature lets those you are working for determine whether results are disseminated publicly and, if so, the extent of that dissemination. Sponsors may give full and open credit to SRI for the work done, including the opportunity to publish, they may simply keep the results secret, or they may attribute whatever advancement to themselves…all of which may be legitimate. Second, perhaps with the exception of professional journals, the Institute often chooses not to publicize even where it was free to do so. Clearly, an increased attention to the commercialization of its intellectual properties feeds the tendency to not publish at all. Finally, there is the lack of distinction between SRI and its parent University that sometime gets blurred. As a result, few—even within SRI—were or are fully aware of the scope of its achievements. Some examples of SRI's visibility problem follow.

Automated Banking

The December 1999 issue of the *Proceedings of the IEEE*, the main publication of the world's largest professional electronics group, takes a retrospective look at a "classic" 1972 paper, the "Social Role of Computer Communications" by IEEE Fellow, R. M. Fano:[A]

> A major force that has led to the use of computers in the operation of society is the growing volume of transactions of various types that must be handled. For instance, the Bank of America was led, in the middle of the 1950's, to pioneer in the use of computers by the realization that manual handling of checks would have required, in the foreseeable future, the entire adult population… (p. 2130)

On the televised ACM Computer Bowl in 1994, the Toss Up Question 7 was:

> We are all familiar with the term ATM standing for Automatic Teller Machine. But way back in the 1950s, the Bank of America installed one of the first computerized banking systems, built by GE. It was called ERMA. What did the letters ERMA stand for?

The answer, which was correct, was: Electronic Recording Machine, Accounting.

Both instances illustrate SRI's long-standing visibility problem. For it was SRI that formulated all the design concepts for ERMA, gave it its name, and first built and demonstrated the system. For the banking industry, the results of SRI's work were momentous: not only did ERMA become one of the world's first large dedicated computers, but it changed forever, procedurally as well as mechanically, fundamental banking processes. SRI's role in the work was not revealed, primarily because the computer-based process was so groundbreaking that the Bank of America wanted it to be kept private. SRI's dedicated work over 4 years to demonstrate the concept before handing over its manufacture to GE was acknowledged only fleetingly. Were it not for a Harvard business case study and a resulting article in the *IEEE Annals of Computing* in 1993, SRI's role might have been ignored forever.[B] Even this limited exposure didn't alter the above lack of awareness.

Personal Computing

Of the hundreds of accounts of the beginning of personal computing, most place its origins at Xerox's Palo Alto Research Center, at Apple Computer, or at one of several small companies that were the first to try to develop hardware profitably. However, SRI defined and demonstrated many of the original concepts defining and enabling personal computing in the mid- to late 1960s, before either Apple or the Xerox Center existed. Only within recent years have its foremost visionaries, Doug Engelbart and a few members in his SRI laboratory, begun to receive recognition. Even then the confusion with Stanford University often arises just as it normally does with the

first computer network transmission in 1969 between UCLA and SRI, which is often attributed to the university.

Drug Discovery

The Web page of the Walter Reed Army Institute of Research (WRAIR) makes the following statement about the malarial drug halofantrine:

> "discovered by WRAIR, halofantrine underwent preclinical and clinical development in our department…. Halofantrine was approved in 1996, and since then, the drug has been used by millions of people for the treatment of falciparum malaria."[C]

While it may be within a sponsor's prerogative to make such claims, halofantrine was discovered and developed in SRI's Life Sciences Division between 1965 and 1975 in work for WRAIR funded through the U.S. Army Medical Research and Development Command.[D] The Army needed a new drug for use in Southeast Asia because of developing resistance by the falciparum form of malaria to the existing drug, chloroquine. SRI also invented a modified form of halofantrine, called desbutylhalofantrine, which was SRI's original first choice for WRAIR. That drug has fewer side effects, but is still in clinical trials. The Army claims to have discovered that drug as well.

Economic Development

India's National Council of Applied Economic Research (NCAER) is that country's most authoritative source of economic and social information. Working in partnership with both the Indian government and its private sector, and in cooperation with national and international institutions, it has been compiling the information needed to understand India's economy for 35 years. An account of its genesis on its Web page mentions that this nongovernment research center was "founded in 1956 by the Ministries of Industry and Finance, Government of India in cooperation with the Ford Foundation." Had the whole story been told it would have indicated that NCAER was the idea of SRI's Dr. Eugene Staley who went to India under Ford Foundation sponsorship to help revitalize the Indian economy. Finding that the country had no information to use in assessing its economic condition or to gauge progress, he proposed the SRI-like research center, calling it NCAER. Similarly, SRI designed the National Institute of Small Industry Extension Training to train small business owners to help build India's middle class. Both institutions are vital and influential today, but SRI's essential role in development has disappeared from the official history.

The Ubiquitous Digital Fax Machine

While electronic mail was struggling to emerge into the mainstream information flows of the 1980s, many were surprised by the rapid growth in sales of the facsimile machine. Its digital version was fast, cheap, and increasingly omnipresent. One company that helped lead that surge was the Japanese office equipment and imaging company Ricoh. With some justification, it assigns the first digital fax transmission to its RIFAX 600S machine in 1973, and claims to have invented the unit.[E] But, once again, the first machine was built at SRI under a 1970 contract with Savin and CBS; Ricoh subsequently acquired the rights to the machine. SRI had worked with other providers of optical scanners, compression algorithms, and modems to design and build that first digital facsimile machine.

Endnotes

[A] The retrospective view appeared in the *Proceedings of the IEEE*, 87(12), 2130-2135, December 1999, and the original paper was in the same journal, 60(11), 1249-1243, November 1972. Neither mentions SRI.

[B] A. Fisher and J.L. McKenney, "The Development of the ERMA Banking System: Lessons from History," *IEEE Annals of Computing*, 15(1), 1993.

[C] Retrieved February 16, 2000, from http://wrair-www.army.mil/depts/pharmacology/Drugs.htm

[D] W. T. Colwell et al., *Journal of Medical Chem*istry, Vol. 15, 1972, p. 77.

[E] From an interview of Jim Ivy, President of Ricoh (USA) Products Group, by the *Digital Times,* September 5, 2000. "Ricoh…created the first digital fax machine, which was a Ricoh invention."

Appendix B
A Brief History of SRI

Though much of this history is based on material referenced in the ongoing endnotes and footnotes, some, beginning with SRI's separation from Stanford University, comes from the author's own research and impressions. It does not represent an official position by either SRI or the University.

Stanford Creates a Research Institute

Stanford Research Institute, or SRI, was founded as a subsidiary of Stanford University to pursue goals the University had in common with industry in the western United States. SRI's Articles of Incorporation, or its Charter, which were drafted in autumn 1946, indicated that the Institute's mission fell within the broad purposes of the University. Two of the provisions in the University's Founding Grant were relevant to the new Institute:

> *to assist, by experimentation and research, in the advancement of useful knowledge and in the dissemination and practical application of same*
>
> and
>
> *the public at large, not alone the comparatively few students who can attend the University, are the chief and ultimate beneficiaries of Stanford University.*

Thus, in the abstract, the Institute was to operate very much in accord with Stanford's original aims. The University's direct influence was stipulated in SRI's Charter; namely, that the University Trustees would be the general members of the SRI corporation and elect the Institute's directors; that SRI would promote the educational aims of Stanford; and that, should the Institute ever be dissolved, SRI's net assets would be transferred to the University.

The beginning of SRI was the consequence of the creative dynamics of perhaps a dozen people. However, arriving at an alignment of purpose was anything but simple. At least three, and perhaps four, independent groups or players played a part in SRI's genesis. These separate entities first looked not to Stanford's Charter but at the need for a research enterprise in the Far Western United States, one that would operate under the aegis of a university. Most of this unfolding is well documented in the first of two volumes on the early days of SRI by Weldon B. Gibson, who was known locally as well as internationally as Hoot.[A]

The earliest of these groups consisted of two Stanford chemistry professors with administrative roles, Robert Swain and Philip Leighton, and a prominent alumnus, Dudley Swim. Swain, who would serve briefly as acting president of Stanford during the tenure of Ray Lyman Wilbur, began discussions about a University research institute as early as the 1920s. The three issued a concrete proposition in late 1942, but it was not until after World War II that interest in the idea intensified. In the late summer of 1945, after informal discussions with Stanford President Donald B. Tresidder, they formally submitted to him their concept for an institute at Stanford.[1] Tresidder reacted with interest, and within 2 weeks he had dispatched Leighton and Swim on a tour of Eastern U.S. research institutes. Around that time two separate groups of industrialists were working on a similar idea.

One of those initiatives was by a group of three Southern California industrialists, who in July-August 1945 conceived of a Western applied research organization they called the "Pacific Research Foundation." The group consisted of Maurice Nelles, Morlan A. Visel, and Ernest L. Black, all executives of Lockheed in Burbank, California. Having heard of a similar interest in the Bay Area, Black presented

[1] Interestingly, Swim and the others thought the Institute ought to have two major thrusts: "consulting and research and patent development for its own account." The former, at least in the form of management consulting, was discouraged by the University in the early days of SRI, and royalty or patent-based income, with a very few exceptions, did not become a principal focus for SRI until the early 1990s. In a chronology of Stanford/SRI history compiled in January 1995 by lawyer Kirke Hasson (Pillsbury, Madison, and Sutro), the Swain committee also recommended that half of SRI's "annual earnings" go to Stanford.

their proposition to the third—and the most effective group—which was led by San Francisco industrialist Atholl McBean. In spite of two, perhaps more, developed concepts for a research institute, it was McBean who gained the ear of Stanford's Vice President for Development, Alvin Eurich and, in turn, that of Tresidder. Before the end of 1945, McBean, with encouragement and financial support from other Northern California executives, won the support of Tresidder and Eurich that eventually brought SRI into existence.

Another person whose ideas had an important impact on the type of organization SRI became was Henry T. Heald, president of the Illinois Institute of Technology and later president of the Ford Foundation. The San Francisco industrial group had asked Heald to visit a variety of university and industry research facilities on the West Coast and to make recommendations about a possible new research institute in the West. Following an 8-day tour of the region, he met with the group in San Francisco on January 24, 1946, and they concluded that an industrial research institute on the West Coast was needed.

In a short, 900-word report, Heald fairly well described what SRI would come to be: He indicated the need for an institute that would engage in high-quality industrial research for individual companies, associations of companies, and government agencies at all levels. He stated that the institute must have a first-class staff and adequate space and facilities. The final recommendations were clear and to the point:

> "it is strongly recommended that a research foundation…. be developed on the Pacific Coast…located at and operated in close affiliation with Stanford University."
>
> "…industrialists interested in the establishment of a research organization [should] ask Stanford University to organize it, provide the University moral support…and…an initial gift of $500,000."
>
> "…the Foundation [should] be organized as a separate corporation with trustees including several members of the Stanford Board…. The President of Stanford, or some other chief administrative officer, should be president of the Foundation."

Heald also advised the business leaders to move quickly to begin the organization, leaving its future nature to be determined by subsequent events.[B]

Within a month of Heald's report the Stanford trustees agreed in principle to create Stanford Research Institute. Tresidder then asked the University's counsel Morris M. Doyle to draft a charter and the search began for an Institute Director. The degree to which the efforts of the other, earlier parties influenced the ultimate definition of SRI is hard to gauge, but the propositions clearly converged in the Office of the President where the final structure of SRI was defined. The faculty committee's recommendations that the Institute be nonprofit, that a contractual arrangement allow the University to control the Institute, and that it have a range of activities from basic to applied industrial research that would help strengthen University-industry relationships were enacted. Thus, out of this somewhat chaotic genesis, SRI emerged as a separate organization, a nonprofit subsidiary of Stanford University.

Stanford's Dean of Engineering, Fred Terman, was also sympathetic to an applied research organization tied closely to science and technology. His notion, however, centered more on providing a place where faculty and students could pursue their own interests as opposed to those of Western industry. Terman was seeking to bring more science into the engineering part of Stanford and hoped that a new institute could support that goal. Though Tresidder did not implement Terman's desire for such close University ties, Terman did help attract some of the early Institute's talent and urged them to enter the emerging field of electronics.[2]

Papers for the incorporation of SRI were filed with the State of California in November 1946 and the University trustees accepted the charter the following month. Stanford thus formed SRI and the president of the University became the chairman of SRI's Board of

[2] Stewart Gillmor, Terman's biographer, indicates that Terman was also interested in a research institute that would work closely as an applied technology arm of his part of the University. According to a conversation with Gillmor in June 2000, Terman urged Jesse Hobson and Ralph Krause, both early and pivotal SRI leaders, to come to SRI. Terman also permitted some sharing of Engineering faculty ideas with SRI and also made some joint faculty/SRI appointments. Gillmor's book, *Fred Terman at Stanford* was published by Stanford University Press in October 2004.

Directors, first Donald B. Tresidder, then Acting President Alvin C. Eurich, followed by J. E. Wallace Sterling. Eurich, who was also the University's director of development, became vice chairman of SRI's Board, indicating that, at least at that moment, the University viewed SRI as integrally tied to its own growth.[3]

The new SRI Board consisted of 32 prestigious Western executives.[4] In less than 2 years, SRI also formed a council of SRI Associates, additional business leaders with some interest in SRI, to help underwrite the Institute and build connections between it and the industrial community. A 1950 report to the Board indicated that of its industrial (commercial) work, 68% came from California, 13% from other western states, and the remainder from other parts of the country. Furthermore, some 75% was industrial and 25% governmental.[C] Thus, the early linkages forged were indeed with industry. But these, as it turned out, were never enough to sustain SRI's growth, and government work was needed from the outset.

In spite of the University's preference for industrial work, SRI's dependence on government sponsorship began essentially at once. A passage from the Institute's first annual report, covering October of 1946 to the end of 1947, reads:

> "The acceptance of research, with a minimum of planned and directed sales effort, has resulted in unbalance between governmental and industrial research; 69 per cent of the work during 1946 and 1947 was for governmental agencies and only 31 per cent for industrial sponsors. This unbalance arose because of the relative ease with which governmental research could be obtained.
>
> No more governmental research will, in general, be accepted unless the contracts provide for enough overhead to cover expenses, and then only when surplus space can be used and when industrial research is expected to stem from the governmental research. A governmental project may occasionally enable us to add to our staff people who are needed for other reasons, or may help pay for research that is planned for other purposes."[D]

Thus, the predilections were clear, but industry contracts, Western or otherwise, proved unable to meet the financial demands of the growing Institute. The same report noted that four of the most important Western industries—nonferrous metals, paper, food, and forest products—spent, respectively, 62¢, 39¢, 19¢, and 7¢ of every $100 of value-added from manufacturing on research. These staid industries obviously wouldn't offer much potential support, no matter how competent SRI became in those areas. Given that many companies also had their own small research groups and that information technology was yet to emerge, it is not surprising that the Institute had to seek government funding. SRI's growth needs came from attracting good people, and doing that meant acquiring up-to-date capital facilities and the buildings to house them. New, essentially free quarters were found in Menlo Park and were adequate, but good capital equipment would require appreciable discretionary income.

During these early years the University continued to formulate and enforce policies that influenced the kind of work that SRI conducted and, at least indirectly, the kind of people it hired. In early 1947, SRI's first director, William Talbot, hired Maurice Garbell as the Director of Aerophysics Research. Part of Talbot's instructions were that "no research activities should be undertaken between the Institute and any agency which will conflict with the interests and well being of the various university departments and that every effort will be made to cooperate with these departments." Talbot wanted closer and collaborative ties with University faculty and access to graduate students, but the University

[3] From SRI's second director, Jesse E. Hobson, comes this reflection: "You may remember that Dr. Tresidder (Stanford President) died suddenly in early 1948 after I agreed to go to Stanford but before I arrived. As I think now about the next two or three years it becomes more and more apparent that one man really made possible the development of Stanford Research Institute and that was Dr. Alvin C. Eurich, Acting President of Stanford University. He gave me and the Institute outstanding support and confidence in the face of rather strong skepticism, doubt and—in some cases—out right antagonism. We would never have survived through the fall of 1948 without his very strong support with the Board of Trustees of Stanford Research Institute. There were two months that Fall when I did not know until the last day of the month whether or not we could meet our payroll and I knew there were those who wanted to close the Institute, take the loss of four or five hundred thousand dollars and forget the whole affair." (Charles J. Maisel and Treva W. Jones, *A History of Stanford Research Institut*e, SRI internal publication, October 1962.)

[4] Appendix C lists the 1949 SRI Board.

proved unwilling.[5] In fact, within 6 months he and Garbell had violated Talbot's own stipulation by submitting a proposal to the Office of Naval Research (ONR).[E] Furthermore, in December of that same year SRI's Carsten Steffens told Tresidder that Talbot had said SRI would become a completely separate organization.[F] This and other such developments probably did not sit well with Stanford's president, for by early 1948 Talbot was gone, replaced by Jesse Hobson of the Armour Research Foundation in Chicago.[6]

Terman would assist in bringing Hobson, a fellow electrical engineer from Purdue, to SRI. Within a month, Hobson was followed by another Terman colleague who would also become very important to SRI: Tom Poulter, after whom SRI's Poulter Laboratory is named. Terman's links with the wartime Radio Research Laboratory (RRL), which he had led at Harvard, and with ONR would also bring strong talent to SRI. First, Ralph Krause and Tom Morrin, both from ONR, came as Director of Research and Director of Engineering, respectively. Shortly thereafter, a dozen or so former RRL engineers also came west to help create SRI's Engineering Division.[7] Like Terman, Hobson himself initially advocated a close interaction with the departments of the University. While some of that early interaction occurred in both the sciences and engineering, it neither amounted to much nor did it grow to a point of advocacy on either side.

Given this situation, operational autonomy from the University was inevitable. The University's oversight began to diminish as it and the Board gained confidence in Hobson. As the Institute gradually achieved profitability, it embarked on a growth path that soon gave the University pause in considering what it had created. Stanford conducted an organizational and financial audit in 1950 to gain a snapshot of SRI, including its reputation and its needs. That audit, initiated by the SRI Board, revealed that the Institute was indeed growing rapidly. It had achieved research revenue of nearly $2 million in 3 years, whereas comparable research organizations had taken from 2 to 10 times that long to do so. The audit also praised the quality of the SRI staff and its national prominence in three of its five major areas of work. The report also revealed the early existence of what would become a chronic problem at SRI, the quest for adequate capital equipment. The outlay in 1950 was about one-third the $5,000 per researcher that was then considered a minimum.[G]

Staffed with competent and creative research talent, SRI soon grew to be a vibrant and self-realizing organization. The Western industry-laden SRI Board came mainly to appoint the SRI president. With but few exceptions their benign but distant interests brought little work to the Institute. SRI's research practices became, and remained, the responsibility of its senior staff and first-and second-level managers.

In retrospect, these were heady days. SRI's uniqueness, at least in a Western setting, brought many important people to its doors and to the convocations it would hold. People like David Sarnoff [8] and Vannevar Bush would stop by or lend association. These episodes are well chronicled in Gibson's two books.[H]

SRI developed a culture defined by competent work and an uncommon freedom to pursue a broad diversity of problems important to both industry and government. For 20 years it grew in staff and revenues, but over much of its life it has had trouble creating enough discretionary money. SRI was, of course, an institute and not a company. Semantically, an institute normally exists in support of a cause

[5] Ernest Barbour O'Byrne's Ph.D. thesis, *The Research Institutes of Stanford University* (June 1951), quoted an interview with Talbot revealing that the reason was essentially a salary imbalance. Salaries were higher at SRI, which caused consternation among faculty members and their students. Many years later, I also became aware of Stanford faculty members' concerns about losing their good graduate students to SRI before they finished their Ph.D.s. Over the years students have been able to continue their thesis work once becoming SRI employees, as I did, but that was not a common practice.

