A Lifetime Pursuit

by Christina Engelbart

From a Biographical Sketch of Douglas C. Engelbart

Douglas Carl Engelbart has a life-long track record in predicting, designing, and implementing the future of organizational computing. The grandson of early pioneers of the West, he grew up during the Great Depression on a small farmstead near Portland, Oregon. After graduating from high school in 1942, he went on to study electrical engineering at Oregon State University. World War II interrupted his studies for the Navy, where he served for two years in the Philipines as an electronic/radar technician. After completing his B.S. in electrical engineering in 1948, he settled contentedly on the San Francisco peninsula as an electrical engineer at NACA Ames Laboratory (forerunner of NASA).

However, within three years he grew restless, feeling there was something more important he should be working on, dedicating his career to. He thought about the world's problems, and what he as an engineer might possibly be able to do about them. He had read about the development of the computer, and seriously considered how it might be used to support mankind's efforts to solve these problems. As a radar technician he had seen how information could be displayed on a screen.

He began to envision people sitting in front of cathode-ray-tube displays, "flying around" in an information space where they could formulate and portray their concepts in ways that could better harness sensory, perceptual and cognitive capabilities heretofore gone untapped. Then they would communicate and communally organize their ideas with incredible speed and flexibility. So he applied to the graduate program in electrical engineering at the University of California, Berkeley, to launch his crusade. Berkeley had a serious R&D program for developing a general-purpose digital computer, the CalDiC. There was no computer science department at that time; the closest working computer was probably on the eastern side of the country, with MIT's Project Whirlwind.

He obtained his Ph.D. in 1955, along with a half dozen patents in "bi-stable gaseous plasma digital devices," and then stayed on at Berkeley as an acting assistant professor. Within a year, however, he was tipped off by a colleague that if he kept talking about his "wild ideas" he'd be an acting assistant professor forever. So he ventured back down into what is now Silicon Valley, in search of more suitable employment.

He settled on a research position at Stanford Research Institute, now SRI International, in 1957. There he earned another dozen patents in two years of working on magnetic computer components, fundamental digital-device phenomena, and miniaturization scaling potential.

