Silicon Valley, INNOVATION, & *the* History of Modern Computing:

Reflections on a Conversation among Doug Engelbart, Gordon Moore, and Regis McKenna

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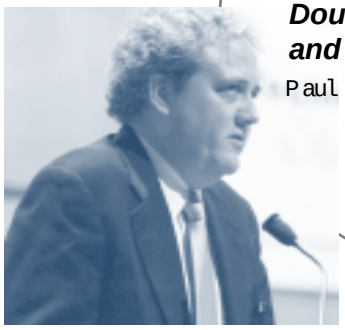

Introduction

A few short years back, when the Internet first exploded into public consciousness, one could hear all sorts of assessments of what it was and what it meant for society. A journalist for *Wired* compared it to the invention of fire—or was it the wheel? Dave Barry of the *Washington Post* said it was like "CB radio, only you type instead of talk" (he said this at a time when the Internet was still primarily a text-based medium). Some called it the greatest creation of wealth in history that did not involve doing something illegal. This latter statement has been harder to find since the collapse of the dot.com phenomenon, although it still contains a germ of truth. Historians have an interesting vantage point when surveying the phenomenon of Silicon Valley and the invention of computers and networking. They know that the claims now being made for the Internet were also made in the 1970s, when personal computers like the Apple II were first introduced. They even know of similar statements made in the 1950s about "automation" and how it would soon lead to a life of total leisure; statements made in all seriousness when vacuum-tube computers like the UNIVAC first appeared. Historians know how easy it is to get ahead of events when predicting the impact of a technology, but they also know that a genuine innovation requires a good measure of hard work, intelligence if not genius, savvy marketing, and luck.

On the evening of October 4, 2001, members of the Society for the History of Technology, the Santa Clara University community, and others from Silicon Valley community were privileged to hear a panel discussion by three genuine pioneers in computing and networking technology. The packed auditorium showed that historians also know that, even after extravagant claims are discounted, what has happened in Silicon Valley in the past 40 years has truly been remarkable, if not unique in the history of technology. The panelists were Douglas Engelbart, Director of the Bootstrap Institute and winner of the Turing Award and National Medal of Technology, Gordon E. Moore, Chairman Emeritus of the Board of the Intel Corporation, and Regis McKenna, Chairman of the McKenna Group. I was honored to serve as the moderator of the panel. From their experiences and knowledge, these are three gentlemen who know the difference between hyperbole and genuine innovation.

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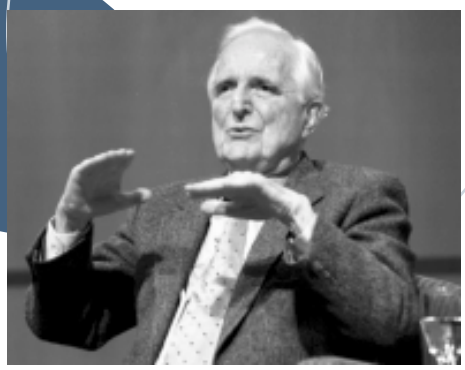
Mike Malone, whose many books and articles have chronicled the events of Silicon Valley, introduced the discussion. Setting the stage nicely with his view of what made the Valley such an innovative place, he spoke of the essence of Silicon Valley as a state of mind. Those who live here dedicate their talents to something greater than themselves. Genuine innovation, he pointed out, requires three factors: invention, company creation, and marketing. Historians often emphasize the first (sometimes the second) at the expense of the others, but all three are of equal importance. In introducing the evening's discussion, Malone noted how well the three panelists represented each of those factors, and how the efforts of each has had a significant impact on society.

Doug Engelbart: Using technology for simplifying complexity.

