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EXECUTIVE INFORMATION TOOLS

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Augmentation Research Center

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Introduction 2

An organization's success depends on the effectiveness of its executives in guiding the organization through its complex environment. The scarcity and cost of executive talent imputes a high value to its efficiency. Organizations are becoming increasingly interested in providing a supportive working environment for their executives. 2a

A large part of the executive's day involves working with information and ideas -- that is, with knowledge. The executive must be aware of his organization and its environment, through the wide range of contents and many levels of information specificity and permanence. He must solve unstructured as well as structured problems. He must work with others on ideas. Essentially, he is employed to think and to communicate. Advanced information-handling tools can play an important role in improving the effectiveness of the executive's use of his valuable time. 2b

For thirteen years the Augmentation Research Center (ARC) at Stanford Research Institute has been developing computer-based tools to augment the abilities of individuals and groups working with knowledge. This research has been done under the direction of Dr. Douglas C. Engelbart, and sponsored by the Defense Advanced Research Projects Agency, the U.S. Air Force, and other government agencies. 2c

The set of integrated tools developed at ARC is termed the "Augmented Knowledge Workshop (AKW)." The focus has not been on problem-structuring methods or on analytical capabilities, but on an overall environment in which people can work with information and ideas. This effort has been guided by an orientation toward the nontechnical user, such as a business executive. These tools have been applied to the work of a diverse set of thinking groups throughout the United States and Canada with reported initial success. The growth and further evolution of this information environment looks highly promising. 2d

This paper focuses on the tools as they might be applied in a business environment. It envisions the point of introduction of such techniques in an organization at the managerial level, where facilitating work with ideas will have the greatest return. This paper describes the Augmented Knowledge Workshop at a general level, in the context of ARC's assumptions and philosophy on users' needs. 2e

The Executive's World 3

Introduction 3a

The applicability of the Augmented Knowledge Workshop to the business world assumes that the executive depends on his ability to work with information and ideas. This section describes some of the areas in which one might envision information tools contributing to the effectiveness and expedience of such work. 3a1

Although ARC has some feel for the long-term potential of the system, it cannot hope to know the specific needs of each application, with their wide diversity of interests. Each application uses the system in a different way and evolves capabilities for its use at different rates and in different sequences, as called for by the projects on which it is used. Therefore, this section is not meant to be deterministic nor exhaustive. Rather it is a brief list of some of the needs of a business executive that might utilize information tools, needs for which the AKW was designed. 3a2

Viewing the Organization 3b

Information is constantly being generated at all levels of an organization. Much of it may be lost or distorted as it moves through the organizational structure. At each level of the organization it takes on a different form -- one appropriate to the functions of that position. As information moves upward in an organization, it may be condensed and filtered. The communications flow may involve many implicit a priori decisions as to who needs what and in what form. 3b1

While such a flow is likely to be quite functional for everyday work, it may be dysfunctional from the point of view of the executive. The very nature of the executive's job precludes a priori decisions about information needs. He considers all aspects of the organization, to the level of depth required by the decision at hand. He is responsible for unusual decisions, the ones not handled by the operational structure. 3b2

The executive must maintain close contact with his organization. He should be able to view its history or current state at any level. He needs direct access to information, both internally and externally generated, by people or by processes, at any geographic location or at any level in his organization's hierarchy (e.g., at its point of introduction into the organization). He may need special perspectives suited to the question at hand. This activity may have time value, or may be sensitive to the accuracy of the information. Tools that allow the manager to view his organization effectively should help him acquire the information required by his job. 3b3

Thinking 3c

The raison d'etre of the executive is his ability to think. His daily life involves problem recognition, information structuring, idea generation, and (often unstructured) decision making. The long-range success of an organization may depend on his thinking abilities as applied to strategic planning and decision making. Tools that let him get his ideas out in front of him, that help him shape, structure, and work with ideas, gain perspectives on them, view them in different ways, and allow them to evolve, should encourage him to build his thoughts in text. 3c1

Thinking in such an environment might increase the effectiveness of the executive by a number of means. Flexible control over his words allows him to easily mold them until he is fully satisfied. He might gain overviews and perspectives not available by any standard work methods. Such perspectives might encourage better organization and flow. He can integrate ideas rapidly, seeing conceptual ties and manipulating whole conceptual blocks. The ease with which he can move among subjects and the persistent nature of thinking in words might let him set ideas aside and easily return to them, allowing him to better budget his time. 3c2

These tools applied to the more mundane aspects of his thinking day (such as organizing his "desk", keeping reminders and notes to himself, sorting his mail, and scheduling his time) can free him to spend his thinking time more creatively. 3c3

Communication 3d

The manager must communicate with others in his organization. He must be in close contact with his subordinates for the purposes of implementing

decisions and controlling performance. Upward communication is important in obtaining guidance or information and in transmitting results. Communications with colleagues can support his understanding of the organization and provide access to valuable resources. 3d1

Furthermore, communiques have a wide range of time values. Not all deserve the immediate attention of response to a phone call or letter, yet it is often difficult to get a feeling for the significance of a message without receiving it in full. The executive should be able to sort the messages he chooses to receive and respond with the appropriate expendience (though no less effectively due to any delay). Any tool that increases the rate of flow of ideas must also include techniques for handling the greater volume of communication.

