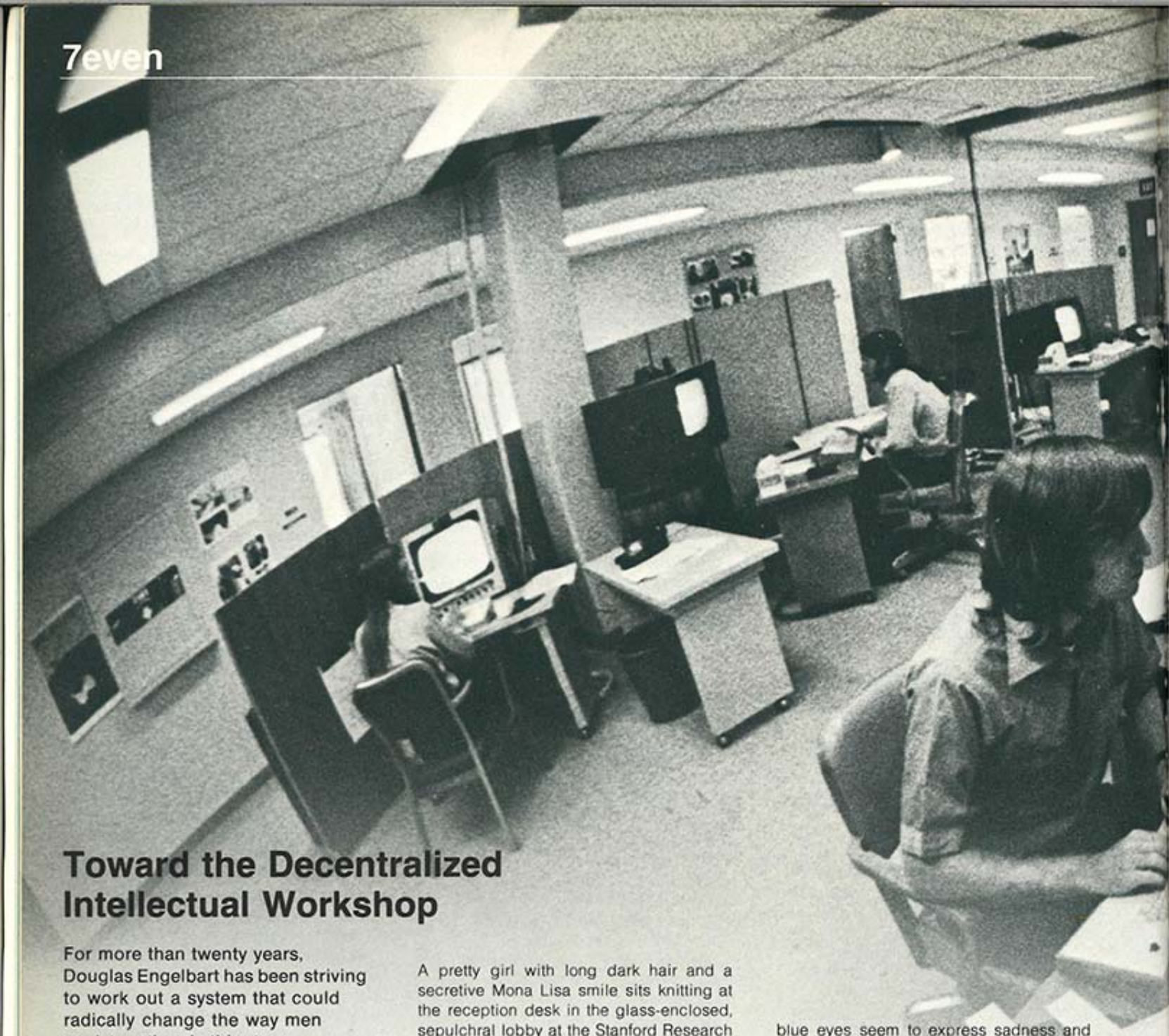


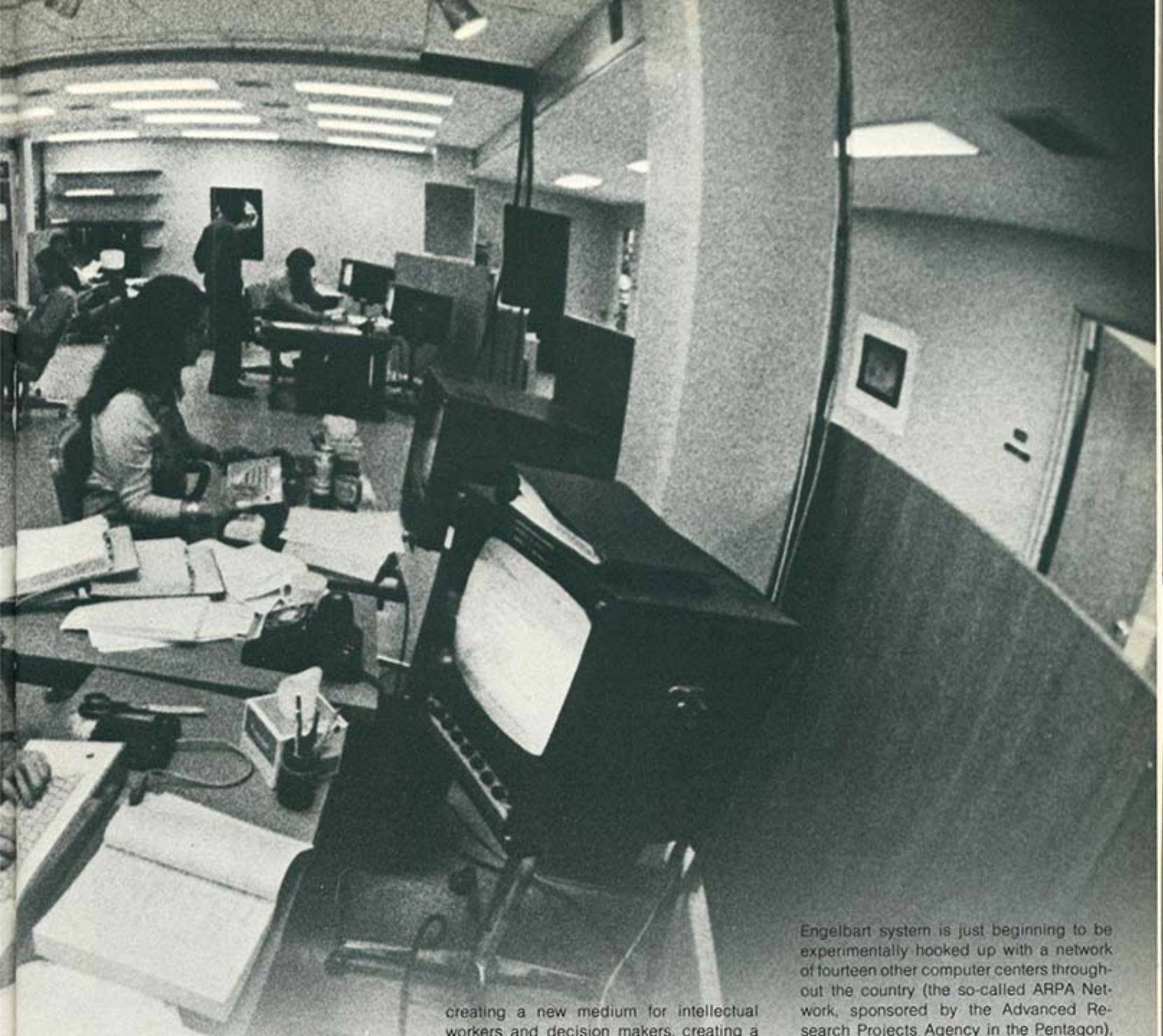
Toward the Decentralized Intellectual Workshop

For more than twenty years, Douglas Engelbart has been striving to work out a system that could radically change the way men work together. In this story • Nilo Lindgren • tells about the man, his dream, and the man-machine "augmentation system" that probably lies in the future of your own organization.

A pretty girl with long dark hair and a secretive Mona Lisa smile sits knitting at the reception desk in the glass-enclosed, sepulchral lobby at the Stanford Research Institute in Menlo Park, California. She barely looks up as she pushes a clearance form forward for the visitor to fill out while she telephones upstairs. She continues knitting, not bothering to look out at the big gnarled live oaks that shade the parking lot outside Building 30. In contrast to the high-pressure clack of the lobbies of the Bay Area semiconductor companies not many miles away, one feels that one has stepped into the atmosphere of a heavy and silent, but cool, summer afternoon.