Doug Engelbart began the forum with a brief account of how he made the kind of commitment that Mike Malone described. After serving in the Navy and receiving a degree in Electrical Engineering after World War II, he took a job at the N.A.S.A (now NASA-Ames) Laboratory in Mountain View. Though others may have been satisfied with a good job, a family, and financial security, he realized that he was only at a beginning. He saw that increasingly the problems of the world were the result of a human inability to deal with complexity. People could devise ingenious solutions to one problem, only to have each solution lead to other more serious consequences. He then decided to dedicate the remainder of his productive life to devising ways of understanding complexity, which, if attained, could then lead to genuine progress. It was characteristic of Engelbart's comments that he felt his efforts were not achieving success, in spite of his development of many tools that have indeed enhanced our ability to deal with complexity. He is, of course, best known as the inventor of the computer mouse, a development that occurred in the context of his work on collaborative sharing of knowledge and information. To Engelbart, the irony was two-fold. On the one hand, he expressed acute awareness of the limitations of the World Wide Web, navigated to be sure with a mouse, even as it has been so enthusiastically embraced. Comparing the Web to the systems of collaborative computing that he has been working on since the 1960s, he found the Web wanting. And, although he recognized the advances in storage, communication, and processing of information that have occurred, he found those advances wanting as well.



Engelbart acknowledged networked personal computing has enormous potential to manage complexity. But he stressed that these systems are not keeping up with the increases in complexity of world problems. Engelbart's vision is for self-enhancing, knowledge-based systems that can be used to accelerate learning, problem-solving, and the development of new ways of organizing information and people to solve complex and urgent problems.

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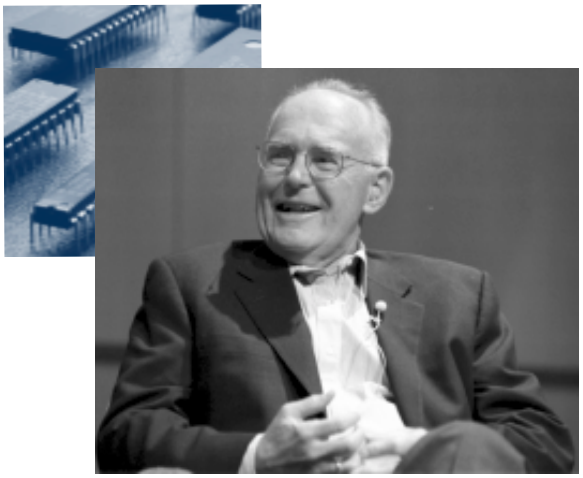
Describing his quest to simplify complexity, Engelbart was characteristically modest as he shared the discussion with two recognized masters at bringing technology to the marketplace profitably. Yet a sympathetic audience recognized his role as the originator of the ideas that were the foundation for profitable innovation.



Gordon Moore: Improving the costs and power of semiconductors.

If the public knows of Doug Engelbart as the inventor of the mouse, likewise it knows of Gordon Moore as the name behind "Moore's Law," an empirical observation about the rate at which semiconductor electronics has advanced since the 1960s. In his opening remarks, Gordon Moore joked about his fame coming from what was simply a matter of plotting some data on a piece of semi-logarithmic graph paper, something that most engineers in Silicon Valley did (and still do) as a matter of routine. Less well-known or understood are his decades of hard work in the trenches, first at Shockley Semiconductor, then at Fairchild, and finally at Intel. Likewise he is not famous, but should be, for instilling and preserving an innovative focus and culture at Intel, the company he co-founded with Robert Noyce in 1968. Now in an emeritus position at Intel, Moore enjoys his fame for the opportunity to address his view of the history and future of innovation in Silicon Valley.

In his opening remarks, Moore recalled that he got involved with the field from "exactly the opposite end that Doug did." He got involved from the bottom up, so to speak, in the semiconductor components that are the basis not only of all today's digital computers, but also of all other digital electronic equipment. The triggering event was the invention of the transistor at Bell Labs, in New Jersey, in 1947. One of the inventors of the transistor, William Shockley, left Bell Labs to commercialize the invention, and moved to what was then an agricultural region below San Francisco. Moore noted that the reason was that Shockley's mother lived in Palo Alto and he wanted to be near her. Observers have suggested a host of other reasons for the emergence of Silicon Valley, but Moore reminded the audience that sometimes big things happen as the result of small, unexpected events. Moore, a chemist by training, joined Shockley's company as the eighteenth employee in 1956.