This becomes particularly important in national or international organizations requiring geographically distributed managers to coordinate their efforts and share information and resources. A thinking environment should provide the executive with an integrated set of communications tools. 3d2

Teamwork 3e

More and more frequently, groups are being used for important decisions and projects. Such groups may or may not be located physically in the same place (e.g. a strategic planning group consisting of the heads of geographically distributed profit centers). These groups, regardless of location and travel constraints, should be able to work together on their ideas on an ongoing basis. In addition to basic communications tools, group dialog and conferencing capabilities, a communal information environment, and the ability to get a perspective on, to refer directly to, and to merge ideas would provide important additions to an organization's team building efforts. Parallel efforts might be replaced by a collaborative effort. 3e1

Tools of Analysis 3f

The executive might require access to tools designed for specific tasks or analyses located throughout his organization or commercially available (e.g., his accounting system, financial analysis tools, or a simulation developed elsewhere). To use them effectively, he should have a coherent environment from which he can reach out to the tools he needs (preferrably using the mode of interaction with which he is familiar) and bring the results into an environment in which he can work with them (perhaps incorporating them into his current work). 3f1

Organizational Knowledge Base 3g

Experience builds capabilities in an organization. The Boston Consulting Group recognizes the effect of learning on all levels of an organization in its concept of "experience curves." [See Reference 8a.] If an organization can facilitate the process of assimilating experience into learning, it might realize a significant competitive advantage. 3g1

Organizational experience may take the form of individual experiences, formal rules, special studies, or a formal or informal knowledge base. The executive should have easy access to the knowledge of his organization. Structured tools may allow him to access structured information, such as formalized company data bases. Communications tools and recorded dialog will allow him to assimilate the many personal experiences in the organization relevant to his problem. Unstructured tools may allow him to look up the collection of experiences or trace the dialog in his organization on a given subject. 3g2

Any form of organizational knowledge base facilitates learning from experience. One might hope that duplicate efforts could be minimized, and the permanence and accessibility of the organization's knowledge could be ensured. A flexible information environment should allow an organization to build forms of knowledge bases appropriate to its modes of operation and to specific areas of knowledge. 3g3

External Communities 3h

A business executive may find his interests closely resembling those of a community of his professional colleagues outside as well as inside the organization. The ability to exchange ideas in real time and in an environment effective for working with those ideas would provide a mode of collaboration more effective than annual meetings and professional journals alone. (Of course new tools must augment rather than replace traditional modes of working; for example, computer-based communication is not intended as a substitute for the occasional face-to-face interactions typical of such communities.) 3h1

The inclusion of universities and researchers would broaden the perspective and resources of such a community. Communities might facilitate the understanding and development of new techniques in the business world, better enabling all involved to effectively operate their organizations and serve their clients and society. A participating business would be at the forefront of developments relevant to its operation. 3h2

One might note the potential for broad community involvement in view of the growing concern for corporate social responsibility.

Assuming the availability of necessary privacy, much is to be gained by an information environment that supports collaboration. As communities evolve and their resources multiply, incentive for participation grows. Those applications joining early should build competence in using the tools and in integrating them into their organizations, which will put them at the center of community activity. 3h3

The Role of the AKW 3i

This paper addresses tools designed to meet a class of needs in the executive's day: those activities involving work with information or ideas. Of course not all of an executive's work is based on thought; he must manage people and a political entity as well. However, it is assumed that information-handling tools will facilitate a significant part of his work. 3i1

Many such tools are being offered or developed; some are activity specific, some are task specific. This paper discusses a system intended to be an overall environment in which to work with knowledge. The focus of this paper is not on the many specific capabilities, but on the framework for integrating tools. 3i2

The system described is intended for use by nontechnical people; as such, the design of the man-machine interface is crucial to the success of its application. The next section discusses considerations in the design of this user environment. 3i3

The Philosophy of Augmentation Tools 4

Introduction 4a

Any set of tools to be integrated so intimately with the executive's work life must be both powerful and effective. The design of a computer-based environment has a great effect on the power and flexibility of the tools that result. 4a1