Before a minute passes, however, that impression is dispelled as one sees, coming down a long glassed-in corridor at almost a loping stride, the broad-shouldered, athletic frame of a man with prematurely gray hair. He seems to break through the glass door into the lobby, and extends a large hand. When he smiles, his face is wistful and boyish; but once the energy of his forward motion is halted and he stops to ponder, his pale blue eyes seem to express sadness and loneliness. Doug Engelbart's voice, as he greets you, is low and soft, as though muted from having traveled a long distance, as though his words have been attenuated by layers of meditation. There is something diffident yet warm about the man, something gentle yet stubborn in his nature that wins respect.

All through the years, he has been trying to tell "somebody" about what he felt was the significance of what he was trying to do and of what he has already accomplished. But these efforts in the past left him largely frustrated, waiting outside the door. People in the computer world thought he was trying to talk about computer issues, but that wasn't it. Doug was interested in changing the nature of the way people work together intellectually through a systemization of all their tools. And the computer, in his view, was bringing in a "completely new dimension" of such tools.



As he and I sit in his office by a low console with a keyboard of buttons and a large glowing cathode-ray tube (or CRT) on which appears a long list of incomprehensible words and numbers, he clasps his hands behind his head and slowly jockeys his weight in his swivel chair. With an expression of deep puzzlement, he says, "It's just curiously slippery the way my augmentation system doesn't quite fit into place within the more recognizable patterns of people's pursuits."

Part of the difficulty stems, as Doug knows, from the fact that his computer-based "augmentation system" has its goals cast in an unusual strategic framework. Part of it stems from the fact that the system is a mix of very high technology in which the human users are highly interconnected. And part of it stems from his own intuitive descriptions that spring out of a vision ahead of its time. Doug has been creating a new medium for intellectual workers and decision makers, creating a new language for the medium, and creating new ways for people to work closely together. The dynamics and interactions of this evolutionary system of people, machines, processes, and languages are difficult to describe simply. Engelbart has been misunderstood so many times, and not understood deeply enough so often, that he has grown wary.

Yet, this time when I visit him, he seems to feel the time is getting ripe. Doug takes me on a tour through the huge roaring computer room in the core of the building, permeated with the smell peculiar to heated electrical equipment. He calls it the "engine room," the heart and the memory of the great electronic information vehicle he believes will come to have a profound effect on the work habits and methods of those whom Peter Drucker calls the "knowledge workers." Another outward sign of definite progress is the fact that the Engelbart system is just beginning to be experimentally hooked up with a network of fourteen other computer centers throughout the country (the so-called ARPA Network, sponsored by the Advanced Research Projects Agency in the Pentagon), for which the center at SRI will serve as a central information service.

But though Doug foresees his system—he has called it a system for augmenting the human intellect, or AHI—reaching a point in the next few years when it will begin to have an "avalanche effect" and pull in more and more users, he is still cautious about raising premature expectations. Pointing about the engine room, he calls it a "fairly primitive, rough, hand-run thing." Yet he also expects it to become the basis of a large industry; he is relying on the creation of such an industry, as the costs for the system use come down and as its intrinsic value goes up.

"I'll bet you ten dollars against one," he says seriously, "that if you stay in your profession, in ten years you personally will be working on a console." The whole business of computer time sharing, of network-

ing, resource sharing, terminals, all that, is moving so absolutely fast.

By "you," Engelbart means all of *us* . . . writers, research professionals, managers, executives . . . all those who would find it enormously useful to have access to systems of manipulating information multidimensionally, at great speed and with great flexibility; systems which will not only facilitate the efforts of teams of knowledge workers, but which also force us to rethink all our usual methodologies and techniques.

Moreover, Engelbart looks to the day—a year or two from now—when he will be able to open up his augmentation system and use it to link up with and engage in dialogues with people such as those who are concerned with management systems and management research. So it is not too soon to begin discovering what Engelbart has been so persistently and so perseveringly pursuing at SRI for the past decade.

There is another, closer reason for weighing the nature of this research. Engelbart has discovered that the evolution of high-technology systems such as his, which requires the intimate cooperation of many people and machines, produces unusual organizational and managerial problems. These are the special problems associated with creating a good research environment in which people will accept real change and move with it. Just as the telephone radically changed all working relationships and procedures, so will the fundamentally innovative information-handling systems now being developed. Because this system is a seed for such systems that lie in the future of many organizations, the way the people involved interact through and with the system contains some clues (touched on later in this story) about the working relationships we may expect in the future.

Being intellectually "augmented" with such a system produces some scary elements too . . . like the way people react when the system "crashes" or is shut down. Once augmented, it seems, it is difficult to turn back to the "ordinary" tools of the intellectual trades—pencils, paper, typewriters, books.