[6] In the early days, SRI tried to steer a path between universities, with their basic research bent, and consulting or the very focused laboratories of commercial companies. In the *San Francisco Chronicle* of December 15, 1952, SRI director Dr. Jesse Hobson reiterated that position. He went on to say that a recent increase in projects stemming from the Korean War was "more government work than we'd like to do."

[7] Gillmor, op. cit., and the RRL *Phone Directory* of 1945. Interestingly, on SRI's first project for ONR, exploration of the natural rubber-producing potential of the guayule plant, ONR's contracting officer was Charles Hilly, who for years would head SRI's contracts group, and Wilson Harwood, who held budget approval authority at the Naval Research Laboratory, and who later joined SRI's Business Group, and opened SRI's work in Saudi Arabia (see Chapter 14).

[8] David Sarnoff, whose fabled RCA research laboratory would become part of SRI in 1987, in the feature address at an SRI Associates Program on November 14, 1951, extolled SRI as "an outstanding example of the natural partnership between research and industry."

whereas companies exist to earn a profit. In any case, SRI was, by both design and practice, a nonprofit organization.

Initially, SRI was housed on the Stanford campus. But within 8 months of its founding SRI moved into a part of the surplus Dibble Army Hospital in nearby Menlo Park. That facility had been built to handle some of the increased patient load on the Letterman military hospital in San Francisco that was anticipated as a result of the expected invasion of Japan. Opened in 1943, the hospital was used for a few years mainly as a place for dentistry, for difficult reconstructive surgeries, and for rehabilitating soldiers who had eye damage or had been blinded. More than 16,000 patients were treated there. But, with the war over, it was closed in early 1946 and declared surplus.[1] Today, more than a half-century later, many of its original, "temporary" buildings are still in use at SRI and by the City of Menlo Park. Once off campus and out of sight, so to speak, the Institute got its legs and grew, and the University exercised less and less influence over its offspring.

Thus, time and circumstances changed the relationship between SRI and Stanford. The distancing had grown so great that by the late 1950s the two had few joint facilities, projects, or clients. A relatively few staff members had joint appointments at the two institutions, but the University trustees were still SRI's ultimate governing body.

In the mid-1960s with the coming of the Viet Nam War, student unrest grew across the nation. That unrest was manifested at Stanford by demonstrations against the classified work that went on in some of the University's engineering laboratories and at SRI. Student demonstrations were held at SRI's Hanover Street location in Palo Alto adjacent to the University and at SRI's main offices in Menlo Park. Because the demonstrations precipitated a fundamental change in SRI's status, a bit more detail is warranted.

The Separation from Stanford

It is safe to say that the tenor of student unrest surrounding the Vietnam War derived from dissatisfaction with the policies and actions of both the U.S. government and the country's largest corporations. Some student factions at Stanford harbored the same opinions and targeted Department of Defense (DoD) work on campus, the industrial alignments of the University's trustees, and SRI for demonstrations. Student concerns began to be voiced as early as 1965 when it became known on campus that SRI had two government contracts concerning chemical warfare. Those concerns intensified in 1967 when they learned that SRI had also taken on contracts relevant to the war in Southeast Asia. In April of that year some students began picketing in front of SRI's Menlo Park campus, as well as at some of Stanford's engineering laboratories. Their protests soon crystallized into demands to end all war-related or classified work, specifically that involving the war in Southeast Asia. SRI's economic development work for developing countries also came under fire as being conducted only to further the self-interests of large corporate sponsors. Almost all of that work was, in fact, sponsored by foundations and international assistance groups.

The students' lack of specific knowledge about the balance of work under way in the engineering laboratories of both institutions and SRI's economic development work did little to temper their outlook. Any association with the DoD or big business seemed enough to levy harsh, sometimes accurate, but usually unfounded demands concerning both the work being conducted and the relationships that led to it. SRI's chemical warfare work, for instance, had been almost exclusively defensive in nature—seeking ways to cope with such a threat. SRI was also investigating counterinsurgency techniques needed for the Vietnam War. As a practical matter, the details or legitimacy of the work made no difference, and the campus and local press followed the students' activities in copious detail. By the end of 1968, the protesting students, along with not a few faculty members, sought SRI's separation from the University.

By early 1969, the demands of the students had become legitimized in University-sanctioned meetings, and Acting President Robert Glaser formed an ad hoc committee to review the association with SRI and to make recommendations. After 6 months of study, including substantial information that SRI provided the committee, the majority of the committee recommended terminating the association with SRI, asking for SRI to compensate the University for its loss of the

Institute. [9] During the committee's deliberations, however, the students, realizing that a separate SRI could proceed freely, had reversed their earlier position. A new facet of the protest, called the April 3rd Movement, was born. That orientation was also reflected in the committee's minority report, which was written by two faculty members who were sympathetic to the students' demands. Their position asked for closer University ties with SRI; a stipulation against military-related work, including counter-insurgency and other contracts related to the war in Southeast Asia; and the requirement for an SRI oversight committee.

Meanwhile, at SRI discussions were being held about the relationship with the University, research freedom, and self-determination.[10] Surveys reflected that the vast majority of the SRI staff had no stomach for others defining what constituted "moral" work and wanted independence. SRI President Charles Anderson and several of the SRI leaders expressed their clear indignation at the notion of a moral oversight by the University community in any form.[11] From the outset, SRI leadership had taken the position that work for a duly constituted U.S. government was, by definition, in the public interest and a legitimate and worthy endeavor. Many SRI leaders, particularly those on the management consulting side, agreed with the original student demand for separation, if not with their reasoning. Another crucial factor was that government contracting agents so disliked the growing uncertainty that they held up contracts SRI had already won. Given these conditions at SRI, the urgency the trustees felt about resolving the crisis soon, and the ad hoc committee's recommendations, separation became unavoidable. In effect, the thinness of the institutional relationship between Stanford and its research institute could not survive the clamor of the time as amplified on campus, the streets, and in the press. The trustees issued a statement on May 13, 1969, laying the groundwork for SRI's separation from the University.[12] Importantly, they put no restrictions on the kind of research SRI could undertake. But other terms of the agreement that would seriously affect SRI were still to come.

As with many divorces, freedom had its price for SRI. Most onerous was an agreement to pay the University from 0.5% to 1% of its *gross revenues in perpetuity*.[13] As a nonprofit

[9] Apparently, President Glaser conveyed to Hoot Gibson at the time that the relationship between the University and SRI had to change (Weldon Gibson, personal communication, June 1, 2000).

[10] As early as November 1968, Stanford Trustee and SRI Board Chairman Arbuckle appointed a subcommittee to study the SRI-Stanford relationship. Among the eight board members on that committee were Trustees Morris Doyle and Ed Littlefield. On the University side Arbuckle was also chairman of the trustees, and a bit later he set up a trustee subcommittee on the SRI question that consisted of Littlefield, Fred Merrill, Thomas Pike, and its chairman, Morris Doyle! Whether the deliberations of this overlapping assemblage retained much independence is doubtful but at least they should have been efficient. As it turned out, essentially all of these men came to a position of wanting to protect SRI as separation occurred; that is, up until the question of a financial settlement arose.

[11] According to a Stanford University press release dated April 30, 1969, President Anderson, in a presentation to a Trustee committee on SU-SRI relations, eloquently defended a widely held SRI opinion. He attacked the "arrogant suggestion that a small group that does not represent a majority viewpoint should rule on the moral acceptability of research" and he was "indignant, then incredulous" that such a review committee could be taken seriously by University people.

[12] According to Anderson, the trustees' quick action was prompted by contacts from SRI's Board. In an address to SRI associates in December 1969, Anderson also recalled how this decision by the trustees provoked consternation among those students who were seeking to control SRI as part of the Stanford family, and they rioted. SRI suffered some damage, and more than 100 students were arrested.

[13] The formula stipulated that SRI's payment would go from approximately 1% of *gross* to 0.5% after $25 million had been paid to the University. According to Dr. Gibson (personal communication, June 1, 2000) SRI Board member Edgar Kaiser suggested this draconian obligation as an acceptable middle ground that might avoid two potential lawsuits surrounding the high valuation of $21–45 million that the Scott Committee had placed on divestiture. One suit might have come from the University or its faculty if the valuation was lower than the Committee suggested, and one might have come from SRI or its staff who might have found the expected fee so high that it jeopardized SRI's ability to exist. In August 1969, at least one member of the SRI Board, Paul Davies, thought that if Stanford was paid anything, it ought to be small. But in December 1969 a memo from the SRI Board to the trustees was drafted and approved. It suggested granting Stanford $25 million provided SRI's name and charter purposes remain unchanged. That memo was passed unanimously by the SRI Board with members Doyle, Fuller, Pike, and Guggenheim, all trustees, abstaining. In an expression of the closeness of these negotiating parties, the memo was then submitted by President Anderson to Morris Doyle as chairman of the trustee subcommittee on separation! Clearly, the University trustees, as general members of SRI, could effectively control the SRI Board. Thus, one could view this situation as a built-in conflict of interest or an opportunity for the quick resolution of a family dispute. The settlement, while onerous for SRI, took on the aura of the latter. (Curiously, contradicting the above Board Minutes and stated dates of tenure, Trustee Ed Littlefield asserts in a letter to Paul Cook on December 5, 1994 that the two boards had no common members at the time.) A memo from the SRI Board to SRI chemist Felix Smith in January 1970 concerning his complaint about conflicts of interest,

corporation with a large portion of revenues from U.S. government grants and contracts with strongly regulated fees, this seemingly small alimony became a substantial and continuous drain on SRI's discretionary resources. By 1989, SRI had given more than $25 million to the University in accordance with the separation agreement. In spite of provisions in the agreement for no payment when SRI's financial health was at stake, some of these annual payments amounted to more than SRI's net profit for the year.[J, 14] Other stipulations had to do with abandoning the use of the Stanford name after 1974 in the Institute's title and continuing to honor those purposes in the SRI charter relating to the University, including reversion of SRI assets to Stanford if SRI were dissolved. These financial terms meant that the modest loan from Stanford at SRI's creation has returned an enormous value to the University.[15] Thus, through this separation, Stanford Research Institute became independent on March 31, 1970.

One of the terms of the agreement was that SRI could continue to use the Stanford name for 7 years.[16] During that time, the transition had little effect in SRI's marketplace, but eventually SRI had to establish a new identity with many clients. Of all the stipulations, however, the "alimony" payment to Stanford was the most burdensome. Otherwise, SRI continued its tradition of independent research and development and was no longer subject to University stipulations about the practice of management consulting.

Thus SRI became and remains a nonprofit, independent contract research institute. It has no endowment and therefore exists through the initiative and creativity of its staff. Its contracts are with many levels of government and industry, worldwide. It has had offices at one time or another in about a dozen countries. It is a place of uncommon intellectual freedom and it relishes its objectivity and competence.

The 1970s at SRI

While the separation from Stanford raised some turmoil for a time, it had no measurable impact on the ensuing 1970s. Over that decade, SRI's rate of revenue growth averaged around 10%. Each year a new revenue record would be set, but, as indicated by a relatively stable staff size of around 3,000, much of those gains were inflation-driven. Just as important as this consistency, however, was the realignment of some of the sectors from which the revenue flowed. Under Anderson, two trends were evident: one was a steady increase in the fraction of revenue from the U.S. civil, or non-DoD, sector. The other was an increase in international business. Both were important diversification factors. In 1970, SRI opened its first overseas research division in London and called it SRI-Europe. Over the next 15 years or so SRI would continue to build on its worldwide

states that because trustees didn't participate in the drafting of the settlement proposals, there was no conflict!

One case could have been made for SRI not paying Stanford anything since its original investment had been repaid with interest. Because Stanford had created a *nonprofit* corporation, its value, in the opinion of some, lay in public trust, at least until dissolution. Although Paul Jorgensen, former SRI Senior Vice President, said he raised this issue as a SRI Board member, it was never pursued. Perhaps because SRI's charter stipulates that upon dissolution, the assets of SRI pass to the University (another nonprofit entity), Stanford's counsel at the time, Warren Christopher, believed that the removal of trustees as SRI general members was grounds for substantial payment to the University. Though one option at the time was to dissolve SRI, it had no favor among the trustees.

[14] A February 1979 memo from Stanford's William Massey to SRI's Harvey Dixon indicates that while Stanford was willing to grant SRI a loan, it would not change the agreement. So this requirement continued until 1990 when SRI President Miller negotiated some exceptions to the 1970 payment agreement when SRI's financial stability might be threatened. The agreement was revisited in 1997 with further stipulations. These negotiated changes invoked promissory notes in lieu of payments during some years and outright relief in others. As of this writing in 2004, SRI is again paying the approximately one-half percent obligation defined in the 1970 agreement.

[15] According to the *San Francisco Chronicle* December 15, 1952, the Stanford trustees had advanced SRI $625,000, with six San Francisco banks providing another $600,000. Both were being repaid at the time of the article. A letter between SRI Board members, from Paul Davies to Stephen Bechtel on August 25, 1969, indicated SRI had paid off the Stanford "loan." Moreover, in a presentation to University Trustees on April 30, 1969, SRI President Anderson stated that SRI had not only repaid the $625,000 loan, with interest, but had also *voluntarily* given the University an accumulation in excess of $800,000, some of which came from times when SRI was but marginally profitable.

[16] The original separation agreement stipulated that SRI would refrain from using "Stanford" in its name following the agreement's fifth anniversary, March 31, 1975. The stipulation was amended in January 1975 to add another 2 years. The SRI internal phone book of March 1977 for the first time contains only "SRI" with "SRI International" appearing there the following September. SRI changed its Articles of Incorporation to reflect the name change in April 1980.

reputation in the areas of business consulting and economic development.

Overall, SRI staff continued winning new contracts. In 1972, it submitted more than 2,000 proposals of all kinds. By 1974, SRI had over 2,000 clients in more than 40 countries and, over the course of 1977, saw some 2,200 projects under way. The decade's business vitality continued well into the 1980s. But as exciting as the endeavor was to its research participants, SRI's long-term financial picture continued to be uncertain due to uneven and difficult-to-predict profitability.

The 1980s and a New Emphasis

For most of its existence SRI has struggled to be adequately profitable, and as the 1980s opened this trend continued.[17] Inflation-adjusted revenues were flat, and government-limited fee structure constrained gross income. Within the business of contract research perhaps the largest influence on income is the fraction of the research staff that is billing time to project. Specifically, the financial swing between billing research labor to overhead and charging it to a client project is huge. Though other overhead costs must also be controlled, managing that one parameter is critical if not easy. Though the sheer number of research staff vying for projects at any one time would seem to even out the revenue stream, the vagaries of the varied markets they visit imposed an unpredictability to financial operations including income. This difficulty has haunted most top-level managers at SRI. Was there a way to help reduce the financial impact of that uncertainty?

Arriving in 1979, SRI's new president, William Miller, decided to look into another form of income, one that would be tied to SRI's ongoing creation of intellectual property. Over its history, SRI had done a small amount of licensing but it had mainly used its intellectual property to win new projects. Serious attention to commercialization meant not only altering that earlier tendency but also taking a more aggressive stance toward retaining those properties in the first place, rather than always assuming they belonged to the client.

Miller had been Stanford's provost but perhaps more significant for this discussion, he was a co-founder of the highly regarded Mayfield Fund, one of Silicon Valley's important venture capital firms.[K] In July 1980, about a year after his arrival at SRI, Miller convened a small task force under Don Fiske, vice president of the Management and Economics Group, to look into establishing a for-profit SRI subsidiary to engage in commercialization. Their work culminated in a recommendation to form the wholly owned SRI Development Company (DEVCO), which would serve to separate SRI's contract research from its new ventures into the commercialization of its intellectual properties. Miller's next action led to an important decade-long relationship in how SRI would handle its intellectual properties.

In April 1982, SRI entered into a three-way agreement with DEVCO and a new venture capital firm, CommTech International. CommTech was to be managed by a general partner, but SRI as a limited partner was to receive one-third of CommTech profits. CommTech was also to pay SRI a percentage of the license fees and royalties it received from directly licensed SRI technologies and 50% of the up-front licensing fees of any limited R&D partnerships. The intention, of course, was to realize value by facilitating the flow of SRI technology to the commercial marketplace. CommTech was to court institutional investors for partnership funding and use that money to form limited partnerships, start new companies, or fund SRI to develop a technology further. In return the arrangement was exclusive, with CommTech having first right of refusal for all SRI-owned technologies for 7 years.

To promote this new type of business internally, in 1981 Miller dusted off SRI's staff royalty-sharing policy and tuned it to give 25% of initial royalties to the inventor(s), with a decreasing scale according to the total royalties received. This was a generous arrangement, and I remember my pet reaction was that it would help retain some staff members by "scratching their entrepreneurial itch" (an itch that was becoming one of Silicon Valley's worst allergies). Though the practice had the potential to create internal schisms between those whose work naturally led to commercialization and those whose work didn't, it was necessary to the new income strategy. In late 1982, Miller also established a Technology Commercialization Office to work with CommTech in seeking SRI

[17] Note that research institutions are not necessarily created to make money. Like all organizations, however, they must have enough discretionary resources to adapt and secure their future position (see Appendix D for a plot of revenue).

innovations and realizing their commercial potential. SRI was then poised, it seemed, to gain income from its commercially relevant work. Though with this process Miller raised some commercialization awareness around SRI, he didn't see it as displacing SRI's core business of research. Importantly, he saw its contribution as being not more than about 5% of revenues.[L]

One example of the new awareness was a review of the artificial intelligence (AI) field. About this time AI was becoming highly touted, with forecasted annual markets of $5 to $10 billion. SRI was a premier player in AI research and so everything fit.[M] But in part because AI was a difficult to implement technology and still emerging, nothing came of the initiative. On the other hand and about that time, some SRI AI specialists left to seek their own fortunes with no participation by SRI.[18] SRI made no attempts at AI commercialization and though a lot of other companies did, the market for AI did not materialize.

As this change was taking place at SRI, forces were at work in the U.S. Congress that would support SRI's commercialization initiative. In 1984 it passed the Bayh-Dole Act. This legislation granted to nonprofits the rights to commercialize intellectual property they had developed under government grants or contracts. This act served to remove the ambiguity of ownership of the results of SRI's government projects with that potential. Now SRI could get paid to explore a technology of interest to the U.S. government and then capitalize on its commercialization as long as doing it involved domestic rather than foreign partnerships. This seemed tailor-made for SRI and its work for agencies like NIH, NSF, and the research arms of the DoD. This entitlement has been exploited many times since and is still an important component of SRI commercialization strategy.

GE's Gift of the RCA Laboratories and a Continuing Focus on Commercialization

In late 1985, Jack Welch, the chairman of GE, purchased RCA. As in all acquisitions, consolidation became an issue: both GE and RCA had large, reputable corporate research laboratories, and the technical overlap between them was considerable. The RCA laboratory in Princeton was some 200 miles from the GE laboratory in Schenectady; that distance was too far, in GE's opinion, to consolidate even non-overlapping parts. Wondering how to proceed, GE hired SRI to help assess the overlap and indicate possible directions to take. At Princeton, the leadership and staff took an active interest in the proceedings, and one of the alternatives discussed was becoming a stand-alone contract research entity. The director, James Tietjen, mentioned various options, including that of independence, to GE management. Roland Schmitt, then head of the GE Laboratory, didn't think that option would work, but explored it anyway with a National Science Foundation Board acquaintance, SRI president William Miller. It undoubtedly didn't take long for the business-savvy Miller to see the opportunity.