ARC has assumed throughout the development of the Augmented Knowledge Workshop that many of its users would not be computer oriented. If the user must devote too much effort to thinking about how to use the tool to do what he wishes, he will be distracted from his primary thinking task and the purpose of the tool will have been defeated. Both in the learning process and in subsequent use, the design of the man-machine interface is an important determinant of the usability of the tools. 4a2

This section describes considerations in designing and implementing both the computer-based environment and the man-machine interface. [For elaboration, see Reference 8f by R. W. Watson.] 4a3

Objectives for the Online Environment 4b

Integration of Tools 4b1

One cannot predict the combination of tools that will be useful in the tasks that the executive addresses. Neither can one predict the subject of a manager's thinking, nor the sequence of activities that will accomplish a task. Thus, the performance of each tool must be independent of the context in which it is used.

This represents a distinctly different approach from those that attempt to predetermine thinking processes and build systems specific to tasks. It points to a generalized information environment, free of dependencies on past assumptions, where the user interactively decides how, when, and on what to employ the capabilities of the system.

Extendibility of the Environment 4b2

One can build tools intended to facilitate thinking at a general level (e.g., writing, reading, and communicating), but there will always be cases where task-specific processes are required. Special combinations of tools, entirely new tools, or special user interface packages may be needed for specific applications. The user should be able to extend the environment in simple ways, or acquire professional assistance in adding new capabilities to his repertoire. The context-independent design philosophy should make it easy to add new tools to the workshop, and furthermore to interface the workshop to other computer systems.

Range of Workstations 4b3

Workstations, such as teletypes and display terminals, allow the user to interact with the computer. The range of available workstations is constantly increasing in scope and capability. These workstations might support, for example, text with large open-ended character sets, pictures, voice, mathematical notation, tables, or numbers. Portable hand-held consoles may soon be available. The user interface should be as consistent as possible across terminal types, to allow a user to work comfortably with devices available now and in the future.

Furthermore, as the equipment becomes less expensive and more capable, it may be worthwhile to place more of the functions in the workstation. The workstation might collect instructions from the user and information from the system, playing a facilitating role in the interaction. A well partitioned system architecture will allow flexibility in distributing the system processes across processors, to make use of money-saving developments in computer resource sharing as they become feasible.

Embedded in a Computer Network 4b4

With the proliferation of specialized processes serving the business community and of advanced research and development in a wide variety of computer-based services, one cannot expect a single system to hold state-of-the-art tools in all areas.

The knowledge workshop may be provided in the environment of a computer network (such as the ARPANET). The user may then reach out through the familiar environment of the workshop to access other people and other services scattered throughout the network. Specialized functions (e.g., accounting or marketing data processing and retrieval) may be performed by other systems.

In such an environment, entrepreneurs might find that specialization is profitable and that there is a large enough market within reach to support it. In a network-coupled computer-resource marketplace, one might expect to see specialty shops providing subject-oriented libraries, and application systems tailored for particular types of analyses (e.g. spelling correction, market simulation, or portfolio evaluation).

The workshop might provide a labor marketplace as well, where one can transact one's knowledge work independent of geographic location. The executive would be able to work as effectively from a hotel room on the other side of the world as he does from his office. One might eventually expect to see the evolution of a new breed of consultants, or new freedom in choosing one's living environment independent of one's job.

Objectives for the Man-Machine Interface 4c

Man-Machine Communication 4c1

There are many ways by which men might communicate with machines; current technology offers only a few. Research may soon allow computerized reading of speech, handwritten script, and video graphics. The communications media should be fast, intuitive and comfortable, and capable of transmitting the diversity of information with which a knowledge workshop is used. A knowledge workshop system must also be designed so as to easily assimilate new communications technologies.

Real-Time Tools 4c2

The speed of system responsiveness should match the natural speed and flow of man's thought processes. Forcing the user to remember an idea while the machine catches up will frustrate him if not destroy the flow of his thoughts. Faster and more capable hardware, constantly becoming less expensive, provides hope for adding capabilities without sacrificing speed. Careful system design might also alleviate the trade-off between speed and capability.

Interface Information 4c3

The user must know what he is working on or looking at, what he has done, what his current options are, and how to specify them. He may also require general information about the online environment. The system must provide information on the context as well as the subject of his work in a flexible and expedient way.

Integrated Set of User Interface Principles 4c4

The many tools in the workshop must be integrated into a coherent environment, with consistent conventions for specifying actions and obtaining help. While the terminology may vary widely throughout the workshop, integrated design will allow the user to learn to use additional functions by increasing his vocabulary, not by having to learn new languages. When in trouble, the user should be able to invoke help or tutorial functions in a standard way.

