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The Augmentation System Framework

Doug Engelbart with Kristina Hooper

This paper has been put together in two stages. The first involved compiling notes of conversations in November 1986 between Doug and me. The second was influenced greatly by conversations during 1987, and relies particularly on quotes from a presentation Doug made at the Hackers' Conference in October 1987. I quote liberally from this presentation so that Doug can make his complex ideas accessible directly to the reader.

The focus of this paper is on "augmentation." "Augment" is a transitive verb which is defined by Webster's as meaning "to make greater, as in size, quantity, strength, etc.; to enlarge." Doug uses this term to emphasize the role of technology in a human context; technology is to be designed to increase human capabilities, to extend them in imagined and unimagined ways, to change the basic character of communities, and to make these more effective.

This perspective on computer technologies has been acknowledged widely in recent years, in theoretical work as well as in marketing slogans. Our widespread use of computers for word processing and "diagram organization" to assist in human expression and to aid in human work—to "augment the human intellect," in Doug's terms—demonstrates this approach directly. Similarly, the papers included in this book typically take as an assumption this human-centered perspective.

It is noteworthy, however, that in the early 1960s these concepts were quite unfamiliar to the computer science community with whom Doug was working. The general approach, then, as it oftentimes still is, was toward the development of technologies for their own sakes, or for the replacement (or minimization) of human involvement.

The approaches described throughout this book were made possible by the questioning of the uses of computer technology pursued by Doug and others early in the development of this technology. Hypertext systems, for example, are important and useful only when one takes an explicitly human view of the reading process in an information environment. It is a set of examples generated twenty years ago by Doug's lab that serve as central prototypes for the linking systems described in this book. Similarly, the entire notion of multimedia presentations—the central focus of this book—assumes a human viewer who is benefiting from the richness of these presentations. From the standpoint of technology, such presentations bring on a range of processing problems that clearly should be avoided unless these presentations are judged to be of value.

There are now widespread examples of Doug's influence in our computer environments—not the least of which are the direct manipulations made possible with the mouse, which he invented, and the simultaneous views of information provided in windowing systems, which he first demonstrated. Yet the crispness of Doug's analyses continues to invite innovation and inventive implementation. Much remains to be done in the context of Doug's analyses to explore the nature of the human communities and the opportunities for changes in these communities that are brought to our attention in a careful consideration of computer technologies. My hope is that this chapter can help people to understand the basic approach taken by Doug so that they can work to expand his investigations in a range of contexts.

In the following transcript, my comments are printed in italics. Doug's comments—either made in the first stage of our preparation, in 1986-87, or quoted from his October 1987 presentation—are in plain text. His comments from the October 1984 presentation are enclosed in quotation marks.

Kristina Hooper, November 1987

AN AUGMENTATION FRAMEWORK: AN INTRODUCTION

"I had this kooky thing happen to me in 1951 where I decided to commit my career to trying to help mankind be able to cope better with complexity and urgency and the problems of the world. I had an image of sitting in front of a display and working with a computer interactively. I had been a radio and radar technician during World War II, so I knew that any signals that came out of a machine could drive any kind of hardware—they could drive whatever you wanted on a display. But I really didn't know how a computer worked. Still, I thought, 'Boy! That's just great!' The images of the different symbologies that you could employ, and other people sitting at workstations connected to the same complex, and working in a close, collaborative way. And I just said, 'Well, that's something I can pursue as an electrical engineer, and maybe try to follow that goal.' So it was about eight years later, after I'd gotten a Ph.D. and had gone to SRI to work, that I got a chance to start sitting down to really put it together, saying, 'Just exactly how would I pursue that?'" (Engelbart 1987)

Many of us just start working as hard as we can when we feel that there is a lot to do. What Doug did instead was to very self-consciously build a framework for his analysis, so that he could be sure of the context in which he was working and so that he wouldn't be distracted by interesting work different from his that was going on around him.