Up until now, Engelbart's project has gone forward in relative isolation. It is, remarks a young engineering associate at SRI, as if the project has lived in a valley for many years, and supplies were air-dropped to it from time to time. But now it was time for the project to make contact with the world, because the project has things the world can use, but also because the project needs a real-world feedback. So now, suddenly, "it is as if people are coming into this valley with bulldozers and roads, and these are going to exert a whole different set of demands on the people in the valley."

The most fascinating ingredient of this story, to my mind, is Doug Engelbart himself. What drives him, what has sustained him, the philosophic backbone of his perseverance, the agonized, gentle, and prolonged quest to fulfill the dream he found twenty years ago. As a searcher, he strives to bring into being the seed of a fundamental change which, to grow fruitfully in the long run, will require the collaboration and assistance of many others.

Steps toward a new kind of information vehicle

Douglas C. Engelbart is not unlike the protagonist of Alan Sillitoe's novel, *The Loneliness of the Long-Distance Runner*. A loner, jogging on his own long course, to his own music, misunderstood, vexingly and sometimes maddeningly obscure, he has had to learn how to cope patiently with frustration of trying to implement ideas that, as various colleagues assert, were years ahead of the art and too costly for most organizations to afford as yet.

The long-distance runner image hits home with Doug. He has in fact, he says, spent many hours jogging around tracks. "I notice, too, that I get passed all the time by people booming ahead, out to run only the half mile. It seemed to be that way all through the years. People launch a project in some related area, and quickly get acclaim and all. But I don't feel that I can see any other way than the long haul . . . not the dramatic . . . although people tell me I'm going in the wrong direction."

Recognition and support for his ideas have come in stages, especially as the implementation of these ideas have made them a little more apparent. But it is still the tip of the iceberg. There is now a "satisfactory degree of understanding of what we have achieved," Doug says, "but there isn't actually any more general understanding of where I'm going and why, and the principles behind this system."

Financial support for Engelbart's "augmenting human intellect" system, after a certain point in time, has actually been quite handsome, being now at the rate of something over one million dollars a year. It has come from the Air Force (AFOSR), NASA, Rome Air Development Center, ONR, then largely from ARPA, which has had the mission of supporting some of (just as its name says) the most advanced research projects going on in this country—those pioneering ventures at the edge of knowledge and at the edge of the technological arts, which might or might not pay off in the long run.