Grades of User Proficiency 4c5

An occasional user with minimal training should be able to work at a basic level and accomplish simple tasks (particularly to acquire help). In fact, an expert user in one area may be a novice in others that he uses infrequently. Attention to an intuitive interface and to novice-oriented tutorial help features will facilitate learning and exploration of the workshop environment.

In addition, the system should reward increased proficiency due to improvements in skill, knowledge, and in conceptual orientation to the workshop's system of tools, methods, and conventions. Advanced vocabularies and concise (fast) control conventions will be important. Furthermore, additions to the workshop should be made available to the advanced user without confusing the novice.

Intuitive Command Language 4c6

The command language should allow the user to express his needs in a vocabulary and form as close as possible to the level at which he naturally thinks. If there is ambiguity in the user's command, the machine should recognize this and prompt appropriately and meaningfully for clarification. However, a completely natural command language may require greater effort and lack precision. Some balance between intuitiveness and efficiency must be achieved.

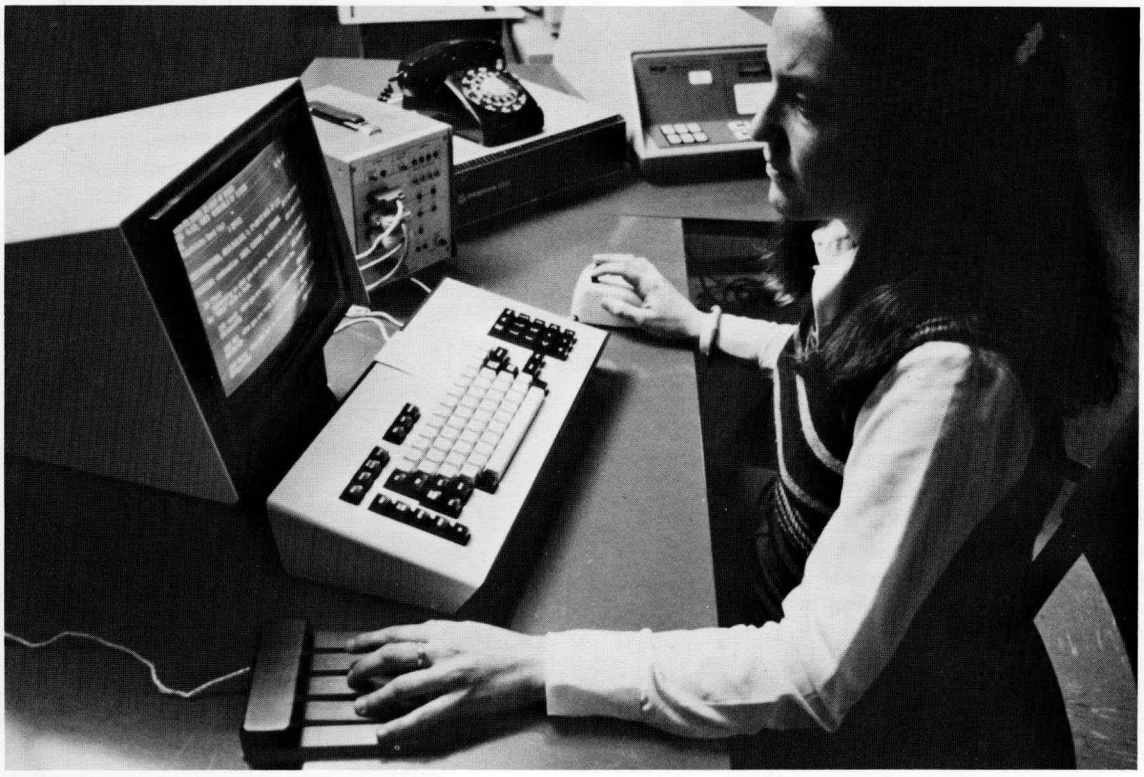
Conclusion 4d

The online environment must provide powerful tools in a framework of easy and efficient interaction, flexible control, and room for growth. Its design -- the extent to which the system meets the needs of its various users -- will determine the extent of individuals' use, its effectiveness in facilitating their work, and the breadth of its application in an organization. 4d1

The Augmented Knowledge Workshop 5

Introduction 5a

The Augmented Knowledge Workshop offered by the Augmentation Research Center of Stanford Research Institute is based on a highly interactive time-sharing information system (currently a DEC PDP-10 computer). This section describes the physical environment (the hardware and its appearance, called the "workstation"), the online tools, and the user interface. 5a1



The Workstation 5b

Terminal Hardware 5b1

One can use the workshop via either a standard typewriter terminal or a display workstation. The user can access all the tools of the workshop from a typewriter terminal, but the display provides a faster mode of interaction.