"So I sat there for two years building a framework. And out came this picture that showed that if you really want to improve how people cope with the world, you sort of peel off a lot and realize that there's a huge system already provided for you as you grow up within a given culture. You're indoctrinated in all sorts of unconscious things. You're taught explicitly conceptual and symbolic things, and a spoken language and eventually a written one. And you're given lots of tools and lots of methods and lots of organizational structures. And all of this constitutes one big system that augments human capability." (Engelbart 1987).

Doug described this framework for analysis succinctly in November 1986:

The components of an augmentation system are the bundle of all the things that can be added to what a human is genetically endowed with, the purpose of which is to augment these basic human capabilities in order to maximize the capabilities that a human or human organization can apply to the problems and goals of human society. Augmentation systems have always existed; they have often been developed unconsciously. Throughout history, augmentation systems have emerged as a result of continuing socio-cultural evolution.

A broadbrush categorization of the components of an augmentation system includes three distinct but interacting elements: language, artifacts, and methodology. Society must train humans to use the three augmentation components in an integrated way.

This analysis of the context in which technologies exists led Doug to posit that an augmentation system framework must consider two types of system contributions. It must involve both human system contributions—the social and cultural frameworks that have evolved at any time in history to support human activities, as well as the basic human capabilities and their possible extensions through training—and the tool system contributions—the capabilities that are provided to enable human activities.

Figure 1 makes explicit these two kinds of system.

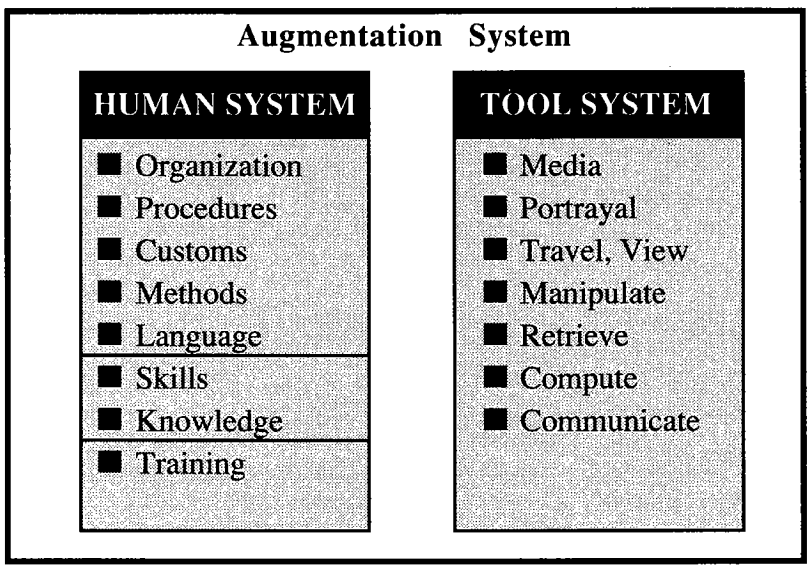


Figure 1. *It is important to consider a two-part augmentation system: the human system and the tool system.*

Figure 2 shows how these two systems might interact to provide an individual with a particular capability—some "example capability." For each capability—for example, programming a computer, setting up a conference, wiring a piece of hardware, or writing an understandable document—can be thought to result from a combination of existing human capabilities and existing tool capabilities, where individuals must have the skills and knowledge to take advantage of these two systems to augment their activities.