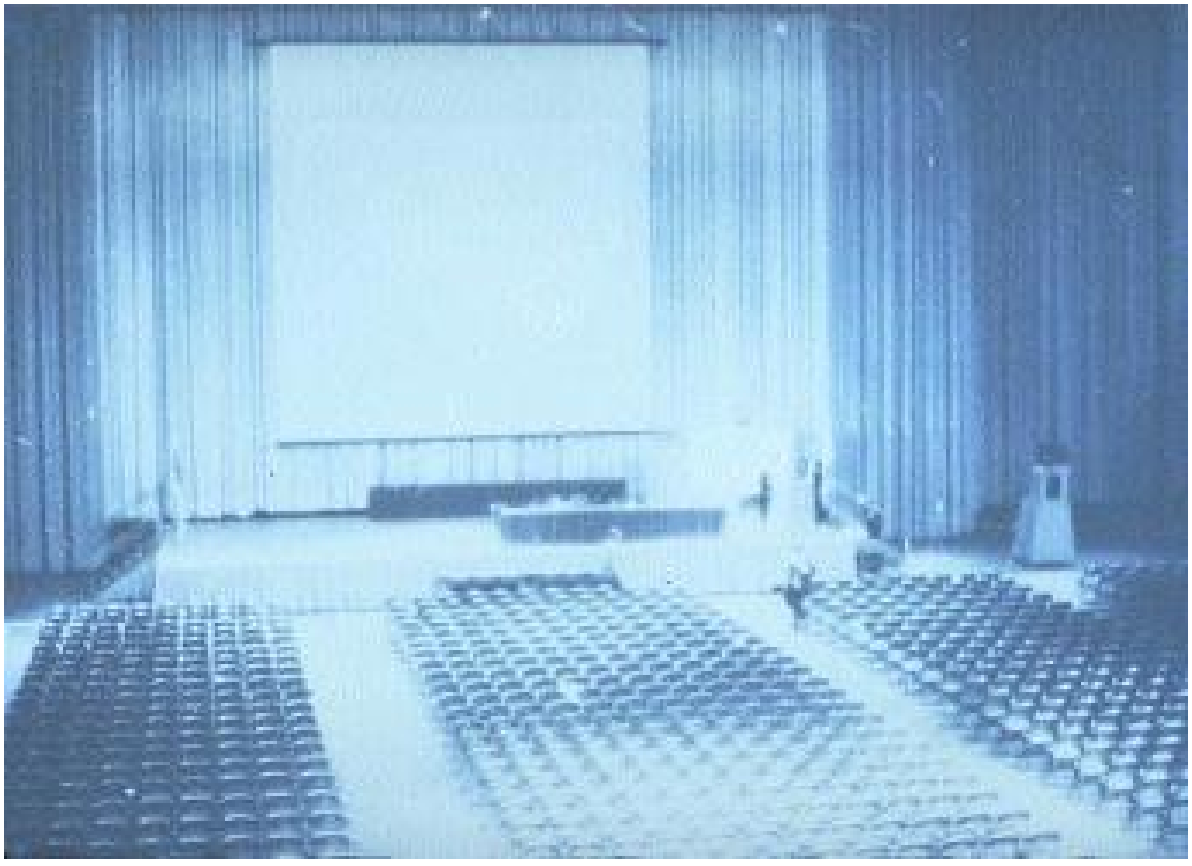
By 1959 he had enough standing to get approval for pursuing his own research. He spent the next two years formulating a conceptual framework for a new discipline that became the guiding force for his 1962 seminal work, "Augmenting Human Intellect: A Conceptual Framework," under contract prepared for the Director of Information Sciences of the U.S. Air Force Office of Scientific Research.

Concepts such as augmenting human intellect, improvement infrastructure, co-evolution of artifacts with social-cultural language-practices, and bootstrapping evolved directly from this work, as did the following twenty years of applied co-evolution. Motivating that framework were, and still are the assumptions that complexity and urgency are increasing exponentially and that the combination of these two will soon challenge our organizations, be they private or public, to henceforth do their changing by effective, continuing strategic principles rather than in incremental steps. Therefore, in addition to aspiring to be increasingly faster and smarter at their core missions (whether creating better widgets, or solving societal problems), organizations will need to get increasingly faster and smarter at how they keep improving. Engelbart saw both organizational missions as relying heavily on a common set of core capabilities, which he encapsulated in the term human intellect. Later, he began using the term knowledge work after reading a '68 Peter Drucker publication, and later still, more purposefully, switched to the larger, centrally significant concept of collective IQ.

His thinking prompted assessment of the infrastructure of capabilities that support the operation of organizations of collectively purposeful humans, capabilities developed atop their genetically endowed capabilities to provide their personal and collective operational effectiveness. A myriad of technical and non-technical elements came into play, such as tools, media, language, customs, knowledge, skills, procedures, and so on. He perceived that these elements had co-evolved slowly over centuries, but that with the explosive emergence of digital technology, the technical elements would shoot way ahead of the non-technical and cause a trend toward automating rather than to augmenting peoples' activities. It would be necessary, therefore, to gain a grip on the elements of that ever accelerating co-evolutionary process, which means purposefully focusing in on the infrastructures of society's activities, those that serve to improve our collective capabilities.

From this emerged the basic concept of bootstrapping. Purposefully investing in improving organizational collective IQ through intelligent improvement strategies promises to yield compound returns. In simple words, the better we get at our collective IQ, the better we'd get at improving our collective IQ.

Early programmatic targets were to create advanced pilot "outposts" well beyond the frontiers of current activities, outposts staffed by highly capable knowledge workers and subject experts to experiment and explore future modes of working. In the spirit of this bootstrapping strategy, Engelbart proposed that an early target for these workers should be augmented support structures for organizational improvement activities, especially by raising the competence of the designers, implementers, and deployers of tools and practices.