The display workstation (pictured above) is based on a standard (commercially available) CRT display terminal. Such a display is used by many as a fast and quiet typewriter terminal by scrolling lines upward across the screen.

A micro-processor is required to use the display terminal in the workshop. The micro-processor directs the sequential stream of characters from the computer to the appropriate place on the display screen, and interfaces the other special devices (described below) to the computer. The micro-processor also allows the user to print on an attached hard-copy printer (or standard terminal) while simultaneously working with the display.

A device called a "mouse," when rolled across the table-top, moves a cursor on the screen. This has proven to be a fast, comfortable, and accurate means of pointing to any character on the screen.

The user can type any character available on the typewriter keyboard by playing chords on a peripheral five-finger keyset. When specifying many commands in rapid succession, each of which only takes a few characters, the keyset saves the user from continually having to orient himself on the typewriter keyboard, transferring his hand back and forth to the mouse.

All the special hardware necessary to convert a standard display terminal into an AKW display workstation is available through the Augmentation Research Center at a nominal cost.

The workstation also requires a communications link to the computer. Typewriter terminals can use standard voice-grade telephone lines with acoustic couplers; this makes them particularly useful while traveling, or from the user's home.

A high-speed data line is recommended for the display workstation.

Local Minicomputers 5b2

Some users may wish to include a local minicomputer in their hardware configuration. The minicomputer interacts with terminals, collecting and interpreting commands, and then sends completely specified commands to the basic processing routines in the central computer. This configuration allows a greater number of workstations and very rapid response, thereby lowering the cost of service. In the near future, this may also allow machine independence and computer resource sharing, realizing further efficiencies.

Organization of the Online Workspace 5b3

While he is working, the user must be provided with information of five basic types:

(1) The Information Being Considered

The user needs to know his location in his "information space," and which of the many possible views is being displayed to him. He generally arrives at his present position from previous points and he may wish to return to previous views as well as to move on to new locations.

(2) The Tool Being Used

In workshops containing many tools and commands, the user needs to know which one is now active and which ones he can next enter.

(3) How To Specify a Command

When specifying a command, the user may need to know what he can or is expected to do next, and how to back up to a previous point. Errors must be explained with appropriate messages.

(4) The Information Being Entered

The user needs to have ways to see and modify information and command specifications that he is entering.

(5) General System Information

At any point, the user may need general information about the facilities and terminology of the system he is using.

The AKW display screen is organized so as to satisfy these needs.

With typewriter terminals, one does not have the two-dimensional display capability. So, while the same information is available, the slower speed dictates that less should be given automatically and that some should be offered in an abbreviated form.

(1) The Information Being Considered

The largest part of the display screen is taken by the window to information, to the users' documents. It can be "moved" within and between documents. With the mouse-controlled cursor, the user can point to anything that he sees in this window. The user can split the window into smaller windows, each of which may hold a different view of the same or of other documents. The user can control the format in which he views information (i.e., place "filters" on the window without affecting the document itself).

The workshop "information space" (the documents viewed through this window) is organized hierarchically. Each user has a directory (an online file cabinet) which contains files. A file may represent a reference document, a paper, an outline for a presentation, a formal report, a book, a data base, a message to a colleague, notes on a number of subjects under various headings (e.g. mail and reminders), etc. Files, in turn, are organized hierarchically, like an outline,

with information nodes holding strings of text of arbitrary length, e.g., paragraphs (shortly to be generalized to pictures and other entities). This structure should be apparent in this paper.

The value of hierarchically structured files deserves emphasis. The ability to view a file to any conceptual depth (by the appropriate filter on the window) allows the user to gain a quick understanding of the material he is reading, move quickly to specific information he may need, or view and modify trains of thought at any conceptual level. Powerful dynamic data base retrieval structures can be built using standard tools, yet tailored to each application. Ideas can be viewed and moved as blocks, with or without regard to their detailed contents.

The use of the structure is at the discretion of the user. For example, it may be used in organizing data for retrieval, or it may represent contextual information itself. Alternatively, one may ignore it entirely, placing everything at a single level. The flexibility of its use allows applications of the system to projects formally requiring specialized software. ARC has found that users learn to utilize the structure, in fact, to think in terms of structure, very quickly.

Files can contain cross citations to specific points within the same or other files, creating networks of information. The workshop has appropriate commands for following these citations, moving within and between files.

(2) The Tool Being Used

A given task, such as sending a message or calculating a budget, generally requires several related suboperations (i.e., tools). The workshop is partitioned into clearly defined subsystems designed to support an area of activity (e.g., sending messages or modifying files). Each subsystem contains a number of logically related tools (single or related commands) and has a name such as BASE (the collection of editing and file manipulating commands), CALCULATOR, etc. (see 5c below). Commands were grouped into subsystems by considering ease of learning and of command specification as well as the logical function. All the subsystems work with the same files, and the user can move from one subsystem to another or execute single commands in any subsystem from any other subsystem.