During the course of SRI's review, one option that had already arisen was for GE to give the laboratory to a nonprofit corporation and enjoy the resulting tax benefit. Of course, SRI itself was such a corporation, and Miller was anxious to open another SRI-associated facility on the East Coast. As it turned out, Welch became interested in the idea, as long as he could believe the laboratory could make a successful transition. Both Tietjen and Miller got to make their cases in person to Welch, although separately.[19] Welch believed the odds were good enough, and Miller happily agreed to receive the laboratory. Thus, in April 1987, the RCA laboratory became the David Sarnoff Research Center, a wholly owned subsidiary of SRI. As part of the transfer and to help make it possible for the new Center to make its transition to self-sufficiency, GE guaranteed $250 million in research funding over the new Center's first 5 years.[N]

[18] Peter Hart and Richard Duda left to form Syntelligence in 1980, Earl Sacerdoti became a vice president of Teknowledge in the same year, and Gary Hendrix helped form Symantec in 1983. To the extent that any of these companies ultimately succeeded, it was not with products dependent on AI technology.

[19] Welch, on the occasion of Sarnoff's tenth anniversary, spoke of Miller as the "true hero" of the transformation "turning a tranquil enclave of technology into a P&L center."

But, moving from a somewhat protected position in a large corporation to self-sufficiency in an open contract research marketplace took a toll. To control overhead costs, Sarnoff had to release about one-fourth of its staff. Because of an attractive early-retirement package that GE offered, this reduction was made in a very humane way. But to help Sarnoff get its legs, Tietjen and Miller agreed to let the Center maintain some distance from its new owner in Menlo Park, at least as far as revenue generation was concerned. The skills of the two organizations were dissimilar enough that competition at the outset did not seem to be a problem. With GE's pledged assistance, a pledge transferred to Thomson CSF of France when it bought GE's television business at the end of 1987, Sarnoff successfully made the transition to contract research. Its people had acquired the skills to market its research to both the U.S. government and to industry, worldwide.

Sarnoff's tradition of innovation thus continued. But in addition to contract research, it also sought to create new companies, to bring new technologies to the marketplace, and to benefit from equity creation—and did so with much greater emphasis than its parent, SRI. But that increase in emphasis would eventually arrive in Menlo Park. Through its selection of subsequent SRI presidents, SRI's Board made it clear that this direction, and equity generation in particular, was to frame the future Institute and help solve the ongoing problem of marginal profits.

At SRI proper the commercialization of its retained innovations continued to receive noticeable attention but with mixed results. The exclusive CommTech arrangement was not creating either the licensing or equity values that were hoped for. Yet in the later part of the 1980s the entrepreneurial atmosphere continued to grow in Silicon Valley, and it found its way inside SRI. To follow up on an example cited earlier, the sanctioned AI exploration had yielded no licensing or equity initiatives but there was still an interesting footnote. In about 1988 two members of the AI center left to form a software company. While producing none of the exciting AI advancements that had been explored, the new company nevertheless became successful and by the early 1990s returned, through gifting, several million dollars to SRI.[20] This exploration into AI says something about the difficulty in searching for and selecting commercial winners. The attractive options may lie in the shadows formed by the glare of those that are more technically advanced. But to stay the course, one of Miller's final actions before leaving SRI in 1989 was to extend the unpopular CommTech agreement for another three years!

The Decline of SRI's Business Group

Another thread in SRI's evolution that was facing important challenges about this time was economic and business development—performed in what we have called here the Business Group[21]—which had been a significant part of SRI from its very beginning. For perhaps three decades, from the mid-1950s to the mid-1980s, this part of SRI had grown to attain worldwide stature. SRI became known for assisting both developing countries and corporations around the world manage the changes and challenges they faced. But across the 1980s the Business Group began to suffer financially; that is, it was requiring subsidy from the rest of SRI. The reasons for this decline are unquestionably many and subject to individual interpretation, but I briefly examine a few here.

The work done in the Business Group was quite different, actually complementary to that in the rest of SRI. Over the years the Business Group hosted the overwhelming share of the Institute's work from the commercial sector. While the remainder of SRI had some commercial leavening in its dominantly government work, a portion of that came from labor loaned to Business Group projects. Thus, though the Institute as a whole appeared to be diversified across a set of uncorrelated research markets, internally the separate groups were considerably much less diverse. The diversity within the Business Group was exemplified by economic development work for governmental

[20] More detail on this company and aspects of the CommTech arrangement can be found in Appendix D.

[21] To be clear, this refers to the practice of economic and business development and consulting centered in Menlo Park and does not include a vital and continuing practice of these areas centered in Washington, D.C. That latter activity has always been part of what is referred to in this book as the Education and Policy Group.

jurisdictions and business development for corporations.

From SRI's beginnings to the early 1990s, the Business Group had a continuing stream of large noncommercial projects, mostly international economic development work for foreign governments, foundations, and international aid agencies. Given the longer duration of these projects, they provided a flywheel effect for contract revenues and income. The smaller, problem-solving projects that the Group was getting from the commercial sector tended to be expensive to win and to execute. In the early 1980s, the Group's leadership separated the economic development and business consulting organizationally. While not intended to decrease Business Group diversification, the reorganization did serve to illuminate each of the components more clearly.

But both sectors of the Business Group's work began to decline into the 1990s. Competition in business and management consulting was growing rapidly. In addition to direct competitors like Arthur D. Little, the large accounting firms were entering management consulting. With their insights into company problems, they had greater access to CEOs in areas such as long-term planning and strategic guidance. While SRI had earlier provided the foundation in areas like strategic planning and innovative business practices, these same CEOs were now prone to thinking of SRI as a technology-oriented problem solver. Even the leaders of Japan's Osaka Gas, with which SRI had had a long-term close relationship, did not turn to SRI when the company wanted to reorganize in the 1990s.[O] Being relegated to technoeconomic work was a continued frustration for many of the Business Group leaders who sought the more profitable long-term support relationships that the major accounting firms were securing. I remember Management Council meetings where Business Group leaders indicated that they were discouraged by client surveys that pigeon-holed the Group as only technology consultants.

There was another view on that topic, however. According to one set of Business Group executives, the decline in SRI's business-consulting sector dated from when principals inside the Group began a voluntary withdrawal from collaboration with the technical side of the house.[P] That reservoir of technical talent was believed by many to be a valuable differentiator in the marketplace of business consulting. In any case and for whatever reasons, the Group's financial health continued to suffer.

One of the ongoing successful parts of the Business Group stemmed from its early innovations in strategic planning *methods* and the services that ensued. SRI had made rich contributions to both the information needed for planning and to the planning methods and tools that could help corporations and other organizations confront their futures. By the 1990s this was called the Business Intelligence Program (BIP) and it continued using these tools in particular scenario planning and market segmentation techniques.

Another notable facet of the Business Group was the corporate gatherings it would organize. Worldwide conferences such as the quadrennial International Industrial Conference that continued for 40 years and new associations across the Pacific Basin were evidence of SRI's stature. But as purse strings tightened, these activities, somehow affordable in the Group's heyday, were now looked at with a more frugal eye. Because such convocations had not been profitable in and of themselves, SRI decided to discontinue them. As a result of these factors and more, the Business Group had become marginalized by the early 1990s, and rather than try to reinvigorate it, a different operating model would be imposed.

The Arrival of a New and Active Chairman

In 1993 Paul Cook was named the new chairman of the SRI Board. He would become its most active chairman since the Institute's earliest days. In January 1994, Cook brought in a new president, William Sommers, whose major experience was in management consulting at Booz Allen Hamilton. Because of that background he soon saw that SRI's business development or consulting side was operating under what he viewed as an inappropriate cost-plus-fixed-fee contract system. This system, driven by government auditing regulations applicable to the technical and educational parts of SRI, made profit sharing, a conventional management compensation approach in the consulting world, impossible. Though some thought had been given to demand-based pricing under

President Miller, most contracts remained fixed-fee.

Sommers was correct in viewing these SRI practices as seriously inconsistent with *his* particular perspective on management consulting. If the Business Group were to conform to *his* notions, something had to be done. Whether his was the operational model the Business Group should follow, whether the world of the large business consulting firms was the right marketplace for SRI, and whether the existing staff, who were vital to the transition, believed in that approach, did not appear to carry much weight. What was clear, however, was that his compensation system could not happen inside of SRI proper.

Thus, adopting the compensation and market template of more conventional management-consulting firms, Sommers moved in 1995 to convert the business side of the Institute into a for-profit subsidiary. SRI's business-oriented Board approved. The new entity was called SRI Consulting (SRIC) and its managers were to be given a more lucrative, incentive-based compensation with additional guarantees and perquisites totally alien to SRI. SRIC was formed around so-called "rain-makers," who were to create the high-valued relationships with those corporate clients that could afford to pay the higher prices that such compensation systems required. This orientation ran counter to SRI's traditional culture, which from the beginning had been more academic and much more egalitarian. While escaping from that past was a specific objective, the majority of existing staff, who were not so oriented, found themselves in an uncomfortable world. Regrettably, while the new company was free of SRI, SRI was not free of it, and the SRIC conversion would turn out to be very costly to SRI.

To implement the changeover, Sommers brought in leadership unfamiliar with the abilities and market orientation of the former SRI staff. Within about 4 years SRIC had eaten up its inherited backlog, failed to win any new long-term clients, and required financial bailouts that were huge for SRI.[22] Nor did any of the "rain-makers" pan out. In spite of hiring about 30 allegedly worthy of that moniker, they proved unable to land substantive new projects. In the meantime, many of those more traditional project developers that had transferred were leaving.

In the end, with but two exceptions, the Menlo Park part of the Institute was out of the economic development and business consulting fields. These were the venerable multi-client programs known as the Business Intelligence Program, begun at SRI in 1959, and the Chemical Economics Handbook that began in 1950. For a few years they remained the only meaningful operational part of SRIC and today both have left.[23] As noted earlier, important economic development work successfully continues in SRI's Washington, D.C. office.

Continuing Refinement of a Strategy for Intellectual Property

For most of SRI's history, its Board members had chosen to have a rather benign influence: reviewing compensation policy, watching the income and capital investment numbers, and choosing the SRI president. But with the arrival of Cook came his resolve to make the Institute a stable and profitable place. Besides the need to deal with the slipping Business Group his other, more passionate orientation was equity generation or start-ups. While temporarily acting as SRI's president, he brought his ideas in this regard to the Institute leadership groups.

As some of us in the Engineering leadership first listened to Cook's message of reform, there arose doubt about the permanency of some areas of traditional research; namely, those that had no commercial relevance. We wondered whether the unwritten but long-held tenet that any well-funded research area had implicit protection would hold up. Cook's emphasis was clear. First, he would remove any ambiguity about how much the Institute would be engaged in intellectual property commercialization. Second, he would closely watch the research areas or labs that had chronic profitability problems. He was a very successful veteran of the company-building world and seemed intent on playing that out at SRI. He cast the impression that research

[22] A good estimate is about $42 million.

[23] In 2001, BIP became an affiliated company, SRI Consulting-Business Intelligence, through a management buyout by its staff. In January 2004, the Chemical Economics Handbook and its related issues were sold to Access Intelligence, an information services company in Potomac, MD.

should, where possible, be tailored so as to ultimately create the value inherent in licensing and equity building.

It did not hurt that in the late 1990s the Silicon Valley model of equity generation was approaching manic proportions. As copious amounts of money flowed into start-ups, the surrounding area was becoming even more expensive to live in, and competition for staff was becoming critical. Simply put, Cook wanted SRI to *use* the Silicon Valley model rather than be victimized by it. To help cure SRI's financial woes, he wanted to incubate new, high-value companies, with their lucrative initial-issue equities accruing both to the Institute and to select people within it. It appeared as though he believed this course could build an endowment that would not only stabilize the Institute financially but eventually give SRI the freedom to pursue research of its own choosing.[24]

On Sommers' departure in December of 1998, Curt Carlson, who was in charge of commercial licensing and company formation at Sarnoff, became president. Given his previous job, his incoming strategy also centered on using SRI's intellectual property output to build not just a large research endowment but even to create a more attractive campus, free of the WWII buildings still in use. Those noble goals seemed possible. After all, the IPO wealth-generating machine was well-oiled and still purring all around the region. Rather than letting commercialization be a shared effort by existing staff, SRI hired mostly new people to intensify the process. Doing so, of course, required investments that would come from either the Institute's overhead for from the already marginal bottom line money. The impetus for commercialization was thus invigorated, but, for reasons elaborated on in Appendix D, there would come constraints on that kind of enterprise that are inherent to a contract research organization.

As important as anything internal, however, came something from the outside. Any inherent difficulty in commercialization, including an inordinate commitment of funds toward it, would find a sobering confirmation in the burst of the dot-com bubble in 2001. The almost immediate decrease in the availability of venture funds made the SRI initiative much more difficult to carry out.

Though still an important part of the SRI operational strategy, commercialization has been scaled back a bit and the core contract research business is again front and center. Unlike the early days at SRI, however, the commercially promising output of the research process will be carefully and continuously examined for value. Seeing how those two facets of operations fit sensibly together in a creative research environment and in the entrepreneurial environment of Silicon Valley will also continue to be examined. For the moment the SRI ship is upright and under sail. Under President Carlson's leadership SRI is again profitable, growing, and projecting vitality in its ongoing research.

[24] A bit more detail of the movement toward commercialization and its ramifications inside SRI can be found in Appendix D covering the SRI business model.

Endnotes

[A] Weldon B. Gibson, *SRI–The Founding Years* and *SRI–The Take-Off Years*, William Kaufman, 1980 and 1986, respectively. Hoot passed away in the late spring of 2001.

[B] This account of Heald's influence has been taken from an issue of the *SRI Journal* (Feature Issue 4, December 1966) on the occasion of SRI's twentieth anniversary.

[C] Maurice Holland, *Survey of the Stanford Research Institute*, report to SRI's Board, August 17, 1950.

[D] *First Annual Report of the Stanford Research Institute to the Board of Directors*, October 1946 to December 31, 1947.

[E] Stewart Gillmor, *Fred Terman at Stanford: Building a Discipline, a University, and Silicon Valley*, Stanford University Press, October 2004.

[F] Gillmor, op. cit.

[G] Maurice Holland, op. cit.

[H] Gibson, op. cit.

[I] *The Dibble General Hospital – A History*, published by Sunset Press, San Francisco, for the Hospital, May 8, 1946 (courtesy of SRI's Bruce Clark), and Michael Sranevik and Shirley Burgett, *Menlo Park California – Beyond the Gate*, Menlo Park Historical Association, Custom and Limited Editions, 2000.

[J] Letter of March 23, 1993, from SRI Treasurer, Don Andrews, to Stanford's CFO, Peter Van Etten.

[K] *SRI Journal*, Vol. 5, No. 2, April 1985.

[L] Ibid.

[M] SRI AI Task Force, *An Assessment of AI Technology Commercialization – Market Overview and Opportunities for SRI*, December 1984.

[N] A good encapsulation of the transition can be found in Miller's testimony to Congress (House Committee on Science, Space, and Technology) on July 13, 1989. A more complete story of the episode can be found in a local newspaper, the *Business for Central New Jersey*, April 2, 1990.

[O] Paul Jorgensen, personal communication, July 9, 2001. For many years Jorgensen was the SRI executive who worked most closely with Osaka Gas.

[P] William Bloom, Ken Colmen, and Doug McConnell, personal communication (in a joint conversation), June 28, 2001.

Appendix C
SRI's First Boards of Directors

SRI Board of Directors–1947
Chairman–Donald B. Tressider, President, Stanford University
Vice Chairman–Alvin C. Eurich, Vice President, Stanford University

Stanford Trustees

Charles R. Blyth	President	Blyth and Company, San Francisco
John E. Cushing	President	Matson Navigation, San Francisco
W.P. Fuller Jr.	Chairman	W.P. Fuller, San Francisco

Others

Atholl McBean	Chairman	Gladding, McBean, San Francisco
Paul B. McKee	President	Pacific Power & Light, Portland
D.J. Russell	Vice President	Southern Pacific, San Francisco
William L. Stewart Jr.	Executive Vice President	Union Oil of California, Los Angeles
James D. Zellerbach	President	Crown-Zellerbach, San Francisco

SRI Board of Directors–1949
Chairman–J.E. Wallace Sterling, President, Stanford University
Vice Chairman–Louis B. Lundborg, Director of Development, Stanford University

T.H. Banfield	President	Iron Fireman Manufacturing, Portland
S.D. Bechtel	President	Bechtel Corporation, San Francisco
Charles R. Blyth	President	Blyth and Company, San Francisco
A.G. Budge	President	Castle & Cooke, Honolulu
James F. Crafts	President	Fireman's Fund Insurance, San Francisco
John E. Cushing	President	Matson Navigation, San Francisco
Paul L. Davies	President	Food Machinery and Chemical, San Jose
Donald W. Douglas	Vice President	Douglas Aircraft, Santa Monica
J.H. Drum	Vice President	National City Bank of New York, New York
Paul C. Edwards	Associate Editor	San Francisco News, San Francisco
Alvin C. Eurich	President	State University of New York, Albany
R.G. Follis	Vice Chairman	Standard Oil of California, San Francisco
W.P. Fuller Jr.	Chairman	W.P. Fuller, San Francisco
F.C. Lindvall	Chairman of Engineering	California Institute of Technology, Pasadena
Edward D. Lyman	Partner	Overton, Lyman, Plumb, Prince & Vermille, Los Angeles
Atholl McBean	Chairman	Gladding, McBean, San Francisco
Garret McEnerney II		McEnerney & Jacobs, San Francisco
Paul B. McKee	President	Pacific Power & Light, Portland
Paul Pigott	President	Pacific Car and Foundry, Seattle
Alden G. Roach	President	Columbia Steel, San Francisco
S.W. Royce	President	Huntington Hotel, Pasadena
D.J. Russell	Vice-President	Southern Pacific, San Francisco
Tom Slick		Milam Building, San Antonio
William L. Stewart Jr.	Executive Vice-President	Union Oil of California, Los Angeles
Mark R. Sullivan	President	Pacific Telephone, San Francisco
Roland Tognazinni	President	Union Sugar, San Francisco
W.W. Valentine	President	Fullerton Oil, Los Angeles
Lingan A. Warren	President	Safeway Stores, Oakland
Brayton Wilbur	President	Wilbur-Ellis, San Francisco
James D. Zellerbach	President	Crown Zellerbach, San Francisco

Appendix D
SRI's Business Model and the Question of Adaptation

Again this appendix is formed from the author's experiences and impressions over 40 years at SRI. They do not represent any official view of SRI.

Contract Research—SRI's Core Business

Research carries the connotation of trying to introduce something new. If you enter into a formal arrangement to explore a new area, under specified terms and conditions, describing that work as "contract research" makes sense. But, if the contract is for developing something specific or predictable, a more appropriate term would be "contract development." Though that second term is never used at SRI, the Institute undertakes both kinds of work. And, clearly, losing track of such a distinction invites trouble. True exploration with only vague notions of outcome is clearly different from performing a specified task, in a limited time, with an expected outcome. Failure in true research should be forgiven, even though it is sometimes not, whereas failure to complete predictable development is often unforgivable—a sign of poor work or a badly written contract. Happily, much of SRI's work lies between these two limits, and outcomes are generally acceptable; however, the path followed to attain them may not have always been predictable.