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From hope to glory. San Francisco's Brooks Hall set up for the historic demonstration of the computer mouse, hypermedia, and on-screen video teleconferencing, 1968.

It was in 1963, an outcome of the proposal written for the Air Force, that he began receiving the funds for his own research laboratory, which he later dubbed the Augmentation Research Center. The evolution of his laboratory over the next fifteen years followed this strategy, and its extended record of unusually creative and coherent tools and work processes can to a considerable extent be traced to the fact that everybody worked the new way -- programmers, designers, project managers, application-support staff, and the considerable array of pro-active end-user organizations supported through the ARPANet from 1974 into the late '80s.

The year before, the Defense Department's Advanced Research Projects Agency (ARPA) had brought to Washington a man who made a singularly important difference in the history of computers and networks. Dr. Joseph C. R. Licklider (always called Lick) came from Harvard, via the Cambridge consulting firm of Bolt Baranek and Newman, with an unusually open charter to foster research associated with the theme on which he himself had previously published, "Man-Computer Symbiosis," and toward the technology necessary to do "time sharing" of a computer's processing power between a number of concurrently active on-line users.

Because Engelbart's published framework of 1963 and the pursuits proposed therein were so much on line with his, Licklider began steering funds to him despite voiced misgivings of some of his colleagues -- something that came into the open some years later from unguarded chatter by some of them at a cocktail party. "Nothing personal, you understand," it's just that "way out there in Palo Alto, there isn't the computer and programming talent to justify investing good R&D dollars." The year before, a proposal made to a government funding agency had been turned down in almost those exact words in spite of being rated as "a very interesting proposal."

The first two years of ARPA support were relatively unproductive -- problems in aligning actual work with bootstrapping concepts, which were deemed inappropriate by prevailing paradigms of management, engineering and computer programming. Meanwhile a fortunate bit of funding arrived from a NASA psychologist named Bob Taylor. (Later, Taylor moved to ARPA and became a significant factor in launching the ARPANet.) That started a project to experiment and evaluate various available "screen selection" devices -- pointers -- to see which would be most appropriate for use in on-line computer interaction. Engelbart proposed the research, and was listed as the Principle Investigator, but it was his friend Bill English, an extremely effective engineer and organizer, who put together the tests and analyses which yielded the effective results. Engelbart had thought of the basic idea for the computer mouse several years before and, almost incidental to this, suggested with a few simple sketches that maybe building and testing this kind of a device would help round out the experiments. So, Bill built it, and some unknown person in the small group of designer, programmer, machinist, test subjects -- no one can remember who -- started referring to it as the mouse. And it just happened to win the tests; and people on the project began building and using them throughout the following fifteen years.

The Augmentation Research Center was developing the kind of technology that Engelbart believed would be required to augment human intellect, and to support the bootstrapping/augmentation process as well. Throughout the '60s and '70s, the lab pioneered an elaborate hypermedia-groupware system called NLS (for oN-Line System) most of whose now-common features were conceived of, fully integrated and in everyday operational use, by the early 1970s (see table).

In the Spring of 1967, it was announced that the thirteen ARPA-sponsored computer research labs, including the Augmentation Research Center, would be networked to promote the sharing of resources. Engelbart was thrilled. The ARC became the second host on the ARPANet, which he viewed as an excellent vehicle for extending his lab's NLS provisions into a collaboration distributed well beyond the confines of his ARC. He also perceived NLS as a natural to support an on-line directory of resources and therefore he proposed that ARPA support a Network Information Center (NIC).

During the 1968 Fall Joint Computer Conference (a semi-annual joint meeting of the then major computing societies) held in San Francisco, the ARC lab harnessed some leased video links to the conference site, borrowed an unusual, new device that could project dynamic video brightly onto a 20-foot screen needed to provide readable NLS screens in a space holding 1000-plus attendees. At a special session, Engelbart, operating NLS from the stage through a home-made modem, used NLS to outline and then concretely illustrate his ideas to the audience while members of his staff (with their faces shown on the screen) linked in from his lab at SRI. A standing ovation concluded this "mother of all demos," the first public demonstration of the computer mouse, of hypermedia, and of on-screen video teleconferencing (Ref. 1).