Certain tools (such as moving the window to a new view or seeking help) tend to be used as suboperations of many or all tasks. They are implemented as "universal" commands, available in any subsystem.

The name of the currently active subsystem is always displayed. Additionally, the user can examine the list of subsystems that he has used.

(3) How To Specify a Command

The command as specified so far, prompts indicating what to specify next, and error messages as they occur (see 5c8 below) are displayed across the top of the screen.

(4) The Information Being Entered

As the user types in information, it appears at the top of the screen. It may be edited in simple ways as it is being typed. When the typing is completed, the text will be put in the appropriate place in the file (where it may be freely modified with all of the BASE subsystem tools).

(5) General System Information

The entire workstation can be used with the Help subsystem to obtain general information about the system, the online environment, vocabulary, and folklore (as described in 5c8). The user's position in the information space will be restored when he has finished using the Help tool.

AKW Subsystems 5c

As described above, the many tools in the workshop are grouped into subsystems, each with a specific intent. The most commonly used subsystems are briefly described here, to give the reader a feeling for the scope of capabilities in the Augmented Knowledge Workshop. 5c1

Reading: The Most Basic Tool 5c2

The ability to move the window through and between files is available in all subsystems. In the process, the user may change parameters of the window to provide special views.

For example, one may limit the view to any given level of depth in the hierarchical structure, limit the number of lines of each node displayed, set up content-analysis filters, request certain display formatting features (e.g., blank lines between paragraphs) or information about each node (e.g., by whom and when it was last edited).

One may follow pointers to other views (possibly to views of other files). One may scan for content or for a specified node. One may also list or follow viewing paths back through previous views of a file, and through the previous succession of files.

Editing Subsystem 5c3

The BASE subsystem holds all the most frequently used tools, allowing the user to manipulate the content of files and the files as a whole. Many aspects of this subsystem are available on a variety of commercially available systems; their integration into the unique Augmented Knowledge Workshop environment and conformance to user-oriented design philosophies lends uncommon power and effectiveness to text editing and document production tools.

Modifying Text

The user has available a rich set of commands that allow him to freely modify the information before him. He can work at the structural or content level, deleting, adding, moving, replacing, or transposing anything he sees in his window. The mouse-controlled cursor is particularly effective in this activity.

Manipulating Files

Entire files may be created, moved, renamed, or deleted. They may be made private or open (to everyone or to a specific list of individuals and groups).

Publishing

By placing special formatting codes in a file, one may format the file for output on a wide variety of hard-copy devices, including the terminal itself, a high-speed line printer, or Computer Output to Microfilm (COM) devices. The latter offers publication-quality output suitable for photo-offset printing, giving the user control over type font, columnation, and full justification as well as the standard parameters of page layout and special text generation (e.g., numbering) available on all output devices.

Another subsystem intended to facilitate output formatting includes a tool that applies a variety of predesigned formats to the user's file, making high quality publication available to all.

Teleconferencing

The user may perform any operation in the system while his terminal or display is linked to that of another user, physically anywhere in the world. Two people sharing views and simultaneously working with the tools of the workshop, particularly in conjunction with a standard telephone voice connection, proves to be a very effective mode of collaboration. That this may occur in the same environment in which each does his work adds an integrative power to the teleconferencing tools over and above precluding adjustment to an entirely new user environment.

Calculation Subsystem 5c4

The equivalent of a desk-top calculator (with ten registers) is available as a subsystem. Its power lies in its ability to interface directly to files, reaching in for data and placing the answers in the file as commanded. This subsystem plays an important role where simple numeric analyses support a document (e.g., proposals, budgets, or financial analyses).

Community Dialog Support Subsystem 5c5

One can have any file or piece of a file permanently cataloged. A copy of it will be stored under an assigned number. Additionally, citations will be delivered to a distribution list specified by the author.

The distribution list may include groups as well as individuals. This allows the definition of working groups or communities of common interest, and provides any easy mechanism for community dialog and for the development of a community knowledge base. In combination with the effective individual information-handling capabilities, the resultant order-of-magnitude increase in the rate of flow of ideas should make feasible a true community collaborative effort.

This communications tool allows the recipient to read the document at his leisure, and to respond with comments including pointers directly to places in the original file.

Furthermore, the file stands as a permanent reference and part of the user-community knowledge base (unless specified as private). Recorded dialog might provide an interesting source of information for studying the development and current state of an idea. The excellent cataloging system allows this dialog support tool to be used as a private or public library as well. An application might expect this function to grow in value as the group works in the Augmented Knowledge Workshop environment and builds a history of dialog.