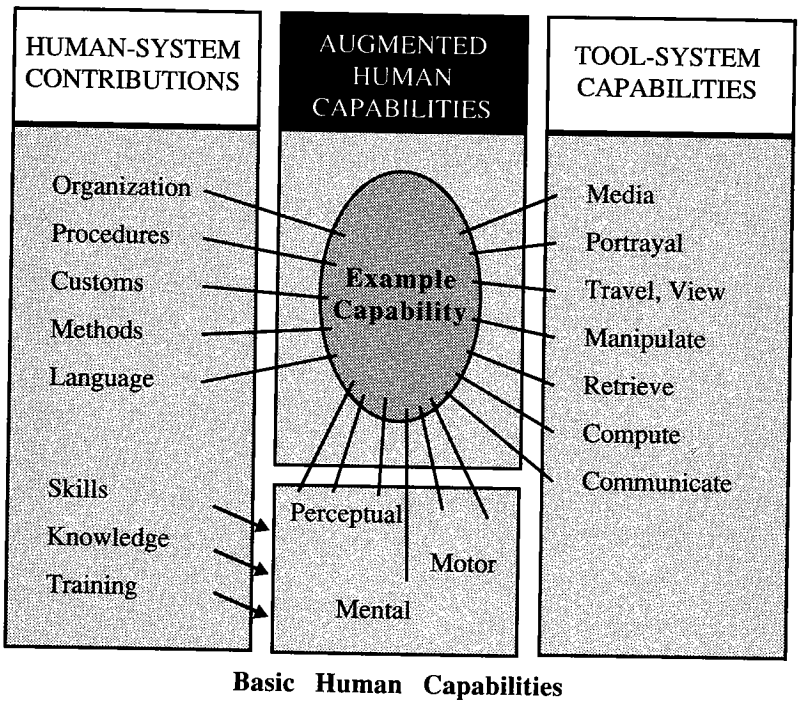


Figure 2. *Most of our capabilities are composites: any "example capability" can be thought of as a combination of human-system and tool-system contributions. These capabilities come from the human having the necessary skills and knowledge to employ these augmentation systems.*

The complexity of this analysis becomes clear when one acknowledges that each new capability interacts with the wide range of existing capabilities. A new set of example capabilities will continually evolve from the interaction of the human and tool systems. Figure 3 shows a way to think of this.

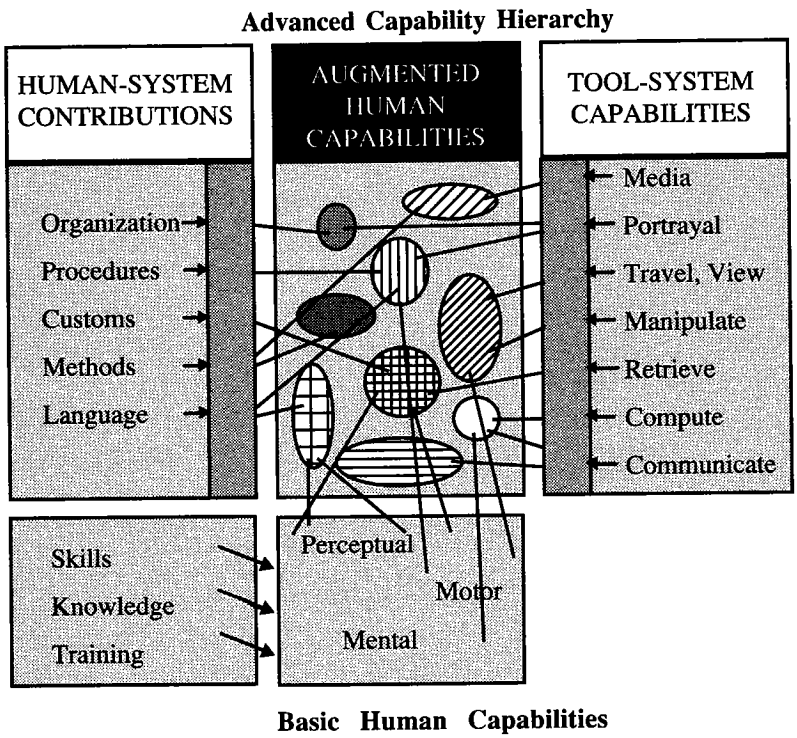


Figure 3. *Our capabilities grow hierarchically: Each new capability interacts with the wide range of existing (interrelated) capabilities.*

Doug argues that we need to focus on a systematic way to understand this evolution, without oversimplifying it and "losing the phenomenon." For computers can provide critical new capabilities to support some of the most human of human endeavors.

"And so I said, 'Gee, that means this little computer toy coming along isn't all that different anyway; it's just another category of tool.' But then if you start thinking about how all of this evolved in the first place, you realize that one doesn't just suddenly evolve a bunch of tools. It is the co-evolution of all of these different aspects of what it is that helps augment a human. And so I thought, 'Well, I guess that's right....'