The augmentation framework requires an effective integration of psychology and organizational development with all these advances in computing technology. Engelbart strongly believes that the co-evolution of human natural capabilities and those of artifacts should be based on rigorous exploratory use in a wide variety of real-world applications (Ref. 2). Therefore, in the mid-70s, he began building up a community of users via the ARPANet. These knowledge-work architects collaborated in pilot trials and the establishing of future requirements.

From the beginning, Engelbart applied a bootstrapping strategy by using NLS for distributed collaborative software engineering, technology transfer, and community support (Refs 3, 4, 5). Not only did his knowledge-work architects use the NLS, but the entire R&D operation did. The system was further developed and maintained by using NLS in creating structured hypertext files with links between the source code, design documents, specifications, bug reports, change requests, think pieces, commentary, rationales, customer records, and so on. At its peak, Engelbart's ARC lab had grown to 47 people, including the Network Information Center. (For a more detailed autobiographical rendition of his "odyssey" since 1951 (Ref. 6).

Among the Augmentation Research Center's Pioneering "Firsts"

- the mouse
- 2-dimensional display editing
- in-file object addressing, linking
- hypermedia
- outline processing
- flexible view control
- multiple windows
- cross-file editing
- integrated hypermedia email
- hypermedia publishing
- document version control
- shared-screen teleconferencing
- computer-aided meetings
- formatting directives

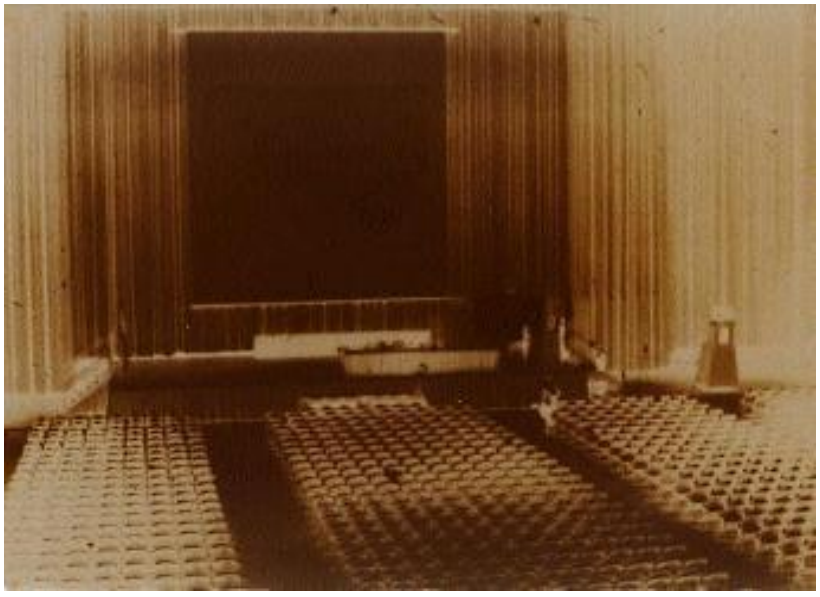
- context-sensitive help
- distributed client-server architecture
- uniform command syntax
- universal "user interface" front-end module
- multi-tool integration
- grammar-driven command language interpreter
- protocols for virtual terminals
- remote procedure call protocols
- compilable "Command Meta Language"

Said Doug Engelbart, "Many of those firsts came right out of the staff's innovations -- even had to be explained to me before I could understand them. They deserve more recognition."