User Programming Subsystem 5c6

As indicated earlier, the ability for the user to extend the system is important. The workshop now offers two forms of extendability.

The user can create sequences of commands and have these sequences executed at will. One sequence can be automatically invoked when the user first enters the workshop environment.

The user can create the sequence either by typing in the text that represents the commands to be used, or by executing the sequence of commands once, the system recording each command for subsequent playback. Either of these techniques allows simple programming without knowledge of any programming language and with only user-level knowledge about the online environment.

User programs written in the system's programming language (similar to ALGOL) can be used like any of the standard subsystems, or programs can be built as window filters. A high-level language allows easy specification of all aspects of the user interface of a program. As mentioned above, window movement, subsystems access, question mark and syntax facilities, and command-word recognition are automatically provided in user-programmed subsystems, supporting a consistent set of user-interface principles.

Programs that are well used and of general interest are being shared with others in the form of a library of applications subsystems. As a general need for a program becomes apparent, it is incorporated into the standard set of tools in the workshop.

User Interface Specification Subsystem 5c7

The user may control the many interface parameters, such as the detail and amount of system feedback and the command word recognition mode (see 5c8 below). The system automatically sets the interface parameters to specified options when the user enters the system. This facility may also attach special tools and perform start-up operations. These capabilities allow easy tailoring of the total interface to the needs of specific users or groups of users. Beginning and experienced users can set their

interface parameters to match their differing styles of use.

Self-Help Subsystem 5c8

There are several levels of feedback and help available to the user in working with the workshop; the first two are available in all subsystems:

Command Word and Argument Recognition

A number of options are available for specifying command words, e.g., recognition after the first character is typed. By whatever form, recognizing and filling out a command word verifies that the system understood what the user intended to specify.

When the system recognizes a command word or argument being specified, it completes it and generates "noise words" that remind the user of what to do next. For example, in the "Move Word" command, the noise words precede each selection of a word that the user makes:

Move Word (from) (to follow)

When the user completes the specification of a field, he is prompted with a few characters indicating the type of input expected next (e.g., a command word or text selection) and the alternatives available to him for how he can specify the needed input (e.g., type in or point to text on the screen).

Error messages indicate any incorrectly specified arguments. The user is left at the appropriate point within the command specification.

Current Options and Syntax

If the noise words and prompts are not sufficient to remind a user about the options next available to him, he may request a list.

If he strikes a question mark, the system displays in alphabetical order all the command words that are legitimate for the current field.

If he strikes <Control-S>, the system prints out the syntax of all possible commands, given his present position in the command specification.

The question mark and <Control-S> are used extensively. They provide a convenient way of refreshing one's memory about infrequently used commands or of exploring new commands.

Help Subsystem and Help Data Base

If the above facilities are not sufficient (perhaps because of uncertainty about a concept or the meaning of a word, or when more information about the effects or use of a command is required), the user can enter the Help subsystem. Entry can be made from the basic command level or from any point during command specification. In the latter case, the Help subsystem describes the command and argument he was about to specify. The Help subsystem gives the user access to a large Help data base.

Once in the Help subsystem, a simple set of commands and the organization of the data base allow the user to examine related or new subjects, or to back up to higher level descriptions. Subjects range from explanations of specific commands or arguments to general discussions about the system and the online environment. It is designed to allow self-tutorial exploration of the system with minimal initial competence.

Command Design 5d

Naming Philosophy 5d1

Commands are intuitive and easy to specify. In most cases, command words have a normal usage related to the operation described.

The command language for the typewriter version and the display version are as similar as possible (except where the differences between the one- and two-dimensional media prohibit this or would limit either version). This allows people working in environments consisting of both typewriter and display

workstations to move back and forth with ease.

Commands are of the form: verb (delete, move, insert), noun (word, paragraph, file), followed by any additional command words and arguments indicating what is to be acted on.

This approach was taken to aid learning; it seems natural and follows normal English imperative forms. The choice of the verb-noun form seemed particularly appropriate in important areas such as editing, where a given verb (such as Delete) can be applied to many entities (such as a whole paragraph, character, number, string of text, or file).

Learning is facilitated if the user can form a model of how the system works that can be consistently applied. In this case, a user can learn a small set of verbs and nouns, and understand that, if meaningful, any two can be used in pairs. Thus, having learned a small number of vocabulary terms, the novice can apply them in combinations to form commands.

Command Specification 5d2

Command words can be specified by all or part of them, in a variety of modes. Experienced users are concerned that commands be formed with the minimum number of input operations and still have the richness to specify the variety of operations needed; novice users require simplicity and intuitive specification. The workshop was designed to balance this trade-off, and to allow the flexibility to adapt to each user's needs. Each user can choose which command word recognition and completion mode is most appropriate to his terminal type, system response, previous system experience, and present workshop experience level.