"So what's going to come out of all of this in the way of real changes, in the way people can think, formulate, conceptualize, portray, manipulate, communicate, collaborate—all of that? And so I thought, 'Well, I'll just start with a fresh start in a few dimensions.' And one of them was: 'Alright, what would I do to show things in a data structure? Since the hierarchical ways in which we organize thoughts are very basic, you should start out with explicit hierarchical stuctures in multimedia. So as fast as we can, let's get graphics with these, and let's scale and move around quickly with these, and the cross-linkages will help us.'" (Engelbart 1987)

In his lab at SRI, Doug provided extremely cogent demonstrations of just how systems like those he specified in his written descriptions of augmentation systems might appear. For he realized even then that without specific examples—and the lessons that were to be learned in putting together these examples—his analysis would remain far too abstract for most people to understand.

A classic demonstration of this is one that Doug made before a large audience at a Computer Conference in 1968 in San Francisco. Fortunately for us all, it was filmed (Engelbart 1968). In this presentation, Doug showed very explicitly, among other things, how facilely a mouse and a special keypad might be used to directly manipulate and display structured documents. He also showed how multiple individuals—connected via both audio and video links— could work collaboratively on a single document.

These elements, described and demonstrated so clearly 20 years ago, slowly have been showing up in commercial products, often as the direct result of the work of alumni of Doug's lab who went on to work for research labs and computer corporations such as Xerox, Apple Inc., and Sun Computer when SRI closed the Augmentation Lab more than ten years ago.

And there will be more examples of Doug's influence as people begin to understand his analyses, and as we all rise to the challenges and opportunities that computers provide us. For, as Doug asserts, the potential impacts of the computer on our culture are too great for us to let augmentation systems evolve haphazardly. He argues that we as a culture must focus our resources on the formulation of a methodology for addressing complex human-tool interactions—a language system that lets us analyze the current situation in terms that can enable us to develop better and better augmentation systems.

At the same time, Doug makes it clear that it is quite hopeless to design something as complex as an entire augmentation system. And so he suggests a number of direct strategies we might employ in shaping augmentation systems—to influence their co-evolution—while we simultaneously develop methodologies for understanding them.

A brief description of Doug's analysis of methodologies and strategies is set forth in the next two sections of this chapter.

An Augmentation Framework: Methodologies

"Now you're bringing in, in terms of the computer, something very, very radical in the way of tools. I'd learned enough about scaling physical devices to realize that if a quantitative change in some system environment changes past a certain threshold, you get an immediate qualitative change—very much a qualitative change. You change the scale of an airplane and suddenly it won't fly—things of that sort. So I went, 'Well, the impact of all of this technology could just be very, very dramatic.'" (Engelbart 1987)

The complexities of his analysis were clear to Doug very early on, as were the complexities of the computer and human systems he was anticipating. To address this, Doug called very directly for the formulations of very new methodologies for coping with these issues, a call which is still very timely, as our culture has still failed to address these issues directly in our considerations of the impacts of computers on our societies. In our 1986-87 meetings, Doug stated this in the following terms:

We need methodologies and skills directed toward software, toward tools. For in any given knowledge-work domain, there is a special set of concepts, terminologies, and portrayals. The tools developed have an impact on the language. Understanding these dynamics is key. This requires explicit exploration; currently this topic does not get this exploration.

For instance, software designers are the subjects of such potential augmentation, but they are not themselves the researchers equipped to create it.

If not the software designers, just who are the people who work with methodologies and training? Who are the people who consider languages for augmentation that are not concretely programming languages?

What seems necessary to me is the development of a completely new discipline that embraces the whole augmentation system. Think of it as similar to architecture, a whole-system discipline that integrates in a coordinated way the specialty fields of structures, heating, electricity, plumbing, and more.

It is indeed amazing that we have no such focus on the efficient use of our own ideas and communications, even though we often do acknowledge their importance to our goals! As Doug notes, we all struggle with haphazard ways to organize our own thoughts, rarely even able to think of how the ideas of groups might be effectively combined:

What are the methodologies that I apply in collecting ideas and organizing them? Currently, I have a set of haphazard ways to organize things. And we all have haphazard ways of piecemealing methodologies of organizations together.

