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### ABSTRACT

NLS is an extensive system of computer aids being evolved toward supplying a coherent, comprehensive environment in which a knowledge worker can do all of his central, everyday work. Support for collaborative dialogue among distributed participants is one important component of the system.

The Journal is an NLS subsystem with basic methods for handling full-text computerized items that parallel those of open-literature professional journals and associated library services -- i.e. a permanent record of any published item, citation conventions by which later readers can retrieve and access references to other items, and catalogs and indices for retrieval aid. Each of these processes is done much faster in our computer environment, and other computerized services may be added. Altogether this provides a very powerful foundation for a new level of collaboration via recorded dialogue.

The Shared-Screen Telephone option for conference collaboration stems from a special "connection" feature in NLS that enables mutually agreeing users of Display NLS (DNLS) to connect through the computer system, sharing the same NLS control and display portrayal. When simultaneously talking on the telephone and making use of NLS's other extensive features, two people can confer very effectively at great distances.

Our experience with these "teleconferencing" provisions brings out two important points: (1) computer-aided teleconferencing is much enhanced when integrated coherently with effective computer aids for doing one's other knowledge-work operations, and (2) computer networks add critically important capabilities to this enhanced form of teleconferencing.

### INTRODUCTION

One purpose of this paper is to publish a note about two powerful modes of computer-aided collaboration; the other is to highlight a poorly appreciated factor regarding the utility to be derived from computer networks -- how these networks will facilitate human collaboration in a unique and powerful way.

The teleconferencing features described in this paper are implemented as coordinated parts of NLS, the on Line System developed at Stanford Research Institute over the past twelve years. A goal underlying the evolution of NLS is to provide an effective "workplace" in which a knowledge worker can keep his everyday working materials and do his everyday work. Providing him with a personalized, computerized workplace for "core" materials and tasks (akin

to what his office provides for him) has been one of two main concerns. The other concern has been to develop a multi-computer, multi-tool framework wherein from this familiar workplace a user can reach through to access materials and tools from a rich marketplace of specialty services. We have a strong feeling that most people working in such an environment will want to reach through to work with other people at least as often as with computer services. References 1 and 2 provide useful framework fill-in regarding our goals and approach.

There are tens of thousands of hours of accumulated experience in using NLS to do real work, spreading back over a decade, with hundreds of people. The Journal system, with over twenty thousand items in it, is a regular part of the working culture for perhaps a hundred people. The Network Information Center (NIC) has been serving users of the ARPANET since 1971. We have been supporting remote NLS users over the ARPANET in steadily growing numbers -- for four years through the NIC services, and for the last year and a half through our Knowledge Workshop Utility service. The latter is a private, not-for-profit venture launched by SRI to provide subscribers with what for a very advanced system is a very solid computer service. The Utility brings NLS computer aids into terminals in the subscribers' offices for exploratory application by their people on their knowledge work. Also, the Utility has a staff of trainers that circulate between subscriber sites to help develop basic knowledge and skills, help iron out the problems in a group's evolution into different ways of working, and transfer application lore.

Our orientation and work methods have produced an approach to knowledge-workshop development and application that seems fundamentally usable for any special area of facilitation, i.e. whether it is for project documentation, intra-group collaboration, special-forms handling, correspondence, individualized bibliographic citation management -- or, for teleconferencing. Our goal is to establish enough daily users of an advanced system so that a particular service sub-system (such as a mode of teleconferencing) can be tested and evolved in an environment which will closely resemble that of the future. As we see it, tomorrow's users will be people working purposefully on daily tasks in a computerized workplace, and the subject sub-system will be employed within a sequence of other-work operations that enrich the possibilities for harnessing it while providing a balanced view of cost, payoff, relative value among intangibles, and so forth.

## BASIC DESCRIPTION OF NLS

NLS is a powerful, advanced system designed to support basic knowledge work. It has many noteworthy features. I will describe a sketchy few to support an image of the power derived from the dialogue-support applications featured here. (Reference 3 provides an introduction to the central set of NLS features.)

Access to the materials and tools in an NLS workspace can be via an online typewriter (using TNLS), or via a CRT terminal using a cursor-control pointing device (using DNLS -- our "mouse" is the main pointing device in use), or via a batched mix of input text and control directives for "deferred execution" (using the DEX subsystem). The control language and the display-terminal setup are designed for generality, application independence, and flexible growth of control vocabulary and task procedures.

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### RECORDED-DIALOGUE SYSTEMS

Consider a system such as is run by a professional journal within the service structure offered by our libraries. An author, by some process, gets an item published. This is followed by a particular series of processes and services.