In 1977, SRI sold their commercial rights to NLS, along with its service business of supporting customer organizations over the ARPANet, to Tymshare Inc. of Cupertino, CA. Engelbart continued to direct the Augmentation Research Center until early 1978 when the lab was closed down for lack of funding. NLS then became the principal line of business in Tymshare's newly formed Office Automation Division, but under a new name, Augment. The name change brought with it a switch from R&D to commercialization. In spite of Engelbart's efforts, the human/organizational work was cut off, including his carefully cultivated user group.

In 1984, Tymshare was acquired by McDonnell Douglas Corporation, where Engelbart began working closely with the aerospace components on issues of integrated information system architectures and associated evolutionary strategies. It was a welcome extension of his work at SRI.

McDonnell Douglas Corp. terminated Engelbart's laboratory in 1989. The corporation's executive had little regard for the work done by the laboratory. In fact, Engelbart's work was talked about with derision. He and about 18 other ARC staff then followed NLS into the commercial/industrial world with some 13 ARC staff ending up at Xerox PARC while some remained to operate the NIC. That year also saw his house go up in flames while he and his family found themselves in their night attire standing among a crowd of onlookers.



Heart of darkness. In 1989, the ARC was closed down. It was as if a lifetime had been wasted on an obsession.

Engelbart's idealism never made it easy on him. Through the years he has been misunderstood, told he was dead wrong, ridiculed, or simply ignored, which many say is to be expected when one is "20 years ahead of his time." But with each new wave of the computer revolution unfolding (e.g. office automation, personal computing, groupware, hypertext), and people's experience became more aligned with Engelbart's vision, they would typically say "OK, now I see what he was trying to do." Problem is, people are still looking at his past accomplishments while he himself continues to point to the future.

During the last two decades, thousands of knowledge workers in industry and government have benefited from the unique team support capabilities of NLS and its evolutionary successor, Augment. There has been a surge of interest and exploration in the new interrelated topics of computer-supported co-operative work, groupware, and hypermedia. It is now recognized that Engelbart's emphasis at SRI on supporting collaborative work, and associated systems development, not only clearly anticipated this major trend, but produced in NLS/Augment what is still the most comprehensive system for supporting wide-area collaboration (Refs 7, 8, 9).

In recent years, Engelbart has been heartened by the movements in total quality, business process re-engineering, reinventing organizations, concurrent engineering, groupware, hypermedia, the World Wide Web, and all the impressive networks of improvement activities sprouting up all over the world. He hopes that enough synergy can be generated among these activities to ignite a serious, thriving bootstrapping activity -- a collaborative improvement community aimed at spawning those vast improvements in our organizations that will boost mankind's collective IQ to unforeseen heights.

This bootstrapping community would jointly pioneer future work modes, enabled by advanced, rapidly evolving prototypes, and pioneer better and better strategies for designing, implementing, and transforming those work modes into common practice. The community would act as rigorous beta testers of their R&D results, a staging area for implementing and evaluating pilot trials, and a focus for anticipating industrial requirements and much needed industry standards in this arena (Refs 10, 11).

