Some implications of computer networks for psychology

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Computer networking as a subject of psychological research has varied facets, including the social psychology of scientists, the role of group "labeling" practices, and the paradigm development process, as well as the definitions of software, hardware, and communication systems and interfaces that fit the research styles, aspirations, and work habits specific to psychologists.

Although I have been professionally interested in the construction of social reality through language behavior since beginning my dissertation research more than 20 years ago, it came as a considerable surprise to me to find how germane generalizations from that research are to computer networking efforts on behalf of the scientific disciplines.

It is very commonly the case that, if a rubric or label may be taken to apply either to a physical object or to some other component or complex out of reality, there is frequently a strong disposition for the "concretized" option to be chosen. When we are trying to deal with the factors involved in computer networks, there is a widespread inclination to suppose that the referent for a computer network is exclusively hardware. We live in a world in which the physical and tangible have decided cultural priority. Just as people in local school districts have often been more agreeable to spending money for buildings than for support of teaching per se, so in the world of computer networks many find it much more comfortable to concern themselves exclusively with the physical network, rather than with the "full system" a functioning network implies. While there are labeling theory issues at stake in such behavior, it is also a very pragmatic problem as well as one of theoretical interest to the social/behavioral scientist.

An understanding of networks that includes the hardware, network software, and special software and hardware required by specific applications foci for research to be conducted on the network, the intercomputer communications components, the modalities of related human communication, and the various human/organizational/social dimensions of a total network's functioning (as well as the systemic integration of all those subsystems) is not easily gained. Apparently, partly owing to social interaction dimensions of working with people in other disciplines, it is often extremely difficult to get the specialists who have something to contribute to an understanding of networks to conceive of network problems in a "full system" perspective. Those who

think exclusively in terms of the physical network as the whole network do not include a concern for the other facets of a network. Even when there is some success in bringing those other facets within the purview of concern, an interest in a total systems framework building toward one coherent body of theory and research (including human, software, and communications and hardware behavior in a single paradigm) is not an easy goal to achieve. The difficulty is, of course, very much a matter of calling for major scientific accomplishments with insufficient resources to achieve them.

The experience here with computer networks is also very characteristic of other experiences with man-machine systems; i.e., it is very like many other issues and problems that flow from our failure to develop an understanding of men and machines in one coherent research frame. The absence of a genuine, comprehensive theory of man-machine systems does seem a remarkable deficit in a society which, for at least 200 years, has been so dependent on advanced technology and science. One senses a flight from a towering reality for which, in the longer perspective of occidental cultural history, the society was not prepared. Neither technology nor science has been as central to the cultural concerns of our world as their impacts on our lives would seem to warrant; after, say, half a millenium, higher education has still not come to terms with its importance.

Therefore, as one seeks to develop research efforts relating to an understanding of "full system" networks, the first major barrier to overcome is a too narrow definition of the focus of attention for network study. Once that hurdle is passed, there remains another of particular interest to the social scientist. In brief, one feature of the issues that research management confronts is the implication of which categories, with reference to the human components of networks, are to be treated in aggregated form, and which in disaggregated form, as well as what labels are to be used for these aggregations and disaggregations. For

more than a decade, I have observed the jockeying for power positions with reference to networking of different types of academics and administrators. The "successes" of certain groups have made themselves manifest in a definition of reality which treats members of university administrations in disaggregated form in the study of social dimensions of networking for the scientific community. For example, computer center directors have been disaggregated out of the total administrative cadre. Senior central administration personnel—university presidents, provosts, vice-presidents, and the like—constitute another such group. Meanwhile, a category called "users" has grown up—significantly, a highly aggregated category. These terms are used so consistently and are such forceful surrogates for strong interests that rendering them problematic is a very difficult task, perhaps not so much conceptually for the individual social scientist, but certainly in general for the affected public. It would take a vast amount of difficult, and unacceptable, explanation to make a good try at swinging the vocabulary around, so that, with reference to networks for science, at a minimum one would have the aggregated categories of "scientists" on the one side and a group of "servers" on the other. In a social world of computer center directors, the likelihood of self-designations as servers seems extremely unlikely. Similarly, even though the word "scientist" should be familiar to computer center personnel, the likelihood of discussion about computer networks with reference to scientists and servers is extremely unlikely. A considerable tangle of connotation is involved in shifting to speaking of scientists by discipline alongside a set of servers, including university administrative officials, computer center personnel, and others. If you find it unlikely, uncongenial, or difficult to think of, much less label, administrators as servers, you have a kind of informal calibration to the problems involved in getting people to think about defining networks from a user's perspective rather than the so-called managerial perspective of the computer center and parts of the university administration which tends to be preponderant.