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The transistor, which replaced the bulky and fragile vacuum tube, was followed by two other inventions, both of which also contributed significantly to the growth of Silicon Valley. The second invention was the integrated circuit, initially demonstrated by Jack Kilby of Texas Instruments, although it was Robert Noyce of Fairchild who first built an integrated circuit that could be mass-produced. The third key invention was the microprocessor, introduced commercially by Intel in 1971. Moore recalled how he and his fellow Intel employees sought to convince customers to use the microprocessor in their designs. Among those they convinced was IBM, which chose an Intel microprocessor for its Personal Computer in 1981. At the time it seemed like just another design win, but it proved to be of critical importance to Intel and to the direction of computing ever since. He ended his opening remarks with the observation that the "(semiconductor) industry now produces as many transistors every year as printed characters…in all the newspapers, books, magazines…something on the order of 10 to the 17th power transistors a year…"

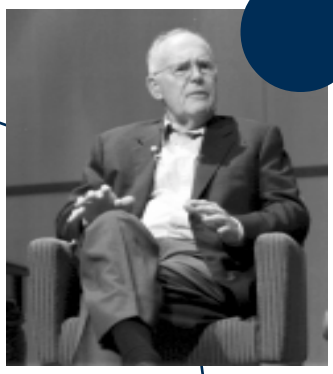
Regis McKenna: Marketing the Microprocessor

The third panelist, Regis McKenna, opened his remarks by questioning how he, a marketing specialist, fit on a panel with such distinguished technologists like Engelbart and Moore. As he described his early days in Silicon Valley, however, it became clear that marketing really was very important to the growth of Silicon Valley. Only through significant marketing efforts did exotic devices like microprocessors find their way into every corner of the modern global economy. Only through both innovation and marketing could Silicon Valley have the impact on the world that it has had.

McKenna pointed out that the microprocessor made obsolete the notion that one could have the advantages of mass production only by paying the price of conformity and inflexibility. In other words, thanks to the microprocessor, "diversity costs no more than uniformity." The microprocessor, and devices like the EPROM (Electrically Programmable Read-Only Memory), when applied to electronic devices, reversed the classic marketing statement, attributed to Henry Ford, that people could have any color Model T they wanted as long as it was black. The implications for a consumer society are enormous, and we are still living in the midst of the revolution this innovation has created.

The Significance of Silicon Valley

The discussions that followed focused on the origins and uniqueness of Silicon Valley. Gordon Moore reminded the audience that Shockley's decision to move from the East Coast was a purely personal decision and has no relevance for those who wish to recreate such a climate of innovation elsewhere. Moore disagreed with those who emphasize the role of Stanford University, specifically the emphasis on the role of Professor Frederick Terman, who encouraged his students William Hewlett and David Packard to start a company in Palo Alto. While Moore acknowledged that Hewlett-Packard is one of Silicon



Valley's largest technology companies, he suggested that its corporate culture does not reflect the essence of the Valley. People rarely leave H-P to found other companies, he noted, while "spinning-off" to start companies is the norm elsewhere in the Valley. Alumni of Shockley Semiconductor and the "Fairchildren" (employees who once worked at Fairchild Semiconductor) are legendary as founders of the companies that give the Valley its dynamism. Moore himself has a degree from Cal Tech, and Bob Noyce, the co-founder of Intel, completed his advanced degree at MIT. Moore also pointed out that "semiconductors are not an academic discipline," and he felt that the research and development being done at companies like Intel generally is ahead of academia.

The other panelists further pursued this discussion of the origins of Silicon Valley. Doug Engelbart recalled how the Advanced Research Agency (ARPA) funded much of his research, and he gave generous credit to one of its directors, J.C.R. Licklider, for having the courage to support what, at the time, was far in advance of the prevailing paradigm of computing. McKenna likewise discussed how Apple Computer, with its Lisa and later Macintosh products, was an "honorable thief" in bringing ARPA research to the consumer. McKenna not only saw nothing wrong with commercializing technologies developed elsewhere, he forcefully argued that this ability to bring products to market is the real strength of Silicon Valley. He stated that in the Valley "Research and Development is spelled with a small 'r' and a big 'D'." The fundamental research that underlies Silicon Valley's products comes from elsewhere. Moore echoed this sentiment and stated that basic research is a "legitimate function of government" and ought to receive government support. He also wondered how the American technology will fare now that Bell Labs no longer has the support it had when AT&T, its parent, was a regulated monopoly. He described the Valley as a great place to start a company but a poor place for it to grow. For many reasons, only a small percentage of Intel's employees work in the Valley, and Intel's employees in Oregon actually generate more patents for the company. But he said that if he were to start up a new company today, he would still consider Silicon Valley the place to do it.