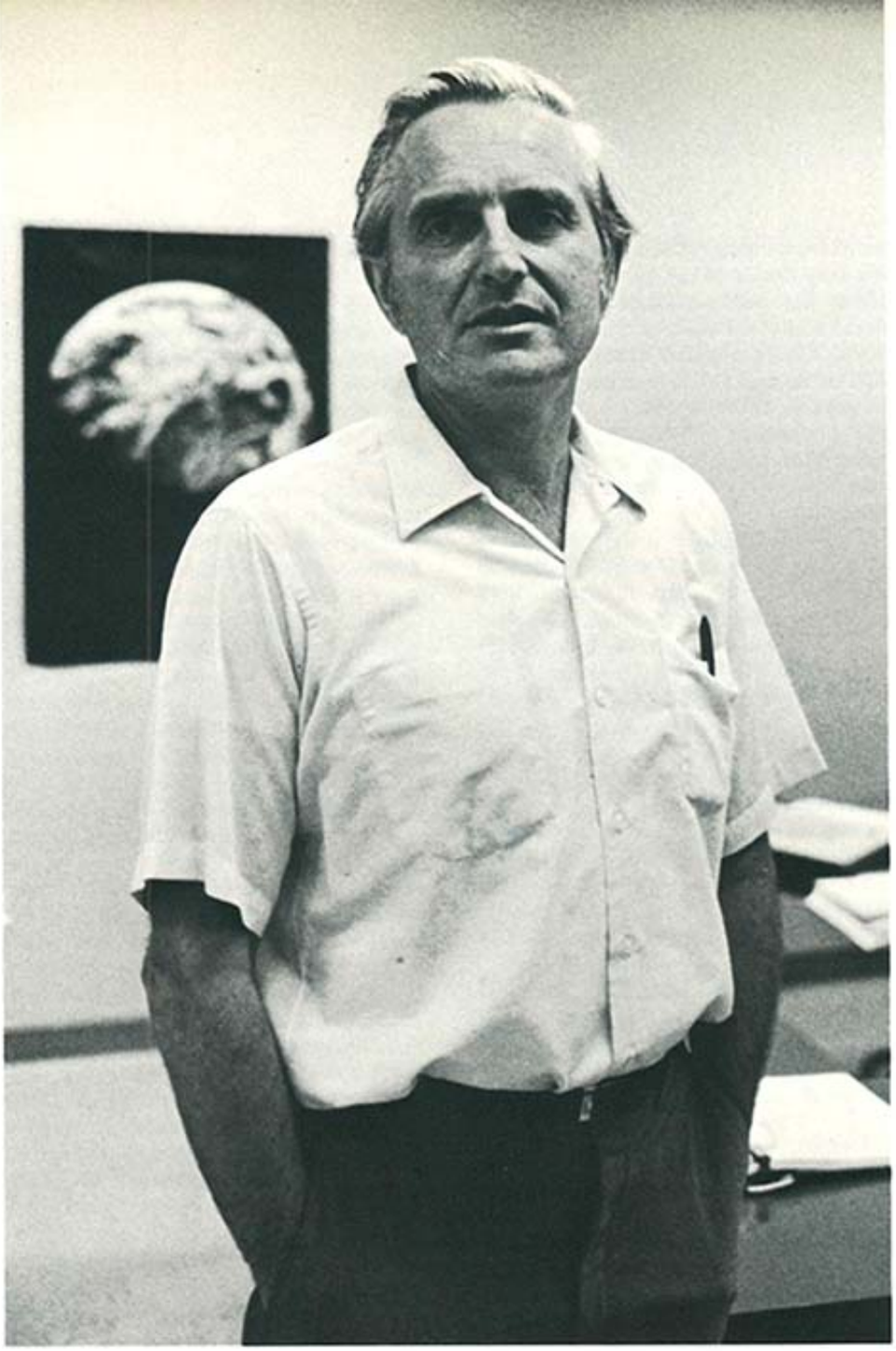
The Information Processing Division of ARPA was first headed up by J. C. R. Licklider, who wrote a now-classic paper in 1960 called "Man-Computer Symbiosis," which crystallized many ideas for many people in the computer field about where such man-machine systems could be taking us. Licklider, one of the father-prophets of the computer field, went to ARPA to start a behavioral sciences division. He also founded a second division on information processing techniques to push interactive computer research (time-sharing being one example). Through this division, Licklider pumped out significant financial support to those scientists who could contribute to interactive computing, and whose coordinated efforts would achieve "critical mass" to get the field moving. The focus of much of this research was to develop systems that would allow many users to interact with a central computer simultaneously from many widely separated individual small consoles.

Licklider was succeeded at his ARPA post by men equally enthusiastic about the future of time sharing, younger men who could see in the future a great network of computers in which information resources could be drawn upon by users everywhere. Licklider and his successors —Ivan Sutherland, Robert Taylor, and Larry Roberts—all gave support to Doug Engelbart in one form or another.

Philosophically, there was a real concordance in Licklider's and Engelbart's ideas, although their expression and emphasis of implementation were individual and different. Licklider tended to focus on the computer as an interactive tool, whereas Engelbart focused on building a new kind of working environment in which the emphasis was on how the *people* worked together.

Doug's first formal explication of the ideas he had been brewing for more than a decade came in a report published at SRI in 1962, prepared for the Air Force Office of Scientific Research. Entitled "Augmenting Human Intellect: A Conceptual Framework," it took a "new and systematic approach to improving the intellectual effectiveness of the individual human being." In it, he set forth his basic objectives from which he has had to "hardly budge at all."

In the introduction to his '62 report, Engelbart wrote: "By 'augmenting human intellect' we mean



Douglas Engelbart expects augmentation systems like his at SRI to bring profound changes in our way of thinking and working.

increasing the capability of a man to approach a complex problem situation, to gain comprehension to suit his particular needs, and to derive solutions to problems. Increased capability in this respect is taken to mean a mixture of the following: more-rapid comprehension, better comprehension, the possibility of gaining a useful degree of comprehension in a situation that previously was too complex, speedier solutions, better solutions, and the possibility of finding solutions to problems that before seemed insoluble. And by 'complex situations' we include the professional problems of diplomats, executives, social scientists, life scientists, physical scientists, attorneys, designers—whether the problem situation exists for twenty minutes or twenty years. We do not speak of isolated clever tricks that help in particular situations. We refer to a way of life in an integrated domain where hunches, cut-and-try, intangibles, and the human 'feel for a situation' usefully coexist with powerful concepts, streamlined terminology and notation, sophisticated methods, and high-powered electronic aids."