Fortunately, a wide variety of organizations elect to fund contract research. In the United States research money that allows considerable exploration is mostly the province of the federal government. On the other hand, industry, whose needs are much more directed, may be blind to longer-term opportunities—a situation SRI has repeatedly experienced. Nonetheless, SRI has won its share of contracts across a varied spectrum of clients. Doing so is an important element in the diversification that characterizes its business model.

Because it was organized to conduct research much like its parent Stanford, SRI's revenue stems from thousands of projects, conceived and won by research principals. At its largest, SRI had more than 2,000 projects active in a given year, with individual researchers essentially working directly for their clients. In all, SRI has conducted over 50,000 individual projects, ranging in size from a few hundred to tens of millions of dollars.[1]

Because SRI's core business is contract research, its work primarily has consisted of *applied* research. But at an eclectic place like SRI, even that quite general term has not pleased everyone. The non-technical groups at SRI, those outside Science and Engineering, have occasionally found "research" too vague and uncertain a description for the work their clients want done. In the beginning years, however, applied research was, as a result of Stanford-issued policy, all that SRI was allowed to carry out; there was no room for what is today mostly referred to as management or business consulting. Not until the mid- to late-1960s, when the link to Stanford had grown vanishingly thin, did the open use of those terms emerge at SRI.

Regardless of their orientation, all externally funded projects lead to revenue, SRI's term for the money it bills its clients. As seen in Figure D-1, contract revenue grew over the years, reflecting first the increase in staff and then, after about 1965, mainly the effects of inflation. Not that a research institute's main goal should be growth, but current-year revenue clearly hides a relatively stable staff size. The constant dollars curve corresponds to a staff of around 3,000 people between 1965 and 1990.

The U.S. government's post-World War II emphasis on research offered a propitious time for SRI to grow. Moreover, industry was also

[1] SRI's project numbering system flows between 1,000 and 9,000 and is, therefore, on its fifth cycle of these numbers. To be exact, the first round of numbering started at 102. The next five rounds went between 1,000 and 8,999, and now SRI has a more endurable five-digit numbering system.

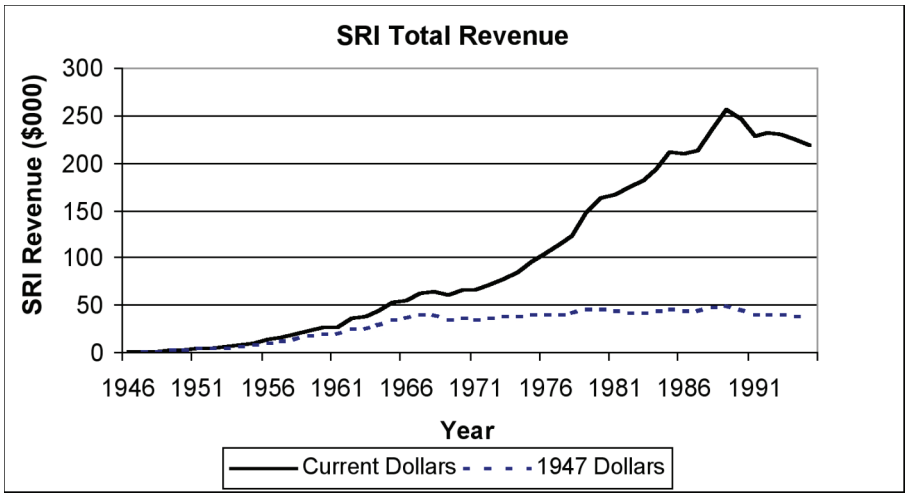

Figure D-1. SRI's annual contract revenue from its founding until the SRI Consulting separation.

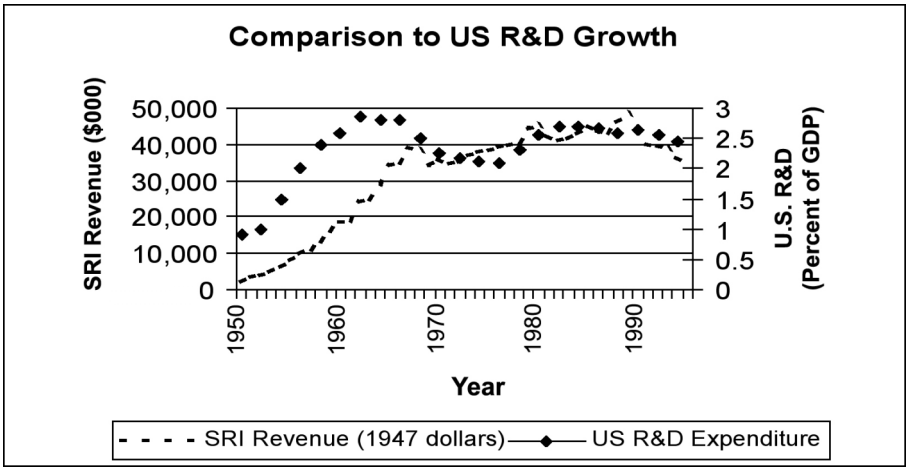

Figure D-2. A comparison of SRI's revenue growth with that of the U.S. commitment to R&D.

trying to profit from the new technology that had been developed during and after the war, and R&D as a percent of GDP really accelerated. A comparison of SRI's revenue, in 1947 dollars, with the percentage increase in U.S. R&D expenditures shows a similar pattern (see Figure D-2).

SRI's mix of projects is also worth mentioning. SRI was founded to serve business interests in the western United States and over the course of the first half-dozen years it did just that. But government-sponsored research has always been a large part of the SRI story and it was not industry, but the Office of Naval Research that sponsored the very first SRI project. Figure D-3 shows the fraction of SRI revenue over the years that came from the U.S. government versus that from commercial or international sources and though the size of the sector was not available for the figure, within a decade of its founding, SRI was doing international work.

Describing the business of contract research would not be complete without considering it as a working process. While contract research at SRI had its freedoms, in the absence of endowments researchers can never be free of their clients' preferences. However, those preferences have ranged widely—from extremely narrow, even utilitarian, to wide-open exploration of general goals. For the most part SRI researchers have sought the freedom to practice as their vision dictates, even to advance a new science or technology. Viewed in terms of a time horizon for realization, the best available compromise between complete freedom and specified detail is perhaps those projects whose impacts lay 5-10 years out. As mentioned, government research agencies and foundations often allow the greatest leeway, and commercial companies allow the least. The great goal of work in the sciences and technologies has been to have the freedom to invent or contribute to a totally new conceptual area like, for example, computer networking in the 1960s and 1970s. With such freedom, researchers know their work will be original, it is just a question of its eventual impact.

While a nonprofit institution, SRI still requires a source of net income that it can use to provide capital resources, hire new people, and make other investments in its future. At SRI that income is called the "contract fee," which is a line item on all contracts.[2] The fee is a small percentage of all other contract costs, including

[2] Exceptions are government or foundation grants, which have no fee and often require a reduced overhead rate.

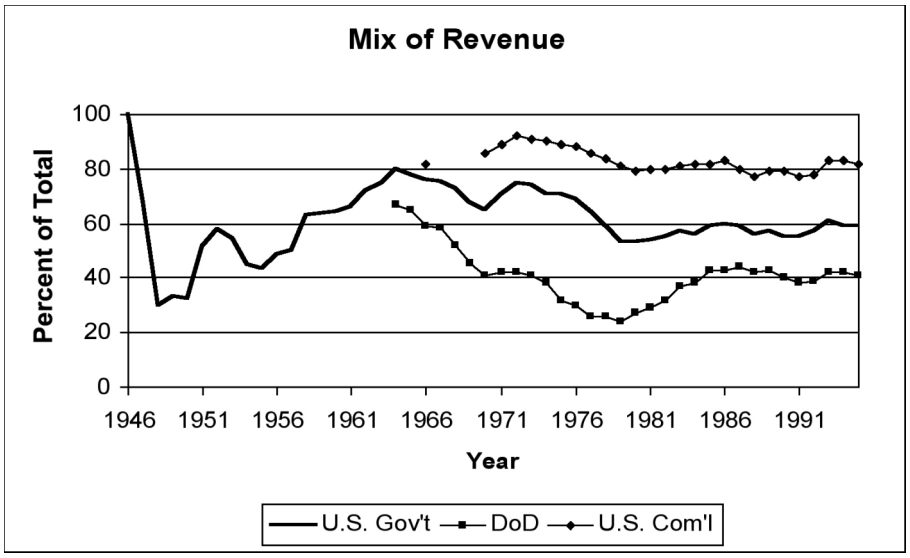

Figure D-3. SRI's revenue mix history. (Until about 1964, SRI distinguished only between government and commercial work. Since that time, each sector has been further divided and the above divisions from bottom to top are, respectively, U.S. government DoD, U.S. government non-DoD, commercial domestic, and commercial international.)

direct charges such as those for labor and materials and allowed overhead or indirect charges. In a full cost recovery scenario, where all direct and indirect charges are expended exactly as allocated, fee is the same as profit.

Before leaving this snapshot of SRI's initial business model, a word about its early culture and research staff is necessary. Much of early SRI was patterned after a university research environment; that is, it grew to be roughly discipline-centered. That it wound up this way was perhaps inevitable since the popularity of applications tends to come and go. Though new disciplines also arise, they do so more slowly. Real world projects, on the other hand, are often client-centered and multidisciplinary; yet they require individual disciplines to provide competent insights and innovative solutions. For most of its existence, SRI has attracted the kind of staff that wanted to expand an area of knowledge and, clearly, innovation becomes more limited when its roots are yesterday's knowledge.

Accordingly, SRI has always "enjoyed" a natural tension: extending knowledge about the most important scientific and technological concepts of the day, and applying that knowledge to solve specific problems. SRI's technical side has always wrestled with this dual need, and discipline-centered research has often proved the path of least resistance. Even in new fields (e.g., artificial intelligence), disciplinary barriers can be quickly erected.

The U.S. Research Marketplace

In the United States research is funded in just three ways, one commercial and two by the government. Commercially sponsored industrial research accounts for by far the largest piece of the research pie, but industry conducts that type of research almost entirely in-house.[3] Moreover, the research is mostly of a short-term nature, directed at products a couple of years out or less. A few exceptions to this rule exist, such as Bell Labs, IBM, and Du Pont, but increasingly even they must respond to Wall Street's dictate that their parent companies show quarter-by-quarter profits. If a contract research place like SRI is already engaged in a particular technology, it can almost certainly conduct research in that area cheaper than a company's in-house laboratory's cost to enter it. But the business world's perception seems to be to the contrary. Underestimating the cost of internal research and the belief that an outside research firm cannot protect intellectual property are two frequent industry misconceptions.

Almost all long-term U.S. research has its origins in the federal government, as typified by NSF and the National Institutes of Health (NIH). With the disappearance of basic research in commercial laboratories, the funding these agencies, and others like them, provide is perhaps the most unfettered research money available. Unfortunately for places like SRI, such

[3] According to the National Science Foundation (NSF), in 1998 industry supplied about $150 billion or 66% of all U.S. R&D. A staggering 98% of that was used by industry itself, and 70% of that was used for the development of products and services rather than research. Industry performed 74.4% of all R&D, universities 11.6%, government 7.6%, and nonprofits like SRI 2.6% (from an NSF report at www.nsf.gov/sbe/srs/seind00/access/toc.htm)

funding is often reserved for universities whose overhead structure is lower as a result of being shared with the universities' nonresearch activities. SRI thus finds it difficult to compete in basic research, and over the years the fraction of its total revenue received from such agencies has almost certainly been less than 10%.

The third major source of research money is the Department of Defense (DoD) and, to a lesser extent, a few other Cabinet departments and NASA.[4] DoD offices, in particular the Defense Advanced Research Projects Agency (DARPA), offer some of the few sources of funding with enough continuity for research to proceed until a logical conclusion is reached. The programs they fund may determine several things: that a particular goal is unattainable or has no further application, that it can be transitioned to a military service for implementation, or that it can be transitioned to a commercial setting. For example, DARPA, with modest supplementary research funding from each of the Armed Services, has been important in advancing information technology in the United States. Even for DARPA, however, adaptation is necessary as the importance of certain technologies fluctuates vis-à-vis DoD missions.

Marketplace Adaptation

SRI, like any other public or private contract research organization, must adapt to the marketplace it finds. Adaptation at SRI usually follows two lines: tracking the steady advance of science or technology and sensing those problems that can be solved through the application of new technology or technology-enabled concepts. SRI's early days were characterized by a relatively noncompetitive contract research environment. While SRI was maturing, university-related, in-government, and even commercial-based research entities were also growing and presenting new competition. But it was literally an act of Congress that posed a new kind of competitive challenge for SRI. Prior to the 1980s, almost 80% of SRI's contracts had been secured noncompetitively; that is, based on sole-source proposals. In 1984 Congress passed the U.S. Competition in Contracting Act (CICA) and in the space of about 3 years 80% of SRI contracts, at least in the Engineering Group, had to be won competitively—a complete reversal. That adaptation, which was forced by both law and competition, drove the cost of doing business significantly higher.[5]

Because winning contracts and thus revenue generation at SRI traditionally took place in the first two levels of the organization, it is there that virtually all meaningful adaptation occurred. Having 1,000 flexible, adaptable project leaders plying the waters of perhaps a 1,000 clients to explore mutual needs, proved an effective way to monitor and match market need. The only additional factor required was making sure that SRI's ideas and techniques were both relevant to clients and directed toward the future. If they were not, natural selection took place, and SRI management was obliged to prune the structure so that better opportunities ahead could be pursued. The present SRI management's marketing mantra seeks to assure prospective clients that whatever SRI undertakes, the result will create definable value for them in the future.

Fiscal Realities and Adaptation of Another Kind

The awarding of research contracts is fundamental to SRI's existence but that's not the only factor required for successful operation. Like any business, expenses must be controlled and there must be enough contract revenue to cover those expenses deemed essential. [6] Meeting this need has not always been easy and as a consequence the profitability, that is, the money needed for reinvestment, has often been problematic.

While some areas of research have remained "profitable" for many years in this nonprofit setting, many have not. The reasons for this unevenness range from the specific type of

[4] As a recent indication of the composition of government R&D, the 2003 allocation had the following breakdown: NIH $26.2 billion, NSF $5.3 billion, Department of Energy $8.2 billion, DoD $58.6 billion, and NASA $11.0 billion, out of a $117 billion total. The proposed 2004 R&D budget is about $123 billion with 51% to DoD and 22% to the NIH.

[5] The CICA as written by Congress was intended to avoid both research funding and nonprofits. However, both of those stipulations were effectively ignored in its application by funding agencies. (*Inside SRI*, Vol. 1, No. 2, June 1986.)

[6] Note that research institutions are not necessarily created to make money. Like all organizations, however, they must have enough discretionary resources to secure and expand their future position.

research, funding for which may go in or out of fashion; the type and quality of staff and their ability to convince clients that their ideas are worth supporting; and the clients themselves. More than half of SRI's funding comes from the U.S. government, and the government's regulation of the overhead and fees of its research contracts and grants govern SRI's profitability in that sector. Add to that limitation the cost of increased competition in the government sector forced by CICA and the result is that SRI's original business model has incurred a certain stress.

In addition to increased competition nationally, strictly local difficulties have affected SRI. The Institute's location on the San Francisco peninsula—one of the most competitive places for workers in certain fields and one of the most expensive areas to live anywhere—can significantly impede SRI's ability to attract staff to its main offices in Menlo Park. A second local factor has been the vast amount of venture capital available in the immediate region of Silicon Valley. That funding availability has lured many out of research and into the area's abundant start-ups, reaching its peak in the late 1990s. With those local stress factors in mind, SRI has, of necessity, taken on some of the traits that characterize the local business environment. Two very important factors will now be discussed that go a long way in defining a long-term SRI model for an activity we will call commercialization.

By the early 1980s, SRI began to reorient itself so that a greater portion of its income came from the licensing of intellectual property, including the creation of equity. Indeed, seeking a highly leveraged financial position by providing or participating in the seed round funding of a new company is tempting. But even seed round funding of numerous potential start-ups is expensive for a marginally profitable Institute. To the extent that such investments significantly erode the funding of new research opportunities or contribute to the overall overhead structure, they hamper SRI's ability to compete in its core business from which commercialization opportunities arise. Venture capital organizations, on the other hand, have few such distractions and can reduce their overhead nearly to zero if need be. This difference suggests a natural partnership: one with substantial money and a tolerance for risk and the other with little discretionary money and an opportunity engine. The research institution produces the technology or other opportunity, and the investor community commercializes it—each capitalizing on its own strength.[7]

While easily forgotten, SRI's nonprofit status and charter require its work to remain in the public interest. It is this status, however, that enables SRI to enjoy an excellent position from which to create and use government-sponsored intellectual property. The 1984 federal Bayh-Dole Act, mentioned in Appendix B, stipulates that nonprofit organizations, typically universities, can take intellectual properties generated under government research contracts and commercialize them. This legislation came about as part of a government desire to stimulate the economy and has resulted in two important advantages for SRI. Research sponsored by the U.S. government gives individual researchers great latitude in seeking innovations and, once SRI has created a set of marketable intellectual property, it is free to commercialize it as it chooses (even overseas partnerships are allowed if, wherever economically feasible, manufacture is done domestically). Simply put, the model consists of conducting a lot of research and technology development under government contract and then gleaning from that work innovations that have an attractive commercial market.

While this type of commercialization is obviously desirable, not all research can lead to intellectual property positions that are of commercial interest. When President Miller first proposed this kind of initiatives around 1980, there were some who thought rewards to inventors might become a divisive problem. The increased emphasis on research for commercialization in the mid- to late-1990s again raised the question of fairness. Two things transpired to allay those concerns. One specified that substantial income from intellectual property would be directed toward needed capital investments in *any* research area and to the staff in general. Second was the fact

[7] The early dispositions in the history of SRI were not aligned with holding patents. From a Stanford Ph.D. thesis that examined the Institute in 1951 comes the following: "Stanford Research Institute does not desire to develop and hold its own patents. It prefers to have patentable discoveries made under sponsored contracts. One of the Assistant Directors explained this policy with the observation, 'A patent is just a license for a court fight.'" (Ernest Barbour O'Byrne, *The Research Institutes of Stanford University*, Ph.D. dissertation in the School of Education, Stanford University, SRI partial reprint dated June 1951.)

that not many such opportunities came to fruition anyway. But the commercialization process still carries important potential for the Institute and it is continuing to be explored. We will now back up and add a bit of detail to a number of important events that had a downstream effect on that subject.

SRI's Move Toward Commercialization of Its Intellectual Properties

Particularly in the context of today's IPO-frenzied world, it is odd that for most of its 50-plus years SRI did not use its patent positions wisely. For most of that period, SRI's Patent Office was lightly staffed, and its chief function was to secure patent positions that could be offered to potential clients as an incentive for new research contracts. Licensing was minimal and had few impacts, and though SRI was in the midst of the world's premier venture capital marketplace, those people stayed away in droves.