Why not put together a whole "academic department" on this subject? Or a specific department in a "work environment"? Why not think of augmentation as a system, and provide it with formal tools of analysis as well as extensive settings for experimentation?

Historically, one of the few settings that have been made available for this kind of experimentation was Doug's lab at SRI, a lab that was closed in the mid-1970s.

In this lab, Doug developed a very systematic way in which a group of workers could exchange information with the assistance of electronic technologies. And he tried his ideas out in the lab. Doug organized the document linkage system shown in Figure 4—The Collaborative Information Domain—which formed a critical focus for the "Community." The document linkage system was intended to add more and more powerful opportunities for individuals to collaborate in this community.

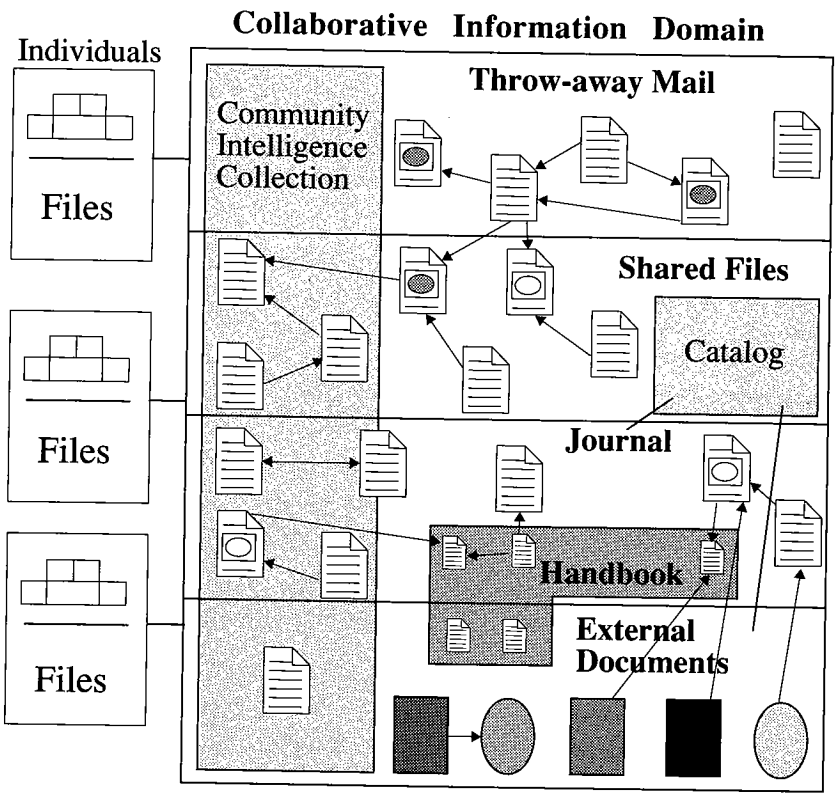


Figure 4. *A document linkage system forms a critical focus for the community; it adds more and more power to how individuals in a community can collaborate.*

The basic unit for this system was a single document. However, as shown in Figure 4, there were four different classes of document:

- *Throw-away Mail included those files that were not of long-term value. These files stayed within the system, to be linked to other files; this added value to throw-away mail, making it relevant explicitly to other elements in the shared domain.*
- *Shared Files were the typical units in the document linkage system. They were contributed by many individuals, and were linked more and more extensively with each use, acting often as references to new documents.*
- *The Journal included the set of online "published works" of the community. Individuals would commit themselves to write these documents, and they would deliberately make them available to everyone for reading and for comment (much as one does when one publishes an article in a print publication). Since documents in the Journal could refer to other relevant documents directly, readers could quickly obtain the context for considering new presentations. This provided for very rapid and condensed recorded dialog on these new idea presentations.*
- *A fourth primary element in the Collaborative Information Domain was labeled External Documents. These were documents not in electronic form—books on individuals' desks, articles in the library, and so forth—that were referred to in other files.*

There was a Catalog in this system, in addition to these four other elements. This Catalog gave users access to the External Documents. It also provided easy access to files in the Journal.