What Doug was then beginning to envision—as simply *part* of the instrumentation of a more comprehensive *system* of augmentation—was something that was like an electronic vehicle with which one could drive around with extraordinary freedom through the information domain. Imagine driving a car through a landscape which, instead of buildings, roads, and trees, had groves of facts, structures of ideas, and so on, relevant to your professional interests. But this information landscape is a remarkably organized one; not only can you drive around a grove of certain arranged facts, and look at it from many aspects, you have the capability of totally reorganizing that grove almost instantaneously. You could put a road right through the center of it, under it, or over it, giving you, say, a bird's eye view of how its components might be arranged for your greater usefulness and ease of comprehension. This vehicle gives you a flexible method for separating, as it were, the woods from the trees.

The analogy is, says Engelbart, that the computer—*properly* programmed—with its associated hardware, displays, keyboards, and so on—is really this vehicle. It has all the engineering built into it to help you maneuver it and to use it as a functional tool. But there is no need for the user-driver to know how it is engineered any more than a driver needs to know how a car is put together. With this electronic vehicle you can handle a lot of information—compose it, structure it, organize it, modify it, move around within it. The CRT's are the windows through which one can observe the richly varied flora and fauna of the information environment.

Though the formulation and detailed structures have necessarily been evolving over the years—through what Engelbart is fond of describing as a bootstrapping technique of creating the tools that would augment the efforts of the people doing the research on an augmentation system—his basic visualization of his objectives had congealed a full decade before the 1962 formal report.

Into his thinking there had come the view and the conviction that there is no real limitation to a person's intellectual effectiveness or a team's effectiveness. Over the ages we have found, he says, "ever better ways to use the intelligence, conceptual grasp, memory, powers of visualization, and so on. Presumably these inherent characteristics have not changed much since the Stone Age. But what *has* changed are all the things man now possesses in the way of tools, concepts, procedures, and methods. These have made a tremendous difference in man's effectiveness."

The ingredient that Engelbart felt was missing in man's use of tools to augment his intellectual efforts was a *system discipline*. The world is filled with augmenting components—hammers, nails, pencils, paper, mathematics, laws of physics, microscopes, typewriters, telephones, radios, PERT charts, decision trees, computers, management theories, ad infinitum—which

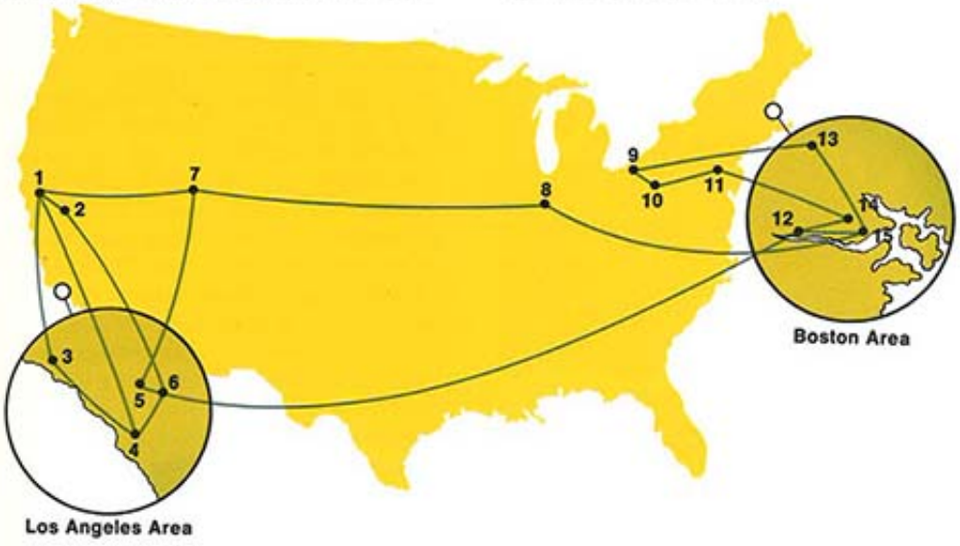
could be pulled together in various ways in what he calls augmentation systems. The system discipline, he explains, "is the consideration of where all those components fit, and the payoff for integrating them is different configurations into the man's domain where he is trained to use them all. An augmentation system comprises all these tools; and then the man's trained to use them." The electronic technology of the computer simply offers a "fantastic breakthrough in the kinds of tools made available within an augmentation system."