There were several reasons for this: one was the perceived fuzziness about the ownership of rights for work done for the government before passage of the Bayh-Dole Act; a second was that good, innovative research was too far in advance of the commercial marketplace. A notable example of the latter was that licenses to the mouse issued in the late 1970s and early 1980s yielded SRI less than $150,000. The mouse's value became apparent only in the declining years of its patent protection, which ran from 1970 to 1987.[8]

This somewhat intermittent approach to dealing with intellectual property commercialization started to change with the arrival of President Miller in summer 1979. Having venture capital experience, Miller was attuned to the potential of this kind of investment. So, Miller took several steps to place SRI in a better position to profit from its accrued intellectual properties. He set up an SRI holding company, revisited the Institute's plan for sharing royalty with its staff, set up a commercialization office reporting to him, and signed an agreement with a new venture capital firm that gave them first right of refusal on all SRI-owned innovation.[9] He completed these important steps by 1982, but having done so did not see commercialization as being a huge preoccupation for SRI, estimating its revenue at something like 5% of the total.[A]

To give a flavor of the kind of action that followed Miller's initiative, consider the 1984 review given a popular field at the time, artificial intelligence (AI). The exploration began with an examination of SRI's inventory of AI innovations. Targets were identified and a report issued but in spite of that prominent and directed examination, no commercialization action was taken. Curiously, in the same laboratory at the same time, two software engineers were building software packages as part of their computer support activities. These were not AI implementations at all but either because these programs lay outside the AI-centered products they were seeking or because one of the programs was already under license, they were not considered by the task force.

One program was called EUNICE, which SRI had licensed in 1982. EUNICE enabled programs written for the increasingly widely used UNIX operating system to run on the also popular VAX computer from DEC that came with an incompatible operating system, VMS. The second SRI program, MultiNet, mated UNIX with the variety of local and wide-area networking protocols that were emerging at the time. These proved to be lucrative arrangements for SRI, netting several million dollars in the late 1980s and early 1990s. Some of that return came to SRI as gifts after their inventor, Dave Kashtan, and his AIC cohort left SRI to form a new and successful company called TGV.[10]

Note the contrast between the top-down exploration of a selected, seemingly attractive technology that didn't materialize versus a natural, unprompted flow of a needed, royalty-producing product that did—all from the same laboratory at about the same time.

Another SRI staff member, Phil Green, an inventor in ultrasonic imaging, was more adamant than anyone about the advantages of commercialization, both for the Institute and for himself. In the 1980s, he began investigating companies that were infringing on his SRI-owned ultrasound patents. Perhaps

[8] A critical factor of timing for the mouse was the Macintosh, which was introduced in 1984.

[9] For more details on these actions, see Appendix B.

[10] TGV stood for "two guys and a Vax" and became a small successful start-up; successful enough to present royalties and substantial financial gifts to SRI. TGV was eventually bought by Cisco Systems.

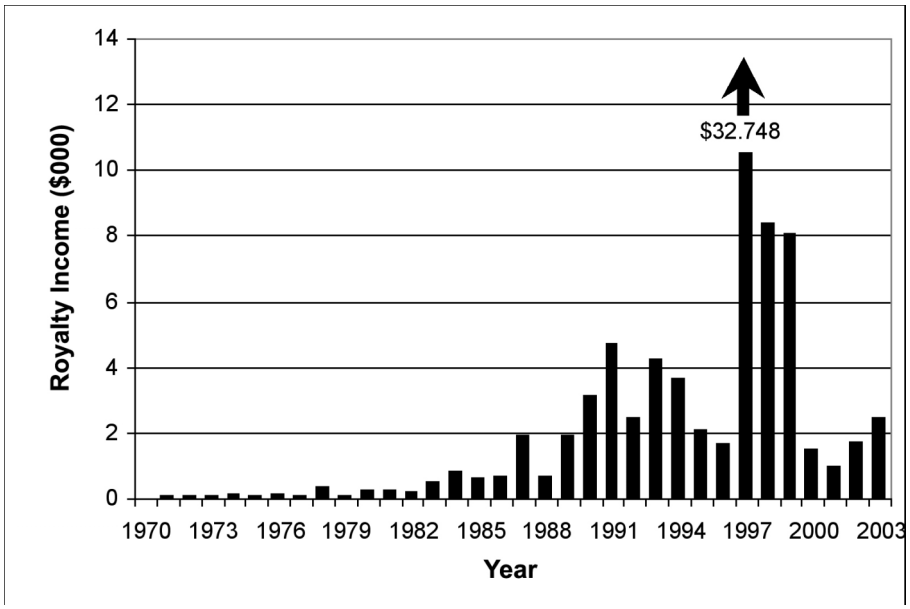

Figure D-4. SRI income from royalties. (Values are after inventors' shares are subtracted. Also not included are the sales of shares SRI accrued from the transfer of intellectual property.)

surprisingly, many "infringers," as he called them, having received a straightforward notification and request for royalty payments, simply responded with periodic checks over the remaining life of the patents. Two firms that didn't cooperate were sued by SRI and ultimately saw a conviction with willful avoidance. All together these ultrasound infringement pursuits returned well over $50 million to SRI. Figure D-4, which shows SRI's royalty income history, net of inventor's share, clearly reflects the change in emphasis in this area and the ultrasound settlement forms the large promontory.

In the meantime, Miller's exclusive commercialization arrangement with the venture capital firm, CommTech International, was not succeeding as hoped. While it had placed some technologies in the market, far more failed or were left hanging.[11] If it was simply a measure of just how difficult and problematic such equity-building initiatives are, it was not welcome news to those at SRI whose technology was under prolonged scrutiny. Under the exclusive agreement, SRI lost all flexibility in exploiting technologies, as well as much of the incentive to do so internally. Whether SRI would have faired better by having retained control and having focused more interest on this issue is not clear, but under the existing arrangement, delays and failed promotions were the norm. I remember, in one case, meetings and arguments went on for years with one failed opportunity after another while other places were exploiting exactly the same technology. To most SRI inventors and managers, the agreement was simply a source of frustration.

A couple of other important risks will round out this discussion of commercialization at SRI and they have to do with its proper balance with research. First, research tailored to commercial products or services entails, by nature, a much shorter lead-time than does more fundamental work, including work that defines the state of an art. If SRI devoted all of its discretionary resources to research with time horizons in the 1- to 2-year time frame, it would almost certainly forego research that resulted in the fundamental advances that sometimes change the world (as did SRI's visionary efforts on personal computing in the mid-1960s and on digital networking in the 1970s). SRI should reserve some resources for visionaries who can see beyond the incremental changes on which the commercial marketplace thrives. Enabling such long-term vision is, after all, part of the original motivation for commercialization building an endowment big enough to grant that kind of freedom.

Another risk is the impact on laboratories that discover an important technology that is subsequently commercialized. Exclusive licensing agreements concerning such intellectual property can curtail or even deny future research contracts in that area for such a laboratory, as well as result in the loss of key

[11] A couple of examples that have had some success are the licensing of SRI printing technology to Accuprint and a very long-chain polymer to Dow Chemical. In the latter case, after some delay, CommTech made the original licensing agreement with Dow and when Dow didn't want to complete the investment needed to produce it, CommTech found a sublicensee who would. That firm is Toyobo who is manufacturing and selling it and trying to expand its use into the large bullet-protective vest market. SRI receives some royalty income from Toyobo. (Source: conversation with Bonnar Cox on May 20, 2004. Cox headed the SRI commercialization effort in the early 1990s.)

people. Some staff members will inevitably leave SRI to join the licensee, but those who remain should not be so encumbered in using the intellectual property that has been sold, that the parent laboratory becomes effectively dysfunctional. That did happen and through the efforts of SRI's current president, Curt Carlson, guidelines are now in place to prevent this win-lose situation, wherein once the golden egg has been sold, the goose that laid it is shot.

Finally, there is the question of balance following this excursion towards commercialization. SRI's core business is unequivocally contract research. That work will be closely examined for commercialization opportunities and perhaps even shaded at times to enhance such opportunities. But research not related to commercialization will also enjoy all the respect it deserves. That balance seems to be now present at SRI.

The Changing Nature of Research in the United States

For perhaps a decade or two, the U.S. government has taken initiatives to spur the national economy. The government has invested in precommercialization technologies, carried out by places like SRI and, in the case of the Department of Commerce, by small start-up companies. But research conducted by U.S. industry appears to be headed in a different direction.

Corporate America is in a quandary regarding the role of research in its future. Because of today's relentless pressure for high market value and profitability, corporate research facilities are being given stringent tests for relevance. Are their expenses justified by their contributions to the product innovations the company needs in order to increase its valuation or to capture or maintain market share? Corporate officers are questioning such utility, even to the point of divesting some of the best-known U.S. research laboratories. The trend seems to be away from long-term research with its vague goals, toward short-term research that directly serves product development. Some companies want to end internal basic research and argue that industrial research is at the end of an era.[B] Targeted are such venerated research operations as Bell Labs, Xerox PARC (now an independent research center), GE's Schenectady Lab, and others.[12]

The reasons for this change vary, to be sure, but a major one is that the ever-shortening pace of product introduction has undercut the more leisurely pace that has typified the traditional research laboratory. Open-ended research projects with outcomes that are difficult to determine are now seen as an unaffordable luxury, no longer worth the low probability of a market-altering breakthrough. Another important reason can be the financial health of the parent company. In the case of Xerox, the biggest reason for scrutiny was that the parent company is threatened by bankruptcy.

But we should also recall that industrial-sector R&D funding in the U.S. continues to increase both in absolute dollars and as a fraction of GDP, possibly as a result of greater acceleration of the product development cycle. Regardless, to the extent that long-term research continues, carefully selected outsourcing will be good for universities or places like SRI that provide steeper and thus more efficient learning curves.

In the meantime federal government actions continue the tendency started during the early 1990s. In the DoD, the narrowing of research horizons is perhaps best evidenced by one of its largest research sponsors, the Defense Advanced Research Projects Agency. There, emphasis has shifted to Advanced Technology Demonstrations, which are geared toward bringing technology to bear on important military problems rather than inventing new technologies, an area in which DARPA had excelled. By the same token, the Department of Commerce makes R&D allocations under the Advanced Technology Program to foster partnerships among government, industry, and academia for pursuing high-risk research intended to have significant commercial payoff. This program allows industry to extend its technological reach to promote new commercial products and conceivably even new companies.

[12] At Sarnoff's tenth anniversary, GE Chairman Jack Welch stated that, "GE R&D is…in the critical path of every major technology intensive program in each of our businesses. And every technical contributor in our laboratory is working on a project that is vital to a current business plan…. The undiverted focus must be on winning in the marketplace." (April 3, 1997)

How Will these Changes Affect SRI and Its Brand of Research?

The industrial world's shortening of its research horizons and greater emphasis on internally funded, rapid-paced product development, has several messages for SRI. If industry still wants to fund some level of long-term industrial research, the resulting outsourcing will provide potential benefit to SRI, particularly if SRI is already engaged in the appropriate field. Using SRI would often be cheaper for the industrial client than internally developing the skills needed. Moreover, SRI can bring to such projects its own intellectual property for exploitation. But if companies continue to cloister their short-term R&D projects internally, SRI will obviously be denied that particular market. And to the extent that corporations also abandon their longer-horizon research, SRI must look to the government.

On the face of it, contracting with an outside research institute ought to be an obvious choice for a company when it has little or no background or capacity concerning what it wishes to explore. Unlike university grants in such cases, which do not yield rapid results and for which preserving confidentiality is difficult, contract research houses such as SRI are skilled in meeting both requirements. Costs are also much more easily controlled with outside contractors as long as the sponsoring company is closely involved. Finally, a broadly based contract research organization has greater ability to employ a new technology, or especially technologies in combination, than does a typical, more narrowly focused company.

Endnotes

[A] *SRI Journal*, Vol. 5, No. 2, April 1985.

[B] Gordon Moore, "Some Perspectives on Research in the Semiconductor Industry," in Richard Rosenbloom and William Spencer (Eds.), *Engines of Innovation: Industrial Research at the End of an Era*, Harvard Business School Press, 1996.

Appendix E
The SRI Atmosphere—The Roles of Research Staff and Managers

In spite of the many varied experiences people find in their work environments, such places have a definable culture or atmosphere. SRI has such an atmosphere and virtually every researcher I have known here, as well as many who support them, is aware of it. On balance, that feeling is invariably a positive one and I believe it stems from some combination of the independence they feel and the general level of proficiency they find. I also believe that the SRI atmosphere is immensely important to its staff, perhaps the Institute's most telling attribute, transcending the inevitable difficulties with people and situations that visit us all. Beyond the feelings of freedom and competence, SRI's atmosphere is also one of innovation and an enticing but illusive potential for interdisciplinary collaboration. The SRI atmosphere is carried dominantly by its people and the roles they have filled over its history. It is with some trepidation that I engage these subjects and it must be, almost by definition, a personal perspective.

Nurturing Innovation

Two extremely important attributes of an applied research organization are competency and innovation.[1] These say everything about the type of person who would be hired or would feel comfortable at SRI. In contract research both orientations must almost be taken for granted since no research client wants to pay for old solutions expensively rediscovered. But how are the right people found? With some risk, competency can be discovered or even measured at the time of employment. After employment, new areas of research can be learned, formally or informally. But the more difficult question concerns innovation.

Because evidence of innovation may be revealed by their prior work, SRI staff often come from research universities or other laboratories. The ponderous question, though, is whether innovation can be taught, enhanced, encouraged, or forced, or is simply an innate characteristic of some people. Good researchers are motivated to exploit their natural creativity simply by being among the first to originate a new concept, abetted, perhaps through competition with their peers. If a researcher is surrounded by peers who are each breaking new ground or setting the state of their art, it is very difficult not to do likewise. To make such an atmosphere possible at SRI, two provisions are necessary: finding the funds to support the innovative activity and making sure that the working environment does not become too administratively distracting. If reasonable encouragement within such an environment doesn't work, my 40 years of experience tells me that not much else will. In starting a new group, building that kind of atmosphere early is critical.

To illustrate how much innovation is intrinsic to the researcher, here are a couple of instances of how innovation sprang from nothing more conducive than a coffee break. Pure serendipity or the right people in the right atmosphere? The setting for one instance began with a rather protracted project with a West-coast paint company that was developing a new latex-based paint. A problem the company was having was the formation of bubbles in the paint that wouldn't dissipate before the paint began to dry. This caused a roughness in the surface that made it unusable. In spite of trying a large number of mixtures, nothing was working well enough. Meanwhile, another SRI laboratory had an ongoing project with a large Western firm that involved the processing of coconut meat it was importing from Africa. The company was extracting oil from the meat to sell to the soap industry, but the company also wanted to know what other uses there were for coconut oil and, just as important, what could be done with the coconut residue? From the

[1] Innovation, as used here, simply means introducing something new and different based on a creative insight or act. It could be an invention or just a new way of portraying a problem or its solution.

former, SRI chemists proceeded to develop a useful substance they called a "plasticizer" that helped plastics shape and hold their form. But, though they racked their brains, they couldn't find uses for the residual meat. Now the coffee break.

The paint researchers were complaining that while they had found a chemical that would smooth the bubbles out, they needed an oil base to go with it. A chemist on the coconut project bolted to his feet and pulled a notebook from his pocket. One of these three coconut oil fats, he said, has some peculiar molecular properties that you might what to look at. Out of a hunch came a double-barreled solution. Tests revealed that one of the coconut residues also fit the paint defoaming need, and it came into use in the other client's paint as well as that of several other paint companies.

A second instance came from a coffee break in the Engineering part of SRI and another cross-discipline question. Could a laser be built to replace the radio frequency sources used in weather radar? The result was the building at SRI of the first weather lidar, or laser-based radar, for probing the atmosphere. That story is unfolded in Chapter 9. While the common denominator here was a coffee break, needless to say it was the caliber and orientation of the people who attended them that made the difference.

One of the best evidences of a prolonged history of innovation at SRI was the creation in the 1960s and 1970s of the rudiments of personal computing. The rough vision existed, but the means to deliver the desired functionality had to be invented and then refined as it came into use. The development lasted almost two decades. But though retrospectively it was revolutionary, the magnitude and value of the innovation were not at the time evident to everyone. With no similar developments to look at, this work was almost totally SRI innovation. Unfortunately, innovation doesn't always take hold and this work ultimately ended at SRI in the failure of outside sponsorship.

Within the bounds of propriety, the SRI researcher is given wide latitude in areas of exploration. That latitude is part of the SRI atmosphere. While a few SRI research managers have constrained their people to pursue subjects in the mainstream of R&D, most are more adventurous. Thus, topics like psychographic segmentation of the consumer population for marketing, or the use of computers to augment human intellect, or even questionable topics such as remote viewing and cold fusion have been given a good airing at SRI. On the other hand, SRI has always had an ethical atmosphere, and many opportunities that would not reflect well on the Institute, independent of outcome or remuneration, have not been approved. As one example, though perfectly legal, projects directly related to Nevada gambling to my knowledge have never been approved. As a practical matter, however, most discretion about whether to undertake a project comes from skepticism about whether enough support can be found to do a subject justice.

A Successful Contract Researcher

In my opinion, the people who make successful contract researchers at SRI have five necessary characteristics. They are *creative*, they understand at least one *discipline* well, like all good leaders they are *motivational*, and they have an ethic for *integrity* and *hard work*. A *creative* orientation naturally takes one beyond the expected or predictable to a broader range of solutions to a given problem or opportunity. It questions not just the invited answer but also the premise itself. On the other hand, creative thought must also be accompanied by enough knowledge to become a good point of departure for not only what changes should occur, but also whether they can be realized. In a contract research organization it is important that imagination exist at all levels of abstraction concerning a problem; that is, from the high-level statement of the problem or overarching goal, down to the details about how the solution might be implemented. This is a lot to ask of one person, so often a team of people is needed to span the levels of perception that many solutions require.

Regarding *disciplines*, it is difficult to make an innovative contribution unless one is steeped in at least one relevant discipline. *Applying* a particular discipline requires enough of an understanding to be efficient and productive in its use. Similarly, advancing the state of that discipline or art demands an even greater appreciation of it. SRI has always had people with such grasps across a set of important disciplines; not to have such a background obviously forecloses research in the

areas to which such disciplines apply. SRI's strength has always been in the rich number of disciplines among its staff.

Having said all that, there are a very few, exceptional researchers who have the innate power to look at an opportunity, and quickly position themselves at the very frontier of the relevant field. Though it may take a year or two, they emerge with a totally new approach that makes a world of difference in the utility or accuracy of the selected field or even in the field's underlying science. Such people are wonderfully appropriate in a contract research environment.

Motivation is necessary in two critical dimensions: one, is the ability to lead a group of project people toward a responsive goal; and second, and perhaps more important, is the ability to sell a potential sponsor that SRI has the understanding, the insight, and the approach to bring new and competent solutions to bear on the sponsor's problem.

Because SRI is a contract research institute, it is obviously successful only when it has an adequate backlog of research contracts.[2] Those individual researchers who can consistently deliver such backlog effectively wear chain mail; that is, they enjoy an enormous protection against whatever internal buffeting occurs. Those who gain long-term sponsorship and do quality work are probably the most revered people at SRI.

The last researcher attribute is best evidenced by how truthfully and consistently one represents him or herself. For most of SRI's existence, that quality has given SRI a reputation for *integrity* and *objectivity* with clients. Some of this stems from the scientific ethic and some from the very direct relationship that exists between the project leader and the client. Personal integrity, of course, builds organizational integrity. SRI's Tom Boyce puts it this way: "When I came to SRI in 1983 and had to call on potential clients to market or explore new work, I was amazed at how accessible people were when you told them you were from SRI. One of the first places I went was the Philippines. I would pick up the phone and call someone cold and, assuming they were in, I could get an appointment that same day or at the latest, the next. That was very gratifying and, you know what? It made me want to leave that contact in as good or better shape for the next SRI person who might call. It was a bond of responsibility I felt in continuing our excellent reputation."

As with any organization, SRI has its leaders, both formally and informally designated. Over most of its existence, technical leaders have been perhaps the most venerated by the staff, either because they are innovative or because they repeatedly bring in significant research contracts by offering prospective clients innovative and timely ideas and solutions. The Institute has several ways in which it honors such people. Each year awards are given for lifetime accomplishments: two Institute Fellows for technical achievement, one person who has contributed substantially to mentoring others to greater achievement, and one for life contributions to society in general. Added to these regular awards is a post-retirement SRI Hall of Fame whose members are elected by the SRI Alumni Association. Appendix J lists all these awardees to date.