- *Two other elements in this document system are worthy of note: The Community Intelligence Collection was the group of documents (some in each of the four basic categories) that dealt with ongoing activities outside the community. Provided by the community for general information, this community-specific view of relevant outside activities was judged critical for the survival and adaptation of the community in the outside world.*
- *The Handbook described the status of the community at any time. It was produced by individuals charged with the task of deliberately sifting through the activities of the community, evaluating and integrating these activities for general consideration.*

This general framework for collaborative exchange provided an excellent setting for watching the activities of the community in Doug's lab, and it provided an efficient mechanism for information exchange.

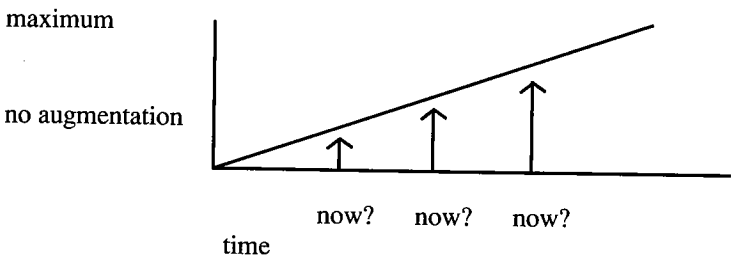
"After that, a big part of that framework got to be what kind of strategic approach one would use if one were pursuing something that offered a revolutionary change. This thing looked to me like the biggest revolution you had ever seen for humanity, in the sense of people being able to connect their brain machinery to the world's problems. And it was going to go on for many, many decades. Even the resources of everybody in here with all the money you could get will be just a drop in the bucket." (Engelbart 1987)

Unfortunately, there are few, if any, organizations currently set up for this kind of analysis. The call for the development of a new methodology for considering human exchanges of information in groups, as well as for establishing centers for the systematic investigation of these exchanges, is very relevant today.

An Augmentation Framework: Strategies

Doug has again and again raised the issue of considering the possibility of a maximally augmented organization. This issue involves a consideration of just what capabilities might be involved in a fully augmented system. It also raises the issue of how this full augmentation might be established. Doug's position is that the process will be evolutionary, that activities that both enhance the current status of augmentation and assist in self-consciously bootstrapping on each incremental gain should be pursued immediately. The use of small groups, particularly in facilitation roles, becomes critical, in his analysis:

First, just where are we now in terms of maximum augmentation? How can we get to the maximum? What are the approaches and strategies that will work?



Evolution is the only viable strategy; we must get the evolutionary process going, directing it at "climbing the hill."

During any period of time, there is a limited set of resources that can be applied to directly exploring the "ascent." Various targeted outcomes/goals that have several dimensions of value can be expected. In simple terms, there are two ways to assess the value of an outcome, and hence to determine a strategy:

(1) How much would the outcome boost our capability in some specified "in-line work"? For example, how might one use available resources to boost the ability of people to do their work?

(2) How much will the outcome boost the capability to "climb the hill"? In other terms, what bootstrapping and evolutionary support are provided by a particular outcome?

Doug then suggests immediate actions, as well as long-term planning to enhance future activities, combining both of these classes of value. And, he provides some specific ideas for

leveraging resources effectively for both classes of outcome:

What are the practical strategies that will allow our society to pursue high-performance augmentation?

My strategy is to begin the "pursuit" with small groups. Small groups are preferable to large groups because of shorter evolutionary cycles, more economical scale of experiments, and more "cultural mobility." Small groups are preferable to individuals because exploring high-performance, augmented collaboration is at the center of opportunity.

These small groups would be the "scouting parties" sent ahead to map the pathways for the organizational groups to follow. I have come to call these exploratory groups "high-performance teams."

One early candidate for these teams' role would be to support working conferences; this would provide a very valuable service and match well with early augmentation possibilities. The approach would provide exploration projects of limited duration, and its cyclic nature would allow for debriefing and system updates. Since there would be a new set of participants for each cycle with this approach, more (key) people would gain new perceptions of what high-performance augmentation can bring to their organizations.