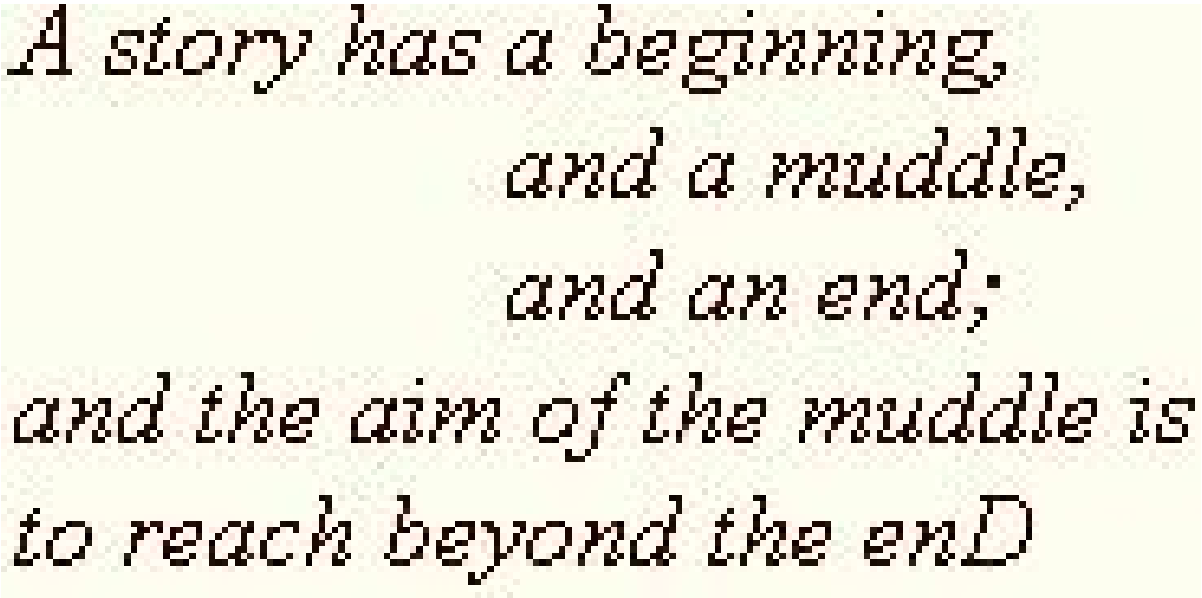
In 1989, after he and his team were unceremoniously disposed off by McDonnell Douglas, Engelbart and his daughter Christina founded the Bootstrap Institute as a California Corporation. Actually, it has functioned more like a non-profit organization in a quest to form strategic alliances aimed at dramatically improving organizations and society at large. They felt the time was ripe to pursue in earnest his comprehensive strategy for "bootstrapping organizations into the 21st century."

Engelbart's focus continues to be on creating high-performance organizations by fostering bootstrapping communities, researching and developing the enabling technologies, best practices, and special strategies for developing and deploying these capabilities on a continuous improvement basis, with pro-active participation from stakeholders in government, industry, and society (Refs 12, 13). Engelbart now divides his time between R&D, consulting, publications, speaking engagements, and leading seminars, workshops, and guiding an enthusiastic team of volunteer professionals in the designing of a prototype open-hyperdocument system (OHS).

Doug Engelbart has authored over 25 publications, and generated 20 patents, including the patent for the mouse. He is the recipient of many honors, notably the Lemelson-MIT Prize, received in 1997 with a check for $500,000, and, on December 1, 2000, from the hands of President Clinton, the highest award for technological achievement the United States has to offer, the National Medal of Technology.

Engelbart's office is located at the operational headquarters of Logitech, the world's largest supplier of computer mice, where he is assisted by Mary Coppernoll, his coworker for 15 years, as well as by Bootstrap Institute volunteers. He and Ms Coppernoll are linked through an Augment emulation running on Windows. Recently, he was delighted to discover his nameplate on an empty office at SRI International, among the offices of many of his friends.

Doug Engelbart, 77, continues to lead an active life in the San Francisco Bay Area, in close proximity to his four children and nine grandchildren. His wife of over 40 years, Ballard, died three years ago. He has enjoyed exercising, hiking, camping, sailing, reading, folk dancing, bike riding (although he appeased his wife long ago by giving up trick riding), raising ducks, earthworms, and bees, making up science fiction fantasy stories for children and giving science lectures to his wife when she had trouble sleeping, and any excuse for a family gathering.



Footnotes:
Re Christina Engelbart. Daughter of Douglas Engelbart and co-founder of the Bootstrap Institute. She wrote the original version of this biography in 1986. At the webmaster's request, Doug Engelbart has elaborated on specific points and updated some of the information.

Re J.C.R. Licklider. The story of Joseph Carl Robnett Licklider and many others, including Doug Engelbart, has been told by M. Mitchell Waldrop in "The Dream Machine: J.C.R. Licklider and the Revolution That Made Computing Personal" (Penguin Books, 2001).
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