The '62 report was the "theory"—the effort "to pull together in a particular perspective the business of an augmentation system." Therefore, the early report was to consider, among many questions, how men are conditioned by their given culture and their given tools and procedures. To build up a science of augmentation systems it would be necessary to do research on how men are conditioned by their tools, and how they can be *re*conditioned by the introduction of versatile and genuinely new tools. How, in fact, do men, intellectually and emotionally, accept genuine innovation?

The computer was a particularly appealing tool, although "just another tool"—instrumentation *along the way*—in this research because it gave a man a wholly new way of producing and manipulating the external symbols he uses. Thus, in the offing were wholly new ways of portraying *concepts*. The way an encyclopedia (the information in it) is portrayed, retrieved, and used in a computer format, for instance, must be very different from the way it is portrayed in the format of the older technologies (paper, ink, printing, binding). The very *nature* of our symbols and concepts "was being blasted open." Doug's vision was of a new kind of freedom, new ways of releasing and harnessing man's intellectual and conceptual power through unlimited new augmentation systems. It was a quest as significant to him as the research problems associated with the harnessing of atomic phenomena in reactors.

The hard problem would be, at first, to lay out an adequate strategy for pursuing such research. The highly elaborate augmentation system at SRI—these "cute toys"—are a small piece of the total action. Doug never lost sight of the fact that the way you organize a computer to augment your activities depends upon how you organize your office, how you organize your creative team, how you organize your means of communication, how you perceive problems in the first place, how . . . it was a problem with many many levels, each level interacting with all the others. Precisely how do you organize a team of researchers to tackle such a manifold reality? And how do you go about winning support for such an ambitious undertaking? Behind the research for a whole discipline of augmentation systems, Engelbart also envisioned the creation of a very large and significant industry.

The ARPA network of fifteen computer research centers will be linked up as shown on this map (plan as of April 1971).



1–Stanford Research Institute
2–Stanford University
3–UC Santa Barbara
4–UCLA
5–SDC Santa Monica
6–RAND Santa Monica
7–U. of Utah, Salt Lake City
8–U. of Illinois, Urbana
9–Case Western Reserve U.
10–Carnegie-Mellon U.
11–Burroughs, Paoli
12–Bolt, Beranek, and Newman
13–Lincoln Lab, Lexington
14–Harvard
15–MIT

The birth of the dream

Doug Engelbart traces his love affair with augmentation systems back to many early experiences when he was in his teens and twenties, but one event crystallized his commitment. One Monday morning, probably in December 1950, Doug relates, he was riding to work and suddenly realized there was nothing in the day that was invigorating to think about doing. As an electrical engineer for the National Advisory Committee on Aeronautics (having earned his BS at Oregon State College several years before), he was "working on 27,000 hp electric drive systems one day and on paging systems the next." Looking ahead, he saw nothing in the week or further beyond in his work to sustain him. He had suddenly become "aware of the need to plan a career rather than following fate." The fact was that the day before he had become engaged to a girl named Ballard.

The next six months were something of a crisis period for him as he tried to think out his career goals and his values. Like many others, he had only had "vague dreams of being a great scientist or something." Almost comically, he calculated the possible working minutes remaining in his life—5,600,000 or thereabouts—and asked himself what kind of return he expected on that investment in the marketplace. Money itself was no goal, assuming he had an adequate amount to get along. Weighing the visible problems—overpopulation, pollution, educational and economic inequities, political-social inequities—he began to wonder how anyone could engage in a crusade to do anything about them that would have a chance of working.

As the weeks went by, it "fell out" in his head that if there were any way of making a significant difference in the capability of people to comprehend these complex and urgent problems, enough so that they could formulate and get resources, harness them, coordinate them, and plan and manage them, then that would be something worth doing. "If we can't do that, we can't make it," he reasoned, "other than by blundering." And it looked as though there were "too much horsepower" loose to blunder. Things were going too fast.

The technology he was acquainted with, however, told him that a computer could handle the information and manipulate the symbols that would be needed for comprehending and mobilizing such resources. Everything, he saw, could be displayed on a CRT.

Then the idea hit him. "The whole bunch fell together! I

just got the image of sitting there in front of a CRT. . . . I can almost reconstruct the image and see the symbols . . . and all the freedom for new symbologies, new processes for manipulating them, new reaches . . . and building on other guys' work. I just thought 'OK!' "

Thereafter followed about ten years of "floundering, trying different things, still being dedicated to this pursuit, but not having any significant forward progress." He tried to prepare himself, tried to talk to people about his concepts. But his efforts at trying to set up a "dialogue" with others—to bring together efforts from different domains and skills—were almost inevitably failures. In those years, unlike today, those scientifically and technologically trained people who were worrying about the "human side" of technology were still relatively isolated from one another. Hard-edged technology was still the king.