Direct distribution -- Each person on a certain readership list is automatically sent a copy of the bundled set of items (issue of the journal) in which the new item is included

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Private hard-copy for personal use -- this is often desired. Office copiers now make this very simple (although with a slight tint of copyright illegality).

Storage, retrieval searches, and later access -- A reliable library system will get a copy and store it so that the copy can later be produced if asked for by an explicit, conventional identifier (e.g., Volume X of Journal Y). Other associated organizations (e.g. one's research department, or the orderly colleague down the hall who subscribes and saves) usually provide auxiliary means for gaining later access to the published document -- but let us consider all such under the statement that "it is expected that with reasonable effort a person can later gain access to a specific item when its identifier is known." Some time after initial publication various indexing services provide support for retrieval searches. The journal and/or a related professional association may provide cumulative indexing periodically. These are available at a good library, where one can do a retrieval process to unearth likely citations, access the document, and walk away with a private copy.

Citation practices -- For a true dialogue to work within this system, careful conventions must be followed about citing previously published items. An important value derived from the above storage and access provisions is that when one author wants to write about the work of another, he can cite it explicitly in his text with assurance that his reader has a straightforward way to access the cited work. Where this cited-work accessibility is dubious, an author is considerably burdened.

Over a period of time the citations to prior works grow into a branching network that keeps earlier, relevant writings linked to present thinking.

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Our Journal system was conceived by this author in about 1966. I wanted an underlying operational process, for use by individuals and groups, that would help bring order into the time stream of the augmented knowledge workers. The term "journal" emerged early in the conceptualization process for two reasons: (1) I felt it important in many dynamic operations to keep a log (sometimes termed a "journal") that chronicles events by means of a series of unchangeable entries (for instance, to log significant events while evolving a plan, shaping up a project, trouble-shooting a large operation, or monitoring on-going operations). These entries would be preserved in original form, serving as the grist for later integration into more organized treatments. (2) I also wanted something that would serve essentially the same recorded-dialogue purpose as I perceived a professional journal (plus library) to do.

We established an explicit Dialogue Support System sub-module in our emerging concept of an "augmented knowledge workshop" system. The earliest thrust in this sub-module was the Journal. After several aborted starts, the current form finally began operation in the summer of 1970. It has served excellently. In our Center, we couldn't imagine doing without a service like this and still seriously claiming that we were using computer tools to best advantage.

Direct distribution -- A special NLS subsystem supports submission and subsequent distribution of the messages, memos, data records, or documents that become permanently "published" in our NLS Journal. An online directory file is maintained in which all of the "registered" dialogue participants are catalogued; each has a short, personal "IDENT" code (mine are my initials, "DCE") that can be found by simple interrogation of this directory. Groups can be given IDENTs also, and the IDENT of one group can appear in the membership set of another group. When one submits an item to the Journal System, he provides any number of IDENTs in a "For Action" category, and any number in the "For Information" category.

The IDENT directory contains for each recipient a specification as to where and how his "mail" is to be delivered. Each recipient has a specially designated "mail box" section in his mail-reception file. For a short item, a formatted citation header and a complete copy of the text are automatically delivered into this mail box. For longer items, only a citation is delivered, containing title, author IDENT, date and time of submission, any associated author comment, a tag for either "Action" or "Info Only" classification, and a computer-useable citation link to the full text. The recipient can follow the link to read the item online, or else to produce a hard-copy printout.

Private hard-copy for personal use -- An automatic hard-copy delivery option is available, although most users choose the "online delivery."

Storage, retrieval searches, and later access -- Title and optional comments are provided at submission time. Many other cataloging elements may also be introduced. For example, a pre-assigned accession number (previously supplied by interactive request by the author with this submission subsystem) may be designated for those cases where cross-referencing is desired and one needs to determine a document's accession identifier before its submission time. The accession number of a Journal item being superseded by this new one may also be referenced, or special descriptors may be added.

If not handed a pre-assigned number, the Journal system automatically assigns a permanent accession number to a new item, sets up a catalog entry, and stores it in "permanent" archives which provide the same type of frozen record that traditional publication does. These archives may be accessed at any time, and the user may once

again view the Journal item online, or make a hard-copy.

Citation practices -- If in reading an item online the user comes across a citation link to a passage in another Journal item, he can follow it directly to a specified passage in the cited item. In writing a Journal item there is a great feeling of freedom about citing other items, given these expectations of easy accessibility. This freedom fosters the use of very short dialogue contributions; when several succinct citation links, directed at specific passages, can be easily used for nouns in a sentence, one can communicate important contributions very quickly and easily.