Another closely related role for a high-performance support team would be as an "integrator" for a large project within a special-interest community. In this role, the team would support dialog, analyze the contributions, integrate them into a Handbook (see Figure 4), and generate special "portrayals" (presentations or documents).

Figure 5 suggests a framework in which facilitation teams can provide training and coaching to a community (in the context of the document system shown in Figure 4). This group can enhance and make explicit the activities of the community, relating these to the document linkage system of this community. In addition, this group can add value by enabling records to be sorted in standardized formats for later easy access and analysis, principally in the Handbook.

This facilitation allows for the effective evolution of the community. This organizational evolution can affect outcomes positively, as well as influence other organizational units positively. It is therefore an excellent focus for the immediate investment of tools, according to Doug's analyses.

This notion of investment becomes key as one tries to make these issues "realities." Specifically, Doug calls for well-supported "outposts" that can try out some of these notions and then send back "lessons learned" systematically to new organizational candidates:

You need high-performance teams. You also need "outposts" for these teams.

There are some teams currently scattered about by accident, but they typically are not carrying out the systematic exploration that is needed "out there"; we need a plan for putting

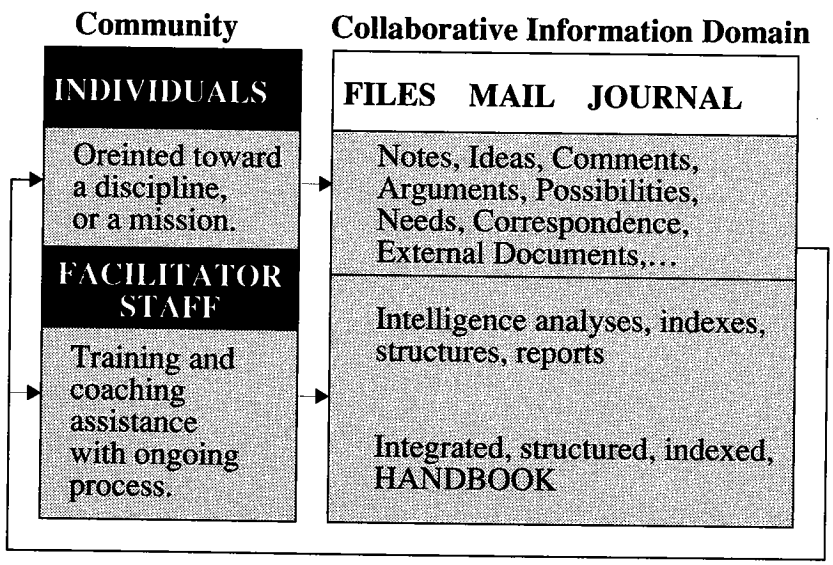


Figure 5. *Facilitation teams provide training and coaching to the community. In addition, they enhance and make explicit the activities of the community, relating these to the document linkage system of this community. This group can also add value by enabling records to be sorted in standardized formats for later easy access and analysis, principally in the Handbook.*

the teams out, and we need a large number of teams.

The first expenditures should be toward the development of outposts. The initial task would be to determine what people would do at these outposts. Another central task would be to determine just who would employ these teams.

The question of who should employ these "experiments" has been a real show stopper for the past few decades, particularly in the U.S. technology business and research environments, in which most of the serious considerations of augmentation systems take place. Doug has weathered this situation for years. His optimism prevails. He has the plan; he just needs to find a way to fund a few outposts and a few teams to get on with the evolution:

"Lots of what we've done since 1968 has to do with the evolution of these things, and especially large organizations all over the place, where the architecture of computer systems has to provide for the concurrent evolution for lots of users—their peripheral hardware, their skills, their methods....

"So it's an absolute thrill to see some of this stuff move like this. It's sort of like being able to come back out of some kind of funny exile and just say—I don't know—'Can I still talk with people about this?' [Laughter and applause from audience]

"There's just an overwhelming amount to do, and we're just getting started. And it's going to be, I think, just the most exciting intellectual thing that anybody's ever been able to participate in historically. The early emergence of language itself was very, very exciting, but it took a long, long time. But here things are just going to catapult." (Engelbart 1987)

Welcome aboard, everyone!

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