Arguments are specified in their most natural order. All commands of a similar type are consistent in the order of the arguments. Arguments can be typed in, left empty and defaulted where appropriate, or specified by pointing to appropriate entities on the screen. Infrequently used arguments are optional and novice users need not be aware of their existence.

A confirmation character completes the command specification and the system executes the command.

Backup During Command Specification 5d3

At any point during command specification, the user can abort the command. This is useful if he gets confused and wants to start over or changes his mind about which command to use.

The user can also delete the last character or word typed in, the last command word, or the last selection made on the screen. He can repeat this incremental backup through each field of the command.

Conclusion 5e

This brief description is intended to give the reader a view of how users interact with the tools in the workshop. The Augmented Knowledge Workshop is an integration of a broad spectrum of tools, designed with the needs of a wide variety of users in mind. The business executive typifies a knowledge worker in his activities based on information and ideas. The implementation in keeping with user-oriented design philosophies should make the Augmented Knowledge Workshop a viable aid to the executive. 5e1

Techniques of Augmentation 6

The Workshop Service 6a

ARC provides Augmented Knowledge Workshop service on a subscription basis to qualified organizations. The subscription includes the computer support, documentation, training, and consulting needed to successfully apply the system to ongoing work. An important part of ARC's service is assistance in the development of strategies for

using the workshop in a way appropriate for the organization, and guidance in developing the procedures for implementing those strategies. Technical support in the form of problem solving and answers to questions is provided on a continual basis. ARC is constantly improving the workshop environment, and may undertake special development work on request. [See Reference 8c by J. C. Norton for more information on the subscription.] 6a1

Application Strategy 6b

The effects of the Augmented Knowledge Workshop are far reaching. Strategies for evolving the total set of capabilities in an organization must be carefully planned. 6b1

Generally, an evolutionary approach allows easy assimilation of such tools. Typically a group within the client organization is selected for the initial application (e.g., the corporate planning office). The group is chosen for the probablility of its effective use and for the value of applying such tools to its work. Once a successful application has been demonstrated, the capabilities may be moved outward in the organization. The more people working in this environment, the greater the payoff for joining.

ARC has been most successful at integrating these tools when a person from the application group is designated "applications architect." The architect serves as the organization's primary technical liaison with ARC, and maintains a close working relationship with ARC. The architect should be someone with a good understanding of his organization and the ability to work with people. (Technical background is of secondary importance.) He initially undergoes special training by ARC. 6b2

The architect is given responsibility for planning which capabilities are assimilated by whom and when, and to which projects the workshop is applied. He may ask ARC to or may himself train his group members in using the system, and may assist in developing patterns of use and information flows appropriate to this new environment. He might undertake the design and implementation of special projects for the organization. He might guide the extension of the workshop service in the organization, surveying for successive groups in which it might be employed. The multi-organization group of architects forms an online community that exchanges ideas and information about the application of the workshop.

Current Applications 6c

Current applications encompass a broad range of activities in a number of organizations throughout the United States and Canada. Over 250 people currently use the Augmented Knowledge Workshop, and new interest remains high. Areas of activity include: 6c1

Projects management
Collaborative research
Document preparation and production control
Data organization and retrieval
Computer-based instruction
Project handbook development
Individual knowledge work

The Future of the Workshop 6d

ARC expects the workshop to support an increasingly diverse set of applications. Each may find itself focusing on one or more (of the above or other) areas of application. As this community grows, ARC expects to see the evolution of many special-interest groups. ARC anticipates that the many groups will take on the role of workshop development in their areas of interest. It is hoped that these special-interest communities will encourage fruitful collaboration. 6d1

Conclusion 7

The Augmented Knowledge Workshop is seen as a prototype and growing collection of tools and services to aid knowledge work. Its impact lies in the integration of tools into a total knowledge workshop. The system has proven effective in a number of applications. 7a

The duties of a business executive include many that would benefit from the application of the Augmented Knowledge Workshop. However, it is by no means a panacea for all of an organization's information needs. It is not intended to compete with specialized tools utilized by business (such as high-volume data base retreival systems and accounting systems). It should be viewed as a thinking environment, not a process. 7b

ARC expects that, in the near future, the Augmented Knowledge Workshop will find wide applicability throughout the business community. The value of augmenting management's effectiveness appears high. The careful design of the man-machine interface and the integration of a wide variety of tools are the keys to expanding use of this system designed for non-computer-oriented knowledge workers. ARC looks forward to an ever-increasing integration of business organizations into the growing online community. 7c

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