The NLS Journal serves its users in a manner similar to professional journals, with these significant quantitative differences: fast, flexible computer aids serve an author in creating a dialogue item, and help multiple authors to collaborate toward that end; publication time is very much shorter; significant "articles" may be as short as one sentence; cross-reference citations may easily be much more specific (i.e., pointing directly to a specific passage); catalogs and indexes can be accessed and searched online as well as in hard copy; and full-text retrieval with short delays is the basic operating mode. The end effect of these changes is a form of recorded dialogue whose impact and value has a dramatic qualitative difference over the traditional, hard-copy journal system.

Our Journal system has been in regular and increasingly heavy use for five years. First users were Center staff members, who approached its use with caution and mixed feelings. The accession numbers are in the 30,000s now -- probably 20,000 are used for Journal items and 10,000 for catalogued hard-copy items whose accession numbers are taken from the same sequence as the Journal numbers.

Since whole documents may be submitted to the Journal it is common practice to submit trial designs and thinkpieces, inviting comment that will appear as a collection of items that cite various sections (or the whole) of the trial piece and often cite other response items as well. Such a sequence has a function similar to other computer-message teleconferencing systems that record a "conference session". Here, though, any item may also be part of other "sessions," or may have citation links to any item at large that a participant may feel is relevant.

At the option of the author privacy controls may be stipulated at submission time. Only those on the original distribution list may access the item, and the item will not appear in any of the public indexes.

#### THE NLS SHARED-SCREEN FACILITY

In this mode of teleconferencing, two or more people, positioned at separated display consoles, can link their displays so that all see the same image, and at option any can exercise control. When simultaneously talking on the telephone the resulting dialogue can be

uniquely effective -- corresponding to an in-person conference around a collective assemblage of their scratch pads, working records, and individual support facilities. To add extra power to such sessions, special conferencing-aid tools and conventions can certainly be developed to advantage.

But consider the great potential already existing when some of the participants -- or even a single participant -- can effectively use computer tools to work with the relevant materials and processes. There is great value in merely conducting themselves as though they were congregated at a magic blackboard -- each easily able to pull forth materials from his notes or familiar reference sources, copy across into his private workplace any material offered from what the other brings forth, and actually demonstrate his own methods, conventions, and special skills, or demonstrate the circumstances where he has trouble and would like advice. There can be sessions for coaching, reviewing, mutual problem solving, demonstrating, etc. The more comprehensive and efficient the collective tools and skills are for doing a single individual's kind of work, the more effective such collaborative sessions can be.

#### IMPACT OF COLLABORATION ON NETWORK UTILITY

Both of these types of collaborative dialogue will undoubtedly need to be generalized in the future. A computer-supported worker would like to connect to many different people in shared-screen, telephoning mode, eventually as a generalized option to telephoning. And sharing in recorded dialogue can't help but be an extremely important foundation for group effectiveness. We must acknowledge that the march of technology will allow us to record ever broader dialogue media for effective studying, and integration, leading to the day when a shared-screen telephone session, with full video connection of participants' images, can be captured in total, within digitized data forms, to be submitted as an item of recorded dialogue so others can later benefit from the record of the real-time conferencing.

Consider the mutual implications of these possibilities for technologically supported collaboration and the potential growth of computer networks. It is obvious that the richer the set of tools and online working practices of the participants, the more striking the value will be of either of these modes of teleconferencing, and therefore the faster the growth in seriously used collaboration techniques. Also, the value of the computer-held workplace will be considerably enhanced through networking to bring a dynamic marketplace into life.

It is obvious that the collaboration will not be served effectively by merely connecting the participants' terminals to each other, or even by connecting to each terminal through a common, central support system. What is necessary is broad-band interconnection between the processes of the participants' respective home workplaces. Other than with networks, how could this broad-band coupling sensibly be provided for collaborators whose

home workplaces are supported in different machine systems?

Reference 4 provides a framework description of how a community of knowledge workers, joined in either a common mission or by a common discipline, could become considerably more effective if they availed themselves of a coordinated set of information services. The first-listed service is "collaborative dialogue." The premise of the paper is that the data, computer processes, and terminals are tied together by computer networking; and the most basic issue is that the human resources -- knowledge, skill, creativity, intelligence, and drive -- are the important things to bring together. For human beings to collaborate effectively in the future through coordinated information systems, it seems unquestionable to me that computer networking is the inevitable foundation upon which communication will rest.