Interdisciplinary Research

It stands to reason that in an applied research world, so often driven by the problems at hand, work bridging distinctly different disciplines would be commonplace. But when an institution is defined by the presence of traditionally separated disciplines, interdisciplinary talents are not easily developed. Over my 40 years at SRI, there have been numerous times, both formal and informal, when the subject of building this kind of interdisciplinary capability has been brought up by management in general terms, as it tried to educate the staff on its virtues and how it could be achieved. If any of those top-down efforts resulted in any concrete interdisciplinary achievements, I am not aware of them. In spite of the legitimate view that there are often rich rewards for exploring the boundaries of two or more disciplines, our educational, research, and even reward systems, not all of which are internal, discourage leaving one's chosen field. Furthermore, because by nature interdisciplinary wedges are not easily foreseen, speaking in general terms about them accomplishes almost nothing.

Yet in a heterogeneous place like SRI, there should be countless opportunities for

[2] Success has more than a financial dimension at SRI. The quality of work, the stature of its staff in their field, and the degree to which its clients benefit are other valid measures of success.

interdisciplinary work. Even if not induced by management, these could come from the informal interaction of different researchers or from the awareness of a need that does not yield well to a unidisciplinary approach. The question is how to encourage its happening?

The best and perhaps only way such endeavors have been successful at SRI is when they arise within some individual who has both the capacity and interest to bridge multiple fields. It is not enough just to identify an interdisciplinary bridge; someone must actually build it locally. That takes a person who is proficient in at least one field and willing to develop a working knowledge of the other. These "bridge people" are a necessary but not sufficient condition for interdisciplinary work.

Beyond having the bridge person, a team is usually needed, and perhaps the most difficult aspect of interdisciplinary work is getting other experts who are steeped in or advancing the art in one field to divert their attention to another. There is clearly some security in remaining within one's own field and, since most research laboratories are organized by discipline, researchers may be reluctant to leaving their organizational home for something that by nature has more risk. If the new effort is difficult enough to require several years of dedicated investigation, that looms as almost a career change to the discipline-centered specialist.

But bridge people do exist at SRI and, if one's notion of interdisciplinary work is more modest (i.e., it can be spanned with a small bridge, so to speak, either in the art or time), a substantial amount of that work occurs. Examples such as the marriages developing between chemistry and material sciences or biology or the blending of chemistry and biology to define toxicology are now commonplace. Business and economics are also easily overlaid on virtually any engineering or scientific pursuit. Lacking at least one bridge person, however, even small bridges can sometimes be difficult to erect.

As a division director, I sponsored for over a year weekly lunches between computer scientists, linguists, automatic speech recognition people, and electrical engineers to discuss the advancement of human-computer interaction. Though the advantage of that goal was fairly clear, it was still difficult to draw people out of their familiar haunts to tackle what most people would think of as inevitable. SRI had invented the world's choice for hand-screen coupling, the mouse, had as good an automatic speech recognition capability as anyone, had invented a handwriting recognition system in 1970s, and was steeped in natural language understanding and other artificial intelligence-based fields; thus, the initiative seemed very natural. Some success came in the formation of a Computer Dialogue Laboratory, a physical but not organizational facility where interaction research could go on and, eventually, it did inspire a very few people into melding automatic speech recognition with natural language understanding to improve on the accuracy of machine-recognized speech. But while that set the state of the art in terms of recognition accuracy, the most recent advancements in automatic speech recognition drew on other approaches and sheer machine power for their success. In the end, gaining a new plateau in human-computer interaction lacked the bridge person and, given no clearly identifiable sponsor with that interest, little came of it. There were no new technologies developed and no commercial successes. Agents, semi-autonomous acting pieces of network-mobile software, were advanced in these deliberations, but they didn't materialize at SRI until a bright young Artificial Intelligence Center (AIC) computer scientist later developed them. That approach did, coincidentally, return to enhance the functionality of human-computer interaction (see Chapter 4, a description of AIC work).

The Roles of Research Management

The position of management in a research institution is somewhat precarious, but not unimportant. Though a research organization's figure of merit is defined dominantly by the creative talents of its research staff, managers do have important roles. Just how important is quite honestly a function of your perspective, but there usually exists within a research management hierarchy a transition from close identification with the research staff and their culture to more remote but necessary preoccupations such as policy and profitability. While the manager rising in this hierarchy probably doesn't feel a creeping estrangement, nonetheless it occurs. Profitability, allocation of resources, and resolving interorganizational conflicts are some of management's duties, and

they are all viewed as distractions by the myopic and impassioned researcher. It is probably the case that good managers in any setting maintain some interaction with the working level but in contract research, where the first two levels are responsible for most of the organization's success, it is crucial. These are the levels that provide virtually all revenue and client satisfaction.

An involved, walk-around manager is a benefit to any organization including those involved in contract research. Here, where the working levels are so critical to income production, it is important that managers identify with those levels and how they can be motivated and helped. You can easily see attempts by some research managers as they try to avoid any cultural transition as they move into management. One example is "dressing down." The "wearing of a tie" is often subordinated to the need for implied acceptance by the stereotyped, open-collared, sometimes disheveled researcher. Many hardcore male researchers I have known will go to almost any length to avoid neckties, wearing them only for the outside world, such as clients. Even then the strange combinations of shirt, tie, and jacket seem chosen to convey their discomfort. Male managers that don't wear ties consistently are likely to be paying some deference to the research culture and giving a little tip-off about their own self-perceptions.

Managing in a contract research organization is certainly more difficult if not more important than in one whose money flows in from the top and is allocated according to someone's preferences. In a contract research setting like SRI, the researcher is expected to decide on the area of work, win the sponsorship to carry it out, and convey to the client the relevancy, adequacy, and competency of the results. That is a great training ground, and in the eyes of a typical researcher, it doesn't leave a huge role for a manager above the laboratory level. There is a prepositional invective used at SRI that goes a long way in typifying its culture. A researcher may sometimes claim, "I don't work *for* SRI, I work *at* SRI!" Strangely, as distancing as it may sound, that statement is often spoken with fondness about how it feels to work at SRI. Accordingly, as a manager at SRI, it was very difficult for me to assert that someone worked *for* me as opposed to *with* me![3]

So, what should a manager's role be at a place like SRI? As you might expect, the answer varies depending on the level of management, and there is probably room for a few different styles. For much of SRI's history, there were five levels of management. Now, there are, preferably, but four, albeit SRI is now much smaller. The first two management levels, those that direct a collection of projects called a program and the laboratory or center director, are still permeated by the research culture…what projects should be sought, what is the expected quality of the work, and who should be doing it. Except for financial aspects, management above that level is often discretionary, but just which discretions get exercised becomes critical. The starting or stopping of research areas, or programs, is an important middle-management activity perhaps not exercised frequently enough at SRI. At the highest management levels, that tendency to become disconnected from the producing levels must also be avoided or become simply an overhead load in the eyes of the research staff.

There are several important things that contract research managers at any level must do:

- Support a culture where creativity and innovation can flourish. Managers and not just researchers must be "keepers of the flame" at SRI; that is, they must be oriented toward preserving an atmosphere of innovation.
- Assure that the quality of work doesn't suffer under client or internal pressures.
- Administer the budget process and its allocations of required levels of performance. It is this process that should be used to reinforce positive outcomes and limit or terminate poor ones. Nonprofit institutes still require fiscal discipline.
- Resolve and correct interorganizational conflicts. Like everyone else, researchers can covet the same roles, clients, and projects as their fellow researchers. While internal

[3] Here I might usefully quote from a memo to my Division staff when I retired in the spring of 1998. It relates my true feelings about being a manager at SRI: "….Finally, I would like you to remember that whatever unfolds, you are the Institute. You don't just work *for* SRI, you don't just work *at* SRI, *you are SRI* and everything you do here has some impact on others, so let it be your best. SRI will succeed only if you do and it will fail only if you fail to meet your potential…."

competition can sometimes be beneficial, SRI is one place it must be controlled. A former head of Bell Labs mentioned to me that even Nobel Laureates engage in jealous wrangles.

- Help clear the roadblocks to interdisciplinary work, especially where the required working level participants have already embraced the venture.
- Set the parameters that enable attracting the necessary talent.
- See oneself as both motivating new and good research, but also as serving and enabling project winners and leaders. Micromanaging is even more deadly here than elsewhere and, in deference to overhead burden that is so important to initiative and success at the project leader level, managers should be lean in their supporting staff.

As with any organization, there are also some things that any manager must *not* do, particularly from higher levels of management:

- Become so detached that you appear to be arbitrary and believe you are free to act without clear regard for the staff that is producing the revenue.
- Assume you can or should direct research content from the top down.
- Be assigned inordinate privileges in convenience, comfort, or financial reward. The exorbitantly paid and pampered CEOs of industry are a terrible model for a research institute.
- Fail to support and defend a researcher who has done good and relevant work objectively, even when the preferences of the client or others would have chosen some other outcome.

I will cite one of two incidents I had in the vein of this last point. We had a project with the FCC to quiet a car electrically so that forthcoming transistor circuits would perform reliably. In an unusual arrangement, our final contract payment depended on our success on an actual car. We knew the spark plugs and the distributor would be the culprits and devised inexpensive ways to modify them. But the automobile manufacturers, who didn't want to raise the cost of a car even one dollar, repeatedly rebuffed our efforts. We mentioned that reluctance in the final report to the FCC and suffered the wrath of the automobile industry association. Because the head of that organization knew the SRI president, we researchers were called on the carpet and asked to delete that observation in the report. Our resolve to report what happened held, the report wasn't changed and, interestingly, we later received two contracts from that same association in the ongoing assessment of automobile ignition noise![4]

Next there is the question of upper management selecting, or more precisely preselecting, future research areas in which the Institute is to engage. Though several SRI presidents, sometimes in the framework of strategic planning, have tried this, it never has worked well. If such a new field is apparent to someone not intimately engaged, it is probably already too late in the competitive research marketplace. Those best equipped to make the determination are those who have both current knowledge of an art *and* are pounding the street looking for opportunities day in and day out; that is, the research professionals or at best their first- and second-level managers. Managers at the second or third levels can sometime help when they form and maintain higher level contacts in client organizations where they can spot early the emergence of new research initiatives. Aided by such awareness, prompted by their own discovered opportunities, and faced with carrying out whatever they propose, it is the fertile minds of those engaged in the research where new research ideas best originate.

Finally, there is the matter of incentive systems. Over the past 20 years or so, SRI has experimented with different plans and one is in place at the moment that rewards good financial performance with limited bonuses. Its tailoring over the years has brought it to a general point of acceptance by the staff. In such an egalitarian research atmosphere, the danger arises when a bonus system becomes too large and concentrated in too few people. Lucrative bonuses, of course, can also play on the unfortunate temptation to distort actual performance in order to collect them. As mentioned above, highly differentiated privilege of any form for upper management is very unpopular in a contract research organization. To present a stark example of the damage a strong incentive system can bring to SRI, consider what happened in the late 1990s to SRI's Business Group. From its founding the Business Group had, like the rest of SRI, been an

[4] The SRI project leader, James Gaddie, personal communication, January 8, 2004.

organization of researchers, analysts, and principal investigators, each making their own way. In 1995 SRI's president changed that model to one typified by large management-consulting firms with very well paid, profit-sharing-oriented managers aided by replaceable minions who would do most of the work. I remember being asked to interview a number of these "rain-makers" and I did not find one that I thought belonged at SRI. The cultural clash was horrific and it was an important factor in the demise of the Group. Even if it would have worked financially, it could no longer, perhaps by design, be a place with any research content. Certainly, research ideas cannot flow down from detached managers as tasks to workers not steeped in the required disciplines. The conversion was fatal to that Group and financially painful for the residual part of SRI.

Finally, there is the general question of management-employee relationships, one evidence of which is the presence of or efforts toward forming a union. To my knowledge this subject surfaced at SRI only once among the non-exempt (from overtime) staff in the latter part of 1976. The initiative lasted a few months and was then abandoned for lack of interest.

Appendix F
Companies Formed by SRI Alumni—with or without SRI Involvement

The listing below is intended simply to illustrate the propensity of SRI alumni to start companies, in some cases multiple times. The assertion is that SRI often becomes a good training ground for entrepreneurs. Since SRI has kept no account of such initiatives at SRI, the list is compiled from casual knowledge. The compilation, therefore, woefully underestimates the true number of companies created. To appear on the list an SRI person or alumnus has to be a principal in the founding of the company. In the preponderance of the more than 80 cases listed, SRI was not directly involved.

Often a person leaving SRI will form a one-person consulting arrangement. Because of the sheer volume and difficulty in verifying such adventures, those cases are not included below. A number of companies have been started by SRI without SRI staff specifically joining the new company in the process. Among these are companies like Polyfuel, Artificial Muscle, Discern, and Cyance. That type of company formation is also not covered here.

As much as the sometimes-approximate dates will allow, the list is in chronological order. The format of each listing is:

Company Name (SRI staff member(s) involved) (founding date) (company purpose or product) (other information or ownership transfer if known)

Electro-Optical Systems (Abe Zarem, Emo Parro, James McCarthy) (~1955) (electrooptical shutter, aerial cameras, ion propulsion) (became **Xerox** Electro-Optical before 1967 and then sold to **Loral**)

Granger Associates (John Granger et al.) (1956) (communications, antennas, electrostatic dischargers for aircraft) (acquired by **Digital Switch Corporation**)

Fair, Isaac, and Co. (William Fair and Earl Isaac) (1956) (helps companies win new customers and new markets) (today, a worldwide company whose adaptive control software manages 85% of the world's credit cards and three-fourths of all U.S. mortgages; perhaps 1,000 employees)

Raychem (Paul Cook) (1957) (electrical insulation products, including ultimately shrink-wrap wire insulation) (purchased by **TYCO** in 1999 for $2.9 billion)

Economic Research Associates or ERA (Harrison Price) (1958) (tourism and recreational market analysis, including Disney World and many other theme parks) (sold in 1969 to **Planning Research Corp.)**

Ridge Vineyards (Dave Bennion, Charlie Rosen, Hewitt Crane, Howie Zeidler) (1959) (World-class cabernets and zinfandels by 1970s) (Sold to Japanese pharmaceutical owner A. Otsuka in 1986)

Explosives Technology Co. (Frank Burkdall, Ben Huber, Norm Zabel, Don Moore) (explosive products, including the guillotine cutters that separated the ascent from the descent vehicle in the first lunar departure) (sold to **Ducommun, Inc.** in 1971)

Telecommunications International or TCI (Bob Tanner and E.M.T. (Ted) Jones) (1961) (antennas)

Develco (Bud Rorden, Len Orsak) (~early 1960s) (general electronics systems)

Scientific Products, Inc. (Reid Anderson) (about1964) (electronic products including a metronome)

Applied Communications Inc. (Bob Weitbrecht) (~1965) (early modems for the deaf community) (Bob received honorary doctorate of science from Gallaudet University in 1974; company now known as **Weitbrecht Communications**)

American Microsystems Inc. (Warren Wheeler, who left for Philco in 1959) (1966) (integrated circuit and semiconductor design and manufacture) (bought by **Gould** in 1982

and exists today as AMI Semiconductor in Pocatello, ID)

Anderson-Jacobson (Reid Anderson, and John Van Geen as a consultant) (1967) (first major producer of acoustically coupled modems) (acquired by **CXR Telecom** in 1988, which is now called **Microtel International**)

Failure Analysis Associates (Bernard Ross, research physicist in NWRC) (1967) (scientific and technical analysis of failure modes and causes) (changed name to **Exponent** 1998 with broader consulting charter and now has 20 offices and 675 experts)

Finnigan Instruments (Robert Finnigan and William Fries) (1967) (smaller, cheaper gas chromatograph mass spectrometers) (now worldwide billion dollar company as **Thermo Finnigan** and **Thermo Electronics** building analytical equipment for drug testing, food production, and telecommunications)

Horner Associates (J. Kenneth Horner) (~1967) (computer-aided chemical design)

Systems Control Inc. or SCI (Phil Merritt, Jean Peschon, Robert Larson) (1968) (engineering systems)

Institute for the Future (Roy Amara and Andy Lipinsky) (1968) (futuring)

Computer Synectics, Inc. (David Jorgensen) (1969) (product unknown) (sold in 1973)

Verbatim (Reid Anderson) (1969) (data recording media, diskettes) (now subsidiary of **Mitsubishi Chemical**)

Center for Continuing Study of the California Economy (Robert Arnold and Stephen Levy) (1969) (long-term studies and forecasts of the California economy for the public and private sector) (a vital concern for over 30 years)

Telesensory Systems (Jim Bliss) (1970) (aids for the handicapped)

DataQuest (David Norman and Bill Coggshall) (1971) (market surveys/intelligence in technical field) (bought by **ACNielsen** in 1978 and later by **Gartner Group** in 1995)

Electroprint Corp. (Gerry Pressman) (~1971) (electronically controlled stencil screening system for placing images on cloth) (financed by Sun Chemical)

Tragon Corp. (Herb Stone and Joel Sidel) (1974) (started as sensory evaluation, including taste testing; now expanded into broad business consulting for the food industry)

Decision Focus Inc. (Edward Cazalet and Warner North) (1976) (decision analysis-based planning and market analysis) (in 1997 merged with **Aeronomics**)

Systar (David Retz) (1977) (software applications for computer networking that served thousands of IBM mini- and mid-range computers)

Evergreen Engineering (Steve Johnson and George Eilers) (~1977) (product development, including medical instrumentation)

Katun Corporation (David Jorgensen) (1978) (office products, copier aftermarket) world's largest supplier of after-market copier parts with revenue of $360 million in 2001; sold to **Banc of America Investors** and **Svoboda Collins Inc.** in 2002)

Harrison Price Co. (Harrison Price) (1978) ("dean of recreation economic consultants")

Machine Intelligence Corp. or **MIC** (Charlie Rosen, Earl Sacerdoti, and others) (~1978) (AI application to assembly-line work)

Symantec (Gary Hendrix) (1979) (started as an AI-based database query language/system called QandA. Now a large producer and distributor of utility software)

August Systems (Bob Wing, John Wensley, Maury Mills) (~1979) (fault-tolerant software)

Strategic Decisions Group (Carl Spetzler, Paul Skov, and James Matheson) (~1980) (decision analysis-based planning) (bought by **Navigent** then in 2000 returned to **SDG** via a management buyout)

Litigation Risk Analysis (Marc Victor) (~1980) (decision analysis application to risk estimation)

Communications Intelligence Corp. (Hew Crane, Earle Jones, John Ostrem, and Peter Edberg) (1981) (handwritten input to computers including Japanese and Chinese; led to Jot and e-signature verification)

Strategic Economic Decisions (Horace "Woody" Brock) (1981) (decision analysis and innovation strategies)

Kestrel Institute (Cordell Green) (1981) (logic programming and AI software)

BusinessLand (David Norman) (1982) (PC sales/service to enterprises) (one of the first companies in PC sales and in 6 years rose to the

world's largest supplier of computers with over $1 billion sales/year)

E*TRADE (William Porter) (1982) (online, discount equity trading)

Mirage Systems (Phil Fialer, Larry Sweeney, and others) (~1982) (military stealth technology)

Microbot (John Hill) (~1982) (miniature robots for teaching) (sold to **UMI** about 1991)