Engelbart went to Berkeley for his PhD, where finally, in desperation, after failing to sell ideas like computer-based teaching machines, he resorted to working on physical phenomena for computer componentry, to complete his degree. Thereafter he went to SRI, where he felt he might be able to work on physical-component development to earn an honest livelihood while continuing to evolve his own ideas from the SRI base. If he were ever to sell any management anywhere on supporting the kind of work he wanted to do, he felt he could do it there.

But by that point he had also decided that it was fruitless to engage in dialogue with others unless he had developed "something pretty specific and coherent that would be visible as a base" from which to approach others to talk about his pursuit. The coherence also had to be reflected in his being able to express his ideas in a "coherent language that they would find interesting and assume to be valuable." He also knew he needed to demonstrate his ideas in some real form that could attract their attention.

To do all this, he decided that he'd "have to dig a hole and develop my own framework." In this withdrawal from the world, he was living out what Carl Jung calls the "departure" of the creative person. It is part of the process that also then demands a "return."

Despite the earlier Air Force and NASA support of his research, Engelbart in the early sixties had been nearly pushed into a corner at SRI, partially because the laboratory managers evidently did not appreciate what he was trying to promote and foment, and partially because he did not know how to present his program to them in comprehensible terms. The relationship of bafflement worked in both directions.

Doug had successfully dug his own hole all right, for a period of four or five years after coming to SRI, but he was also in danger of remaining entrenched in it. The level of his support allowed him only small computers, whereas the scope of his dream demanded a larger, differently organized computer.

Then, in 1964, Robert Taylor from ARPA (who earlier when he was in NASA had recognized the fundamental significance of Engelbart's work and pushed its funding) informed Doug and SRI that the Advanced Research Projects Agency would significantly increase its support. "It's time to get Doug onto a machine that will allow *real* group interaction," Taylor asserted. What he proposed was a million dollars initially to supply Engelbart with an appropriate computer to work with—the hardware—and roughly a half million dollars a year to sustain a higher level of augmentation research activity on the underlying software.

Thereafter, needless to say, there was a greater effort at SRI and elsewhere in the computer world to get a handle on the nature of Engelbart's augmentation system research; and on Doug's part there grew a greater attention to the strategy of selling his visionary scheme.

In one respect, Doug had been successful from early on, once he had bitten into the substance of his research. He attracted a long succession of people over the years, who came to work with him over varying periods of time. Among them, for instance, were William K. English, clearly a key man in the early hardware design and development combined with software activities; William H. Paxton, Edwin K. Van de Riet, and William S. Duvall, who worked on system programming; David A. Evans, who worked on the preliminary design of a recent important "piece" of the overall system (namely, the "dialogue support system"); Johns F. Rulifson and Charles H. Irby, also system programmers for the on-line system. Without these and many other individuals, Doug could not have brought his augmentation system to where it stands today, although it has always been clear that the conception and the inspiration were basically his.

With increased attention on his project, and the size of his augmentation research team growing gradually up to nearly twenty-five people, Doug began to sense a new problem, that of people's expectations of what was coming out of his team's efforts. Somehow they expect, he says, "the greatest sophistication and truth" from the exotic-seeming system, for "things more magical than what we're actually doing with it, with this primitive, rough, hand-run thing." On the one hand, he has discovered that it "takes hours and hours of description and demonstration to begin getting that set of tools over to people," and then at a certain level they express disappointment. "You mean it doesn't run through and answer questions for you and things like that?"

On the other hand, Doug explains, "if I try to show the conceptual model of what I mean by an augmentation system, and the number of levels in it, and what evolution within that entails, and then come around to show why strategically we're spending so much time doing these things that are quite rudimentary . . . someplace in that circuit we almost always get lost."

And, Doug adds as an aside, he sometimes felt embarrassment for Bob Taylor's having to explain to other people why he and ARPA were holding to their support of the research. "I believe," speculates Doug, "that Taylor supported us out of some basic intuition."

Taylor, for his part, says simply and forcefully that once he made the distinction clear that Engelbart was building a fundamentally new kind of working environment or intellectual workshop, and was not interested in computers per se, he had no problems winning other people over to the importance of giving Doug support.