#### ACKNOWLEDGEMENTS

The research and development for the described work has been supported by several sponsors over the past years: the Information Processing Techniques Office of the Defense Advanced Projects Research Agency has given strong basic support over the entire period; the Air Force's Rome Air Development Center has been a steady supporter; the Office of Naval Research provided key support for some of the particulars in managing Journal catalogs; NASA's Langley Research Center gave parallel support with ARPA during the Journal System's formative years. Staff at SPI who have contributed particularly to concept and implementation are William Duvall, David Evans, Jon Hopper, Charles Iroy, and Jeanne North.

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# NLS Teleconferencing Features: The Journal, and Shared-Screen Telephoning

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NLS is to provide an effective "workplace" in which a knowledge worker can keep his everyday working materials and do his everyday work. Providing him with a personalized, computerized workplace for "core" materials and tasks (akin to what his office provides for him) has been one of two main concerns. The other concern has been to develop a multi-computer, multi-tool framework wherein from this familiar workplace a user can reach through to access materials and tools from a rich marketplace of specialty services. We have a strong feeling that most people working in such an environment will want to reach through to work with other people at least as often as with computer services. References 1 and 2 provide useful framework fill-in regarding our goals and approach.

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Different subsystems of tools, for special-application activities, are easy to develop and easy for a user to invoke. Some of these subsystems are maintained as standard "tool kits" by the Utility; others are created experimentally. Some special subsystems are for adjusting any of the extensive options that may be individually chosen for each user (equivalent to chair height, location of lights, telephone-ring loudness, and so forth); for compiling and debugging software; for hand-driven calculation (pointing to textual numeric data to be operated upon by your "hand calculator"); and for locating user-reference material. In particular, one such special subsystem supports the Journal-submission process.

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working records, and individual support facilities. To add extra power to such sessions, special conferencing-aid tools and conventions can certainly be developed to advantage.

8a

But consider the great potential already existing when some of the participants—or even a single participant—can effectively use computer tools to work with the relevant materials and processes. There is great value in merely conducting themselves as though they were congregated at a magic blackboard—each easily able to pull forth materials from his notes or familiar reference sources, copy across into his private workplace any material offered from what the other brings forth, and actually demonstrate his own methods, conventions, and special skills, or demonstrate the circumstances where he has trouble and would like advice. There can be sessions for coaching, reviewing, mutual problem solving, demonstrating, etc. The more comprehensive and efficient the collective tools and skills are for doing a single individual's kind of work, the more effective such collaborative sessions can be.

8b

#### IMPACT OF COLLABORATION ON NETWORK UTILITY

9

Both of these types of collaborative dialogue will undoubtedly need to be generalized in the future. A computer-supported worker would like to connect to many different people in shared-screen, telephoning mode, eventually as a generalized option to telephoning. And sharing in recorded dialogue can't help but be an extremely important foundation for group effectiveness. We must acknowledge that the march of technology will allow us to record ever broader dialogue media for effective studying, and integration, leading to the day when a shared-screen telephone session, with full video connection of participants' images, can be captured in total, within digitized data forms, to be submitted as an item of recorded dialogue so others can later benefit from the record of the real-time conferencing.

9a

Consider the mutual implications of these possibilities for technologically supported collaboration and the potential growth of computer networks. It is obvious that the richer the set of tools and online working practices of the participants, the more striking the value will be of either of these modes of teleconferencing, and therefore the faster the growth in seriously used collaboration techniques. Also, the value of the computer-held workplace will be considerably enhanced through networking to bring a dynamic marketplace into life.

9b

It is obvious that the collaboration will not be served effectively by merely connecting the participants' terminals to each other, or even by connecting to each terminal through a common, central support system. What is necessary is broadband interconnection between the processes of the participants' respective home workplaces. Other than with networks, how could this broad-band coupling sensibly be provided for collaborators whose home workplaces are supported in different machine systems?

9c

Reference 4 provides a framework description of how a community of knowledge workers, joined in either a common mission or by a common discipline, could become considerably more effective if they availed themselves of a coordinated set of information services. The first-listed service is "collaborative dialogue." The premise of the paper is that the data, computer processes, and terminals are tied together by computer networking; and the most basic issue is that the human resources—knowledge, skill, creativity, intelligence, and drive—are the important things to bring together. For human beings to collaborate effectively in the future through coordinated information systems, it seems unquestionable to me that computer networking is the inevitable foundation upon which communication will rest.

9d

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10a

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