McKenna pointed out that this ability to bring products to market was more than simply gauging consumer demand and meeting it. If that were the case then Silicon Valley's success could be more easily replicated elsewhere. He felt that innovators in Silicon Valley had an instinct for knowing what consumers will want, before the consumers themselves knew it. Furthermore, innovation in Silicon Valley combines that instinct with a relentless drive to pursue a vision, even if the vision contradicts conventional wisdom or data from marketing surveys. At several times during the evening, McKenna related his experiences with Steve Jobs, who, McKenna said, did not even wear shoes when he first came to McKenna for advice in

setting up Apple. But Jobs had a vision of personal computing and a desire to carry that vision through. This type of desire and vision drove not only Apple but drives most other successful Valley companies as well.

It was not clear, however, whether desire and vision can solve the fundamental problems of complexity in today's society that Doug Engelbart identified and that he hoped technology could address. Start-up companies tend to have a close horizon, pursuing developments that are not too far from potential commercialization. Bringing the ideas from their initial point of conception to a point where they can be so exploited may have to be a different type of innovation, more suited for a different environment, or a different type of company than found in Silicon Valley.

Concluding Discussion

The initial panel discussion was followed by a lively set of questions from the audience. Many were interested in Regis McKenna's perspective as a marketing person whose contribution to companies like Intel and Apple were not as well-known to the historians in the audience as were contributions of people like Jobs or Gordon Moore. McKenna talked about the negative image of the marketer and contrasted this image with the way marketing in the Valley drew its strength and direction from the engineers. Marketing was not a management-driven activity, and as long as it remains that way, then the experience of Silicon Valley indicates that marketing will not become disconnected from the core activity of the company (as often portrayed in the *Dilbert* comic strip, observed a member of the audience).

While Regis McKenna and Gordon Moore emphasized how well the culture of innovation in the Valley worked, Doug Engelbart continued to see a half-empty glass. He reminded everyone of how difficult, if not impossible, it has been to make accurate predictions about even the basic direction of computing technology a few years into the future. And he wondered about human beings' ability to understand a phenomenon when there is a huge change of scale, as the computer went through after the invention of the integrated circuit, and as now appears to be happening with the development of so-called "nano-technology," devices that are built one molecule at a time. Engelbart was aware that his view differed from the more optimistic views of the other panelists. But many in the audience agreed with his point of view.

It would be impossible to sum up the essence of the evening's exchange of ideas, other than to say that everyone learned something. As one who had studied and written about the work of these three gentlemen, I certainly found the discussion informative. Perhaps the best facet of the evening's talk was how it focused on serious and thought-provoking topics, never straying into the hyperbole and fiction that too often has been the public image of Silicon Valley.

About the Author

Paul E. Ceruzzi is Curator of Aerospace Electronics and Computing at the Smithsonian's National Air and Space Museum in Washington, DC. He is the author or co-author of several books on the history of computing and related topics: *Reckoners: The Prehistory of The Digital Computer* (1983); *Smithsonian Landmarks in the History of Digital Computing* (1994, with Peggy Kidwell); *A History of Modern Computing* (1998); and *Beyond the Limits: Flight Enters the Computer Age* (1989). He recently co-edited, with James Trefil and Harold Morowitz, the *Encyclopedia of Science and Technology* (Routledge, 2001). Dr. Ceruzzi attended Yale University and the University of Kansas, from which he received a Ph.D. in American Studies in 1981. His graduate studies included a year as a Fulbright Scholar at the Institute for the History of Science in Hamburg, Germany. Before joining the staff of the National Air and Space Museum, he taught History of Technology at Clemson University in Clemson, South Carolina.