Etak (Stan Honey, Walt Zavoli, Larry Sweeney, and others) (1983) (digital maps for car and other navigation systems) (now worldwide offices and called **Tele Atlas**)

Syntelligence (Peter Hart and Richard Duda) (~1983) (AI software applications)

Vista Research (Harold Guthart and others) (1984) (remote sensing and signal processing including leak detection and location)

Metapath (Bruce Hunt, Tom Lunzer, Harry Chesley, and Marilyn Pullen) (1984) (local area networking equipment)

Digideck (Connie T. Chittenden and Charles S. Weaver) (1986) (digital data compression for high fidelity recording and transmission) (dissolved in 1994)

CCS Associates (Caroline Sigman) (1985) (started in analysis and risk assessment of chemicals to the environment and now in drug development and toxicology)

The Beron Group (Bruce Beron) (1985) (decision analysis methodology and tools)

Kimball Resources (Dennis Rohan) (1985) (energy management and trading services)

ANSA Software (Rob Shostak and Richard Schwartz) (1985) (built **Paradox** ("2 SRI PhDs") commercial relational database software) (bought by **Borland Software Corp.** in 1989 who licensed it to **Corel** in 1996 where it is still part of their office suite)

Comware Int'l (David Retz) (1986) (Built gateways for IBM systems into the Internet. Now in sensing storage, and display systems)

Interop (Dan Lynch) (1986) (conference on Internet communications and enterprise equipment) (formed after Lynch had been at USC for nine years)

Australian Artificial Intelligence Institute or AAII (Mike Georgeff and Graham Smith) (1987) (contract AI research in Australia)

Global Business Network (Peter Schwartz, Pierre Wack, and Jay Ogilvy) (1987) (futuring)

Global Internet Access Services (Dennis Rohan) (1987) (Internet service provider) (sold to **Verio** who sold it to **Nippon Telephone and Telegraph** in about 1996)

Litigation Risk Management Institute (Bruce Beron) (1988) (risk management and analysis)

TGV (Dave Kashstan and Ken Adelman) (~1988) (communications software and UNIX simulation software for VAX computers) (TGV stood for Two Guys and a Vax; Kashtan hired Craig Conway (former CEO of PeopleSoft) to head TGV and who sold it to **Cisco Systems** in 1996)

Teleos Research (Stan Rosenschein, Leslie Kaebling, Marietta Elliott, and others) (~1989) (robotic systems and devices)

FX Development Group (Dennis Rohan) (1989) (terminals for foreign-exchange, bond, and energy trading; used in ~800 trading companies worldwide) (acquired by **Dow Jones and Company** in about 1991)

Innovation Research of California (Josh C. Abend and later Richard T. Knock) (1991) (software that helps organize and facilitate the creative and innovation process in organizations) (became **Innovation Engines** in 2000)

Health Industries Research Company (Tom Mader and Terry Maccarone) (1991) (market research for healthcare, pharmaceutical, and managed care industries with offices in CA, PA, NJ, and AZ)

Menlo Biomedical (John George, Frank von Richter, George von Haunalter, and later Horst Wolf) (1991) (global pharmaceutical and healthcare research and consulting with profiles on 450,000 public and private companies) (parts purchased by London-based **Isis Research** in 2000 and then by **Synovate Healthcare** in 2003)

Health Strategies Group (Tom Mader, Dee Miller Prince, and Jeff Larson) (1992) (research and consulting to the healthcare products industry with offices in CA and NJ)

Nuance Communications (Ron Croen, Hy Murveit, Peter Monaco, Mike Cohen, and others) (1994) (automatic speech recognition)

Cybercash (Dan Lynch) (1994) (online financial transactions) (acquired by **Verisign**)

Genetrace Systems (Chris Becker, others) (1994) (drug leads via genetic profiling)

Neural Systems Corp. (Connie T. Chittenden and Charles S. Weaver) (1994) ("trainable" digital logic slated to increase digital recording density and communications rates)

enVia (Mark Cummings) (1994) (a "meta-company" or venture capital-like firm that launches companies in the wireless world)

GWcom (Frank Kuo and Jeng-Sheng Huang) (1994) (two-way pagers, and cell-phone data services in China) (now two companies, **GWtech** and **Byair**, with 3 million customers and growing at 25% per year)

Global Internet Software (Dennis Rohan) (1995) (Windows NT network security software) (purchased in 1997 by **Cisco Systems** for $40 million; product became basis for Cisco's PIX firewall system)

Intuitive Surgical Devices (Gary Guthart, now vice president) (1995) (surgical telepresence)

Rooftop Communications (Dave Beyer, John Hight, Bic Nguyen, Thane Frivold, Darren Lancaster, and Jose Garcia-Luna Aceves, with Ed Kozel on the Board of directors) (1995) (fixed site wireless internet access a la packet radio) (sold to **Nokia** in1999 for $57 million)

Netiva Software (Rob Shostak) (1996) (scalable intranet database systems)

Cohesive Network Services (Dennis Rohan) (1996) (professional network engineering services) (bought by **Exodus Communications** in 1999 for $100 million)

Ordinate (Jared Bernstein) (1996) (product for automatic measurement of quality of spoken language)

4C Technology (Yigal Blum, Sylvia Johnson, and Paul Hart) (1996) (silicon-based preceramic polymers) (failed in 1999)

SynVax (Armit Judd) (1996) (synthesis and testing of biologically active peptides and their analogs; based on patents obtained while at SRI; targets are antivirals for flu)

SecureSoft (Mark Moriconi, Olga Korobkov, others) (1997) (secure database access) (became **Crosslogix** in 1997, secured $22 million in venture funding in 2000, purchased by **BEA Systems** in February 2003)

Pangene (David Zarling) (1997) (anticancer and antiviral enzyme inhibitors, radio sensitizers)

AgIndustries (Sally Landels) (1998) (market, competitive, and strategic analyses for the crop protection, agricultural biotechnology, and specialty fertilizer industries)

SportVision (Stan Honey) (1998) (television sport enhancements, including the glowing hockey puck and the virtual yellow first-down line in NFL games)

MobileSoft Technology (John Ostrem) (~1998) (China-based production of Linux-embedded operating systems in small and mobile devices)

DenseNet Corp. (Ravinder Kachru) (1998) (optical signal processing and switching)

SmartOrg (James Matheson and Don Creswell) (~1999 after a time at SDG above) (business development, R&D, and futuring)

DaVinci Heatlthcare Partners (Peter W. Davis, Roger Halualani, Pam Gutman, and Martha McDaniels) (1999) (healthcare markets, with focus on cancer care and related therapeutic areas)

Reactive Network Solutions (Livio Ricculi and Jagan Jagannathan) (2000) (security against network denial-of-service attacks)

Vocera Communications (Rob Shostak) (2000) (wireless communications systems)

Skypilot Network (Mark Rich, Bernie Yetso, and others) (2000) (wireless network Internet access)

China Mobilesoft (John Ostrem) (2000) (software for the mobile telephone and wireless device manufacturers for use in China) (successful products in telephones and wireless devices from 20 different vendors)

CONSULT it (members of SRI's Zürich office) (2001) (consulting in biotechnology, healthcare, pharmaceuticals, and chemicals, as well as venture capital)

Wireless Security Corp. (Dennis Rohan) (2001) (WiFi security systems)

Alterego (Saurav Chatterjee) (2001) (software engine tailoring Web page content to mall network terminals and devices) (acquired by Macromedia in 2002)

Packethop (Ambatipudi Sastri and Michael Brown) (2003) (packet routing systems for wireless networks)

Firetide, Inc. (Keith Klemba) (2003) (Network gear for low cost, rapidly deployable Wi-Fi service, used rights purchased from SRI)

Appendix G
Laboratory Directorship at SRI—Engelbart's Experience

The following account is based on SRI project files and interviews with a number of SRI staff members directly involved, including Dave Brown, Roy Amara, Bonnar Cox, Jerre Noe, Don Scheuch, Jack Goldberg, John Wensley, Earle Jones, and Bert Raphael.

Although Doug Engelbart's two decades at SRI saw monumental innovation and accomplishment, the environment was not always to his liking. In interviews and some articles about him, he relates his struggles with his administrative responsibilities and, at times, his SRI management.[1] Simplistically put, Doug believed that in some cases his SRI supervisors either didn't subscribe to his vision or perhaps didn't trust his ability to pursue it within the SRI framework. On the other hand, the sizable (at least for SRI) early funding that he received from SRI could not possibly have come from a set of uniformly disgruntled or skeptical managers. By way of partial explanation, he freely admits never having had a good grasp of the responsibilities lab directors face at SRI. So, partly to explore how such duties constitute a diversion for such visionaries and partly to provide a record of his dealings with his SRI peers and managers, we will explore this aspect of his stay at SRI. Beyond the personality differences one might find in any organizational experience, Engelbart's discomfort may come down to this: enjoying an environment that can offer a long-term opportunity to pursue one's goals, contrasted with the need to find and manage the resources necessary to carry them out. This process became critical as his group gained laboratory status. He called his lab the Augmentation Research Center or ARC.

Understanding Engelbart's position, first as a project leader and then as a lab director, requires understanding SRI's culture, which gives staff members who seek research contracts great freedom, but also heavy responsibilities, primarily for attracting sufficient outside funding to support their work. While SRI tries hard to tide its people across their natural funding gaps, its narrow profit margins mean that only limited funds are available to provide that protection. Also, research project leaders are responsible for defining projects, both technically and financially, and administering or managing them to the client's satisfaction. If a project leader does all of that well, a supportive, almost collegial role with his managers usually results. On the other hand, clear evidence of technical or financial trouble invites management participation at any stage of a project.

To understand the management issues surrounding Engelbart, it is helpful to divide his time at SRI into three parts: a gestation or investment period (1959–1964), a laboratory or operational period (1965–1975), and the termination period (1976–1977). This staging could apply to any growth area at SRI and a typical manager's role varies across such stages. According to Engelbart's account, the initial phase was characterized by a couple of disconcerting situations. As Engelbart embarked on pursuing his vision, his first manager suggested to him that he needed to become more practical or down to earth. It is hard to know just how appropriate this guidance was, but clearly Doug's future progress would depend on defining how his augmentation concepts could be realized and in this formulation stage, they were often hard to voice. In any case Engelbart did not appreciate such advice and solved this first problem by transferring to another laboratory. His second manager, again according to Doug, created a more serious problem, the unsolicited imposition onto Engelbart's newly won ARPA project of a colleague with a more traditional view of software and computing. Given Engelbart's singular view of how things were to be done, plus his strong desire to lead his own effort, an immediate and substantive conflict arose. Imposing a project team member with or

[1] Stanford and the Silicon Valley–Oral Histories, Engelbart interviews, Nos. 2 and 3. Found at http://www-sul.stanford.edu/depts/hasrg/histsci/ssvoral/engelbart/engfmst3-ntb.html.

above a project leader was contrary to the culture at SRI, where a new project is almost always led by the person who won it. Engelbart thought this second manager's action was important enough to recount over 20 years later.[2]

A review of SRI records and conversations with those directly involved suggests that Doug may not have been able to express his vision in a way that captured the imagination of his supervisors, or at times even his clients. The title of his first 1963 ARPA project was "Computer Facilitation of Computer Programming," not exactly the rubric under which Doug's dream could find full expression and one that might lead a supervisor to decide the client wanted a narrow interpretation. For example, when project leader Engelbart wanted a computer of his own, his supervisor thought ARPA's offer of connection with a remote timeshare host was possibly good enough. Moreover, by early 1964 the ARPA program manager insisted on demonstrable progress,[3] almost certainly before Doug's larger notions of "computer-aided work" had relevant functionality.

As external sponsorship increased in the early to mid-1960s, Doug himself would be promoted to first program and then laboratory leadership. Through the first two phases of Engelbart's career mentioned above, three themes consistently appeared in the comments on his performance by all five of his managers. One was Engelbart's outstanding creativity—"perhaps the most original thinker at SRI." Another was recognition of the value of what he was doing to realize the potential of the "man-computer research area." The third was the nearly unanimous opinion that Engelbart had difficulty with a variety of administrative and managerial roles. In spite of written assessments of such deficiencies, in August 1963 his second boss promoted Engelbart to SRI's first level of management, a program manager, albeit with a stipulation that he be responsible mainly for technical direction. Though carrying out that stipulation was not just Doug's responsibility, it was roundly ignored.[4]

Engelbart's relationships with his supervisors were certainly not all negative. One of the most telling aspects about how he was helped by his managers during the formative phase of the ARC was the consistent SRI investment funding that Engelbart received to help him hone his ideas and display them to potential sources of outside funding. Managers at least two levels above Engelbart must agree to commit discretionary funds. Engelbart would never have received $120,000 in internal funds, as well as some capital equipment, if there were any major concern about the recipient or what he was trying to promote.[5]

In the meantime Engelbart's ideas gained acceptance and outside support sufficient for forming a laboratory began to arrive in about 1964. Doug was promoted to lab director, and over the next decade NASA, ARPA, and others funded Engelbart's work and gave him the computers he needed to literally bootstrap his operation. For directors of successful labs, an SRI manager tends to offer only limited oversight. Management gives the program or laboratory director as much independence as possible, but holds him or her responsible for meeting technical and financial goals. Oversight emphasizes financial matters unless technical failure or undue risk seems likely. Good managers also make sure that all clients' needs are being met. In 1965 Doug's supervisor praised him for his growing involvement in the ARPA and NASA communities and by late 1967 that same manager proclaimed his insight, understanding, and expression of man-computer systems architecture, warning only that, because of Doug's inflexibility in his technical preferences, he may find it difficult to hold on to good people. But at this point, and for the following 4-5 years, Engelbart had empathetic division managers.

But Engelbart's role as laboratory director didn't ameliorate his dislike for his own administrative or managerial work. His staff turnover rate was also high. He was clearly aware of this limitation and admitted in interviews at Stanford that he might not have had the capability or inclination to be both a visionary and a manager. In those interviews he

[2] Stanford Interview No. 2, op. cit.

[3] See the account of the 1963-1964 time frame in Chapter 2.

[4] While their exact date is uncertain, some of Doug's internal problems involved inadequate computer access. According to his account given in the Stanford oral history interviews, even when he did convince SRI management to buy a machine for his use, he soon found himself having to substantially share it with others. Since it wasn't a timeshare machine, his people's allocated time that got down to just 13 hours per week. This constraint was relieved only when the government gave him his own timeshare machine.

[5] At the time, this probably amounted to about 7 person-years of labor.

also mentioned requesting administrative help but it was denied, he said, since lab directors were expected to fill both technical and managerial roles.[6] But records indicate that his SRI managers also wanted him to get administrative support. Importantly, given the size of the ARC, Engelbart was free to acquire additional administrators on his own initiative and didn't. By 1972, to help lighten his load and to deal with criticisms of his staff about his inability to set short-term objectives, he approached his manager for help in delegating. That manager affirmed Doug's critical value to SRI and set up a small management committee to help. Toward the end of that year, when the ARC had over 40 people, Engelbart delegated some control to two assistant managers. While the move no doubt helped administratively, it didn't materially reduce the turnover that had characterized the lab since the early 1970s. And within a couple of years, other dragons appeared at the door to provoke the third and final SRI phase of Engelbart and his laboratory.

In a late 1975 discussion regarding his division's budget for the coming year, Engelbart requested that his Center be given an easier income budget to meet because of some new capabilities they wanted to develop. If agreed to, such decisions normally result in the other laboratories of the division picking up the slack, and they agreed to do so here. But 1976 didn't turn out to be a very a good year for a couple of the labs that had agreed to try to meet a higher than normal budget. As a result all the labs faced pressure to perform better or to cut costs. Engelbart's lab, despite its lower budget, became vulnerable, along with the other weakened labs, to the overall need for cost reduction. Such points of vulnerability are not uncommon at SRI since there is only a limited amount of money available to carry an unprofitable unit very long.

In part because of this uncertain funding situation and the associated internal pressure and in part because of the wanderlust of creative people, ARC staff members continued to leave. As mentioned, PARC was the biggest beneficiary. Richard Watson, who had been one of Doug's first assistant directors and who had helped develop the early roles for the Network Information Center (NIC), left for a government lab in Livermore, CA. Jon Postel, who had taken his place, soon left himself.[7] By 1976 there were perhaps 15 or so professionals left in the Center, with a somewhat smaller number of research analysts providing the NIC services.

Another threat was a decline in external funding. By the beginning of 1975 the ARC had maintained its total size of over 40 people and had revenues of about $2 million annually. But that support would soon begin to wane. For some time the ARPA program managers who were funding Engelbart had often been critical of his rate of progress. Because of this problem, combined with the informal limits on the duration of ARPA programs, support started to decline. Although the critical role of the NIC continued to be supported, the decrease in research funding made it difficult to keep momentum.

There is no more important danger at SRI than an extended loss of external support and consequently no more important responsibility for a laboratory director than to somehow deal with it. SRI has only a limited capacity to underwrite any operation, particularly one as large as the ARC, so that meant either finding more work or reducing staff. Barring either of those, management has to act; either by helping restore funding or seeing that expenses are controlled. To the myopic visionary, this requirement may seem harsh, unsympathetic, and even arbitrary.

To find the needed income and still maintain his research directions, Engelbart started to sell NLS *services* on his timeshare host to government agencies. In the SRI accounting system, this income was hard to reconcile, especially as its volume became unpredictable, primarily as a result of the uneven acceptance of NLS. Accordingly, Doug's division director sought to have him divide the ARC into two parts, research and applications, and then seek normal research funding for what would become a smaller group. When this strategy didn't bear fruit, for whatever reason, he chose to replace Engelbart as director toward the end of 1976. That obviously didn't sit well with Doug and did little to alter the situation.

To understand the specific act by the division director and his new lab manager, it is

[6] Stanford interview No.3, op. cit.

[7] Postel, who had worked on communications protocols in the ARC, including TCP (see Chapter 3), went to USC's Information Sciences Institute, where he became one of the founding figures of the Internet.

important to understand their assessment of where the ARC and its NLS functionality stood. Although they saw the value of what Doug and the ARC had created in the 1960s, they also saw the world catching up in certain aspects of those innovations that had high market appeal, such as text editing. Though such new, competing functionality was but a small part of the total NLS package, they still thought Doug's directions were not adapting to the changing technology and his inflexibility was hampering his retention of creative staff. From this viewpoint, then, and with a technical leader they thought was unwilling to work with them to improve the lab's chances of succeeding, they decided to put the ARC up for sale.

Several firms were approached and even Engelbart, together with his NLS development staff, decided to bid. According to the new lab manager, that bid was a symbolic $1. But sometime in 1977, SRI's overall director of research operations learned of the interest of Tymshare Corporation of Cupertino, California, in providing new functionality for its users. At that time it was one of the largest providers of time-sharing services in the world. Since such services were the company's core business, and it used machines similar to those in the ARC, Tymshare believed that providing some of the unique features of NLS would give it a competitive advantage over other companies beginning to offer time-sharing service. Overall, the negotiations went on for over 6 months and, in an unprecedented move, SRI sold the ARC and its intellectual property to Tymshare on January 20, 1978. SRI and Tymshare signed an agreement transferring the rights to NLS for $200,000 plus royalty stipulations. In order to stay with his created world of NLS and its nascent offerings, Engelbart and many of his researchers left for Tymshare. About a half-dozen decided to remain at SRI and transferred into existing labs such as the Telecommunications Sciences Center (TSC). The NIC and its perennial leader, Elizabeth "Jake" Feinler, also relocated to the TSC.

In short, Engelbart had to weather some tough storms at SRI, but the most important were the ones that face almost all innovators there. Engelbart's ability to develop his vision, at least to the extent that it laid the foundations of personal computing, clearly benefited from the freedom that SRI provides. But that freedom also carries the responsibility to gather the necessary resources, whether you are a project leader, a lab director, or higher. If that is impossible, for whatever reasons, the technical content, no matter how innovative, is of far secondary importance. While turnover of valuable staff members had been a problem in the ARC through the 1970s, the group's termination at SRI was thus governed more by external causes, by a funding world with its own limited capacity to persevere. Engelbart, with his vision firmly intact, now found himself immersed in the constraints of a profit-making organization, while the continuing development of personal computing took on a life of its own elsewhere.

Appendix H
First Radar Echoes from an Artificial Satellite

In the flurry of curiosity and interest following the orbiting of Sputnik, SRI radio researchers became probably the first people outside the Soviet Union to make radar contact with an artificial satellite. The initial part of this account is taken directly from SRI Staff Notes, October 1957. The article (shown in italics) gives a flavor of SRI's reaction to the event, but because of several inaccuracies, a number of edits are interspersed in brackets. The main purpose for including this story is its reflection on the natural and competent curiosity of SRI staff and how that curiosity leads them into purely voluntary and collaborative explorations.[1]

Special Techniques Group Tracks Sputnik with Radar

Staff members from the Radio Systems Laboratory are picking up and recording the radio signals from the Russian, man-made satellite at regular intervals. This, of course, is no longer news. However, the enthusiasm with which staff members attacked the problem of tracking down the satellite is worthy of comment.

The satellite's first pass was observed and recorded at the SRI field site on Friday, October 4, at 7 p.m. Engineers working under Dr. Allen Peterson, head of the Communication and Special Techniques Groups, set up radio-receiving and direction-finding equipment and went to work plotting the orbit and recording the transmitted "beep" signal.

The reaction of the press was immediate, and, soon, staff members were besieged with calls. Working voluntarily on an around-the-clock basis, sleeping in between passes, the engineers from the Radio Systems Laboratory have been maintaining a constant vigil on "Sputnik."

Lambert Dolphin, Ray Leadabrand, Ray Vincent, Bud Rorden, Rolf Dyce, Bob Rach, Roy Long, Ed Post, and other volunteers from the Engineering Division took turns at various operations.[2] *Hurriedly assembled, functional equipment (including an "analogue computer" made from a globe, scotch tape, string, and a wire coat hanger) was put into play and, as Ray Vincent said, "A crude but very effective 'analog computer' resulted which was instrumental in establishing the orbit."* [With only a rough idea of the satellite's velocity and altitude (it was in an elliptical orbit), the early Doppler and directional data from the satellite's transmission gave imprecise satellite locations. But using orbital mechanics and slide rules the orbit was iteratively refined. The globe mentioned was merely a convenient but coarse three-dimensional plotting surface on which the satellite's inclination and orbital tracks could easily be visualized.]

The activity up on the hill behind Stanford is now a fairly well coordinated operation. A few minutes before a "pass" staff members take their places. The radio direction finder is put into play and the operator reads observed bearings to a recording secretary at 10- to 15-second intervals. The recording equipment, tuned to the transmitting frequencies of the satellite, goes into action. Instruments scan, compute and record. Prior to this activity, the orbit has been accurately plotted on a giant plastic globe. Changes are made, new orbits are computed and, all the while, different voices are passing and periodically shouting instructions and observations which are plotted and fed to the computing center in the SRI bus, where Professor Leland E. Cunningham of the University of California works at orbit computation. [Prof. Cunningham was actually in U.C.

[1] The refinement of the story came from email correspondence from three of the SRI participants, Ray Leadabrand (May 31, 2004), Bud Rorden (May 31, 2004), and Roy Long (June 2, 2004) and from a phone conversation with Walter Jaye on June 25, 2004.

[2] Among the other SRI staff members not mentioned in the article but who were part of the vigilant group included Walter Jaye, Frank Firth, Loren Dye, Ron Presnell, Myles Berg, Ron Panton, Ralph Evans, and Howard Zeidler.

Berkeley trying to get the software of his new IBM 704 to work and didn't apparently contribute to the early calculations, which were all done by hand.] *Many persons outside the Institute have provided valuable assistance in their activity. Members from the Propagation Lab at Stanford University have coordinated their efforts with those of the SRI staff.* [Don Weaver, a colleague at Montana State in Bozeman was measuring the same things, thus helping to pinpoint the orbit. Another site with whom SRI was in contact was MIT's Millstone Hill radar. SRI was one of perhaps only four sites outside the USSR that would have been able to get a radar return from Sputnik.]

A few hundred feet away, SRI's radar van, loaded with transmitting, receiving, and recording equipment, is also a beehive of activity as the radarscopes are scanned for echoes from the satellite. "She's coming in loud and clear," someone shouts. A few minutes of concentrated activity ensue, then quietness settles over the group as "Sputnik" fades into space.

Data taken to the SRI bus, which has been pressed into service as a temporary computing center and dormitory, are analyzed. Computations are made by other volunteers who predict the time and location of the next "pass." The crew then relaxes, provided equipment adjustments or changes are not required. They sit around and sip coffee and discuss the next "pass." A few may try to catnap, but, within the hour, the satellite will be zooming in from somewhere over the Pacific. So, peaceful sleep is out of the question.

Comments

The caption on an illustration from the above-referenced Staff Notes indicates that the dish antenna had but a 12º beamwidth and thus, with the satellite traveling about 18,000 mph at an altitude of 300 miles, it would be in the beam for only about 12 seconds. While the radar apparently had the degrees of freedom to track planetary objects, it could not be programmed to do so. This meant that the dish had to be prepositioned from estimated orbital data and then the satellite's distance and rough direction would be verified when it passed through the dish's beam. A short note in the November 1957 *Proceedings of the IRE* (Institute of Radio Engineers) by Allen Peterson describes the equipment set-up and data types in detail. The SRI radar dish was a 61-ft parabolic reflector. The procedure was to first learn Sputnik's orbit from Doppler and direction finding equipment, then predict when it would over-fly the Stanford field site, and finally position the dish so that the satellite would intersect its beam. Radar echoes were obtained when the 2-ft diameter satellite came within 700 miles of the site.

The SRI group was taking the above data on the satellite's signal approximately four hours after the Russians, at about 6 pm EST on October 4, announced it was in orbit. Promotional material on SRI's radar facilities indicated that the first radar returns were obtained 2 days after the launch. But the IRE paper states that the two radar returns detected on the morning of October 9 were from what was likely co-orbiting rocket staging equipment. Then, on the morning of October 10, 1957, a radar return from the satellite itself was obtained. According to Walter Jaye, the MIT Millstone Hill radar was down for maintenance at the time and therefore, in all likelihood, these self-initiated efforts resulted in the first such radar contacts with an artificial satellite, at least outside the USSR.[3,4]

The sheer existence of Sputnik brought a rapid change in the military posture and preparedness of the U.S., particularly the importance of space-directed radar systems. Radar programs that were on the verge of cancellation were hastily renewed, including some at SRI, and SRI was immediately given a contract from the Air Force to develop ways to more accurately track these new heavenly bodies.

[3] Walter Jaye, personal communication, June 24, 2004.
[4] There is indication that the Millstone Hill radar was manually directed to also get skin reflections from Sputnik "within a few days" of Sputnik's injection. (*MIT Lincoln Laboratory–Technology in the National Interest*, edited by Eva G. Freeman, published by Lincoln Lab, 1995, pp. 111–112)

Appendix I

First Client List for SRI's Long Range Planning Service

The 74 charter participants of LRPS as of January 1, 1959.
(Companies after 74 joined later the first year.)

1. International Business Machines
2. Wellington and Company
3. Investors Diversified Services
4. Minneapolis Honeywell Regulator
5. Fireman's Fund Insurance
6. Shell Chemical Company
7. Southern Pacific Company
8. Time Incorporated
9. Dewey & Almy Chemical
10. Title Insurance & Trust Co.
11. Olin Mathieson Chemical
12. General Telephone & Electronics
13. Burroughs Corporation
14. Rexall Drug & Chemical
15. Allied Chemical Corporation
16. The Bendix Corporation
17. Lockheed Aircraft Corporation
18. North American Aviation, Inc.
19. Ford Motor Company
20. Prudential Insurance Company
21. Douglas Aircraft Company
22. Packard Bell Electronics Corporation
23. Rockwell Manufacturing Company
24. Consolidation Coal company
25. Philco Corporation
26. United States Steel Corporation
27. The Boeing Company
28. Rheem Manufacturing Company
29. Denver & Rio Grande Western Railroad
30. Stockholms Enskilda Bank
31. Goodyear Tire & Rubber Company
32. American Motors Corporation
33. Massachusetts Mutual Life Insurance
34. Dow Chemical Company
35. Hooker Chemical Corporation
36. General Dynamics Corporation
37. Ciments Lafarge
38. United Shoe Machinery
39. Union Carbide Corporaton
40. Owens-Illinois
41. Brunswick Corporation
42. Amsted Industries
43. Merck and Company
44. F.S. Moseley & Co.
45. Japan Chemical Fibres Association
46. Koppers Company, Inc.
47. Chrysler Motors Corporation
48. Bechtel Corporation
49. Underwood Corporation
50. Monsanto Chemical Company
51. B.F. Goodrich Company
52. Hughes Aircraft Company
53. Courtaulds North America, Inc.
54. Consolidated Mining & Smelting
55. Smith-Corona-Marchant, Inc.
56. Weyerhaeuser Company
57. The Lummus Company
58. Parke Davis & Company
59. Imperial Oil, Ltd.
60. The Pure Oil Company
61. Standard Oil Company of Indiana
62. General Electric Company
63. Northwestern Mutual Life Inc.
64. Puget Sound Power & Light Company
65. Baldwin-Lima-Hamilton Corporation
66. Technicolor Corporation
67. Aetna Life Insurance Company
68. Borg Warner Corporation
69. Royal Typewriter Company
70. Schwabacher and Company
71. Hercules Powder Company
72. Dean Witter & Company
73. Benton & Bowles, Inc.
74. Canada Air Lines

(later in first year)

75. American Cyanamid Company
76. Canadian Pacific Railroad Company
77. Del Monte Corporation
78. Empresa Geral de Fomento (Portugal)
79. Standard Oil Company of New Jersey
80. Food Machinery & Chemical Corporation
81. Merrill Lynch, Pierce, Fenner and Smith
82. Minnesota Mining & Manufacturing Company
83. Texas Instruments, Inc.

Appendix J
SRI Staff Awards

SRI Fellowship Award–for outstanding lifetime scientific and technical achievement

Year	Name	Contribution
1980	Edward M. Acton	Anticancer drug development
	Walter G. Chesnut	Atmospheric effects of nuclear explosions
1981	David M. Golden	Combustion products and atmospheric chemistry
	Arnold Mitchell	Consumerism and psychographic segmentation
1982	Gordon T. Pryor	Brain biochemistry and substance abuse
	Joseph H. McPherson	Facilitating human processes in innovation
1983	Ivor Brodie	Electron dynamics in vacuum, gas, and condensed matter
	Henry Wise	Surface physics of heterogeneous catalysis
1984	Margaret A. Chesney	Impact of stress on chronic health problems
	Masato Tanabe	Pharmacology of steroid hormone drugs
1985	Hewitt D. Crane	Multi-aperture magnetics, eye-trackers, signature pen
	Donald C. Lorents	Molecular energy transfer mechanisms in excimer lasers
1986	Jorge Heller	Controlled drug delivery mechanisms
	Barbara S. Vold	Monoclonal antibodies in cancer diagnosis
1987	Joseph I. DeGraw	Synthesis of antifolate cancer drugs
	Arden Sher	Properties of semiconductor alloys
1988	Philip S. Green	Medical instrumentation in ultrasound
	Ronald Swidler	Dyes, fabric modifiers, and color printing
	Oswald G. Villard, Jr.	Ionospheric-based systems and active radar stealth
1989	Gerry B. Andeen	Electromechanical devices and hydrodynamics
	Richard J. Waldinger	Theorem-proving and automatic program synthesis
1990	Thomas Piantanida	Visual perception and virtual reality
	Donald A. Shockey	Analysis of material deformation and fracture
1991	Hanspeter Helm	Ion spectroscopy, imaging in intense laser fields
	Richard C. Honey	Lidar and laser photocoagulators
1992	Charles A. Spindt	Vacuum, field-emission microelectronics
	Enrique H. Ruspini	Modeling and control of systems under uncertain conditions
1995	Mohsen Sanai	Shock propagation and impact dynamics
1996	Theodore Mill	Oxidation chemistry and its role in environmental impacts
	Eric M. Pearson	Advanced technology of military importance
1997	Gary E. Swan	Psychoneurogenetic links in alcohol and tobacco dependence
	Tom G. Slanger	Upper atmospheric chemistry and night airglow
1998	David Crosley	Spectroscopy of laser-induced fluorescence
1999	Charles Tyson	Predicting *in vivo* response to drugs and chemicals
	Earl Blackwell	Adding precision to GPS guidance and navigation
2000	Kristien Mortelmans	Screening the mutagenic potential of new drugs
	Marcy Berding	Understanding the defects in semiconductor material
2001	Keith Laderoute	Gene expression in tumor and normal cells
	Peter Neumann	Computer system integrity and security
2002	Lawrence Toll	Pharmacology of drug abuse
	David Cooper	Optical physics and laser spectroscopy
2003	Barbara Means	Introduction, use, and evaluation of educational technology
	Gregory Smith	Kinetics and chemistry of flames and other gases
2004	Jeffrey Bottaro	High energy oxidation processes
	John Rushby	Innovation, leadership in formal methods of software design
2005	Patrick Lincoln	Research in formal methods, security, computational biology
	Ripudaman Malhotra	Research in new and more efficient energy sources

SRI Mimi Award–for outstanding lifetime achievement in the mentoring and professional development of others

Year	Name	Contribution
1995	Dave Crosley	Coaching and support of young scientists
1996	Don Nielson	Proper balancing of managing and mentoring
1997	Werner Graf	Personal, professional development of co-workers
1998	Terry Middleton	Team building and negotiation
1999	Bob Brown	Sense of community and teaching of leadership
2000	Mary Wagner	Engendering confidence and competence
2001	Matty Mathieson	Team building, empowerment of professional growth
2003	Cynthia Ford	Growth, development of co-workers in info. systems
2004	Jose Blackorby	Developing skills and responsibility in new staff
2005	Christine Peterson	Fostering the prof. development, market awareness of staff

Weldon B. Gibson Award–lifetime achievement toward improvement in the general standard of living and the peace and prosperity of society and added special luster to the reputation of SRI

Year	Name	Contribution
1999	Douglas Engelbart	The origins of personal computing
2000	Edwin Robison	Leveraging the economies of developing countries
2001	The ERMA Team	The first banking computer
2002	Dennis Finnigan	Modernizing business practices, especially in Sweden
2003	Philip Green	Medical systems in ultrasound and surgery

SRI Alumni Association Hall of Fame (as of 2005)

Name	Contribution
George Abrahamson	Leadership in Sciences and overall SRI contribution
Catherine Ailes	Innovation and leadership in science and technology policy
Bernard Baker	Initiation of long-term cancer research capability
Emery Bator	Established first SRI accounting system
Frances Bohley	Administered SRI worldwide industrial conferences
Charles Cook	Growth in physical chemistry, overall SRI leadership
Dale Coulson	Analytical methods for pesticide residues
Bonnar Cox	Division leadership in information sciences
Hewitt Crane	Innovation: magnetic logic, eye-trackers, signature pen
George Duvall	Bringing Poulter Lab to international prominence
Kenneth Eldredge	Inventor of magnetic character system for bank checks
Douglas Engelbart	Value of computing to personal and group capability
William Estler	Early director of public relations; put SRI on world map
William Evans	Advancements of printing and television systems
Elizabeth Feinler	Leadership: first computer network registration service
Dennis Finnigan	Leadership in business modernization
Richard Foster	Analysis of U.S. defense systems and strategies
Michael Frankel	Military communication technology; division leadership
Gustave Freeman	Pathogenesis of human cancer and respiratory diseases
Weldon Gibson	Growth of SRI business consulting to worldwide stature
Jane Goelet	Early and long-term personnel administrator
Jack Goldberg	Leadership in establishing field of computer science at SRI
Bruce Graham	Creation of SRI's first entry into life sciences
John Granger	Leadership in building early SRI reputation in radio systems

Philip Green	Contributions to medical instrumentation
Melba Harrison	Long-time, personable SRI receptionist and supervisor
Marion Hill	Leadership in high energy compounds and their SRI programs
Charles Hilly	Long-time director of contract administration
Jesse Hobson	Second SRI director, spawned largest SRI growth
Richard Honey	Laser radar and laser photocoagulation
Earle Jones	Innovation in printing systems and lab/divisional leadership
Paul Jorgensen	Director of Sciences Group and overall SRI leadership
Fred Kamphoefner	Magnetics, optics, long-term laboratory leadership
Douglas Keough	Seismic sensor design and measurement
Ralph Krause	First Director of Research, set professional tone for SRI
Ray Leadabrand	Ionospheric radar, leadership of Engineering Group
Peter Lim	Contributions, leadership in development of anti-cancer drugs
Kenneth Lunde	Founder of Process Economics Program
Albert Macovski	Television technology and imaging
Frank Mayo	Early leadership in oxidation chemistry
John McHenry	Innovation, leadership in military systems; SRI management
Joseph McPherson	Leadership in client innovation searches
Arnold Mitchell	Creator of Values and Lifestyles program (VALS)
Chozo Mitoma	Pioneered methods for biochemical pharmacology
Tetsu Morita	Innovative lab director in electromagnetic systems
Thomas Morrin	Growth-oriented first Director of Engineering
Jean Ware Nelson	Long-term contribution to Long Range Planning Service
Gordon Newell	Leadership in toxicology
Donald Nielson	Computer networking, leadership in information science
Nils Nilsson	World-renowned pioneer in artificial intelligence
Jerre Noe	First leader of division in information sciences
Allen Peterson	Nationally known innovator in communication systems
William Platt	Operations research applied to economic development
Thomas Poulter	Early SRI leader and founder of Poulter Laboratory
Lorraine Pratt	Built library to SRI-wide importance
Kitta Reeds	Long-time editor; expert in design, writing of proposals
Edwin Robison	Improvement in the economies of developing nations
Charles Rosen	Founder and long-term leader in artificial intelligence
William Royce	Contributions, leadership in planning and economic systems
Donald Scheuch	Long-term leadership in Engineering and SRI overall
Robert Shreve	Long-term leadership in economics and management
William Skinner	Second director of Life Sciences; opened up Japan market
Felix Smith	Leadership: molecular physics and staff advisory group
Robert Smith	Founding of LRPS and opening of first European Office
Charles “Capp” Spindt	Development of field emission cathodes and applications
Marian Stearns	Education of disadvantaged children; staff mentoring
Robert Stewart	Frameworks for organizational and corporate planning
Ronald Swidler	Innovations in dyes, fabric modifiers, color printing
Larry Swift	Geophysics and blast effects measurements
Shigeyoshi Takaoka	Leading and expanding business development in Japan
Masato Tanabe	Anticancer drug development in the field of steroids
Carl Titus	SRI fund raising and builder of SRI Associates Program
Charles Tyson	Advancement in toxicology and drugs using in vitro testing
Robert Vaile	Growth and prominence of SRI role in physics
“Mike” Villard	Ionosphere-based radio systems and stealth technology
John Wagner	First director of human resources and staff advocate