In this situation there are clear analogies with the world of university libraries. Computer center personnel, those in both universities and large research facilities, come to constitute a group of such numbers and expense that they readily seek, and in some measure succeed in obtaining, a significant autonomy—an autonomy vis-à-vis the needs of groups within their respective institutions which justified their existence in the first place. Academic librarians are often very much the same way. I am reminded in this connection of a story of a well-known research laboratory on the East Coast whose directing scientists decided that they would never hire professionally trained librarians. That has come to seem a somewhat dubious decision in recent years. But for a long time it

served to insure that the librarians would not be developing practices and procedures that were consistent with what they had been taught in library school (as distinct from serving the objectives of scientists, for whose benefit the library was called into being).

Such often is the case with computer networks, even when they are meant to serve, at least ostensibly, the interests of particular groups of scientists. Very frequently the computer professionals in the organization in effect prescribe not only the facilities in their general design, but also their day-to-day realization in terms congenial to themselves. Sometimes so topsy-turvy does this reality become that one can point to scientists (senior scientists, at that) who are diffident about expressing their current sense of computer requirements, lest in doing so they offend computer professionals on whom they are dependent for a certain grade and character of day-by-day service. Although I was surprised at the extent to which the 1975 American Sociological Association sessions on the functioning of computer centers in universities were focused on the social power relationships among the people involved, the general idea could scarcely fail to seem likely to one who has looked closely at the current problems in bringing about computer capability that directly serves research and teaching needs.

In general, one would start with the perceived computational requirements of groups of scientists who share complementary computer needs, supplemented by specifications from computer specialists and computer science professionals who perhaps point a better way to the achievement of goals set by the academic disciplines to be served. Then one would want to define the "user" interface, including both hardware and software, in such fashion that it was generally congenial for the scientists, right down to detailing the location and types of terminals. Only after the specification of goals and congeniality of interface would it seem appropriate to go on to the question of what was to be embedded in software and what in hardware and which options were to be taken to achieve those configurational requirements. What one speaks of here is a network in which the scientist and his needs have primacy; the network in design and operation is subordinated to his convenience and his aspirations. There is an emerging set of constituencies in this country for specialized, and probably virtual, network access. To date, economists, language researchers, and chemists are among those who have had the greatest opportunities to develop their requirements for specialized network computing.

We look to psychology as another science within which network needs may be well specified. The computational maturity of the discipline and what we hope can be learned from the special concerns that

psychologists would bring to the definition of a network could be applied by generalization to the needs of other scientists.

Perhaps in part because of the nature of their own subject matter, psychologists are singularly aware of the poor quality, especially the undue complexity, of the scientist (user) interfaces with present computer systems (much less with network systems). There seems to be an interest among some psychologists in undertaking the production of an interface that would be far more congenial. From a psychologist's professional orientation would come a broader definition of the interface problem. A definition of the interface problem congenial to a psychologist might include the terminals (from a human factors standpoint) and properties of the programming languages, the data structures, the operating systems, and certainly the access rules, i.e., whatever a scientist would encounter when he attempted to make use of computing power over a network. Psychologists might wish to give a certain priority to the integration (to the "systematicness") possible in research on the user interface, and, subsequently, redesign that interface to provide for a better impedance match with the properties of the human being as information processor.

One might expect that psychologists, maybe even more than other social scientists, would be concerned with the social problem attributes that a failure to provide comfortable network access could generate. Computers in networks seem to be more intimidating to the general public than (objectionable though they sometimes seem) stand-alone computers. If accessibility to network computers is not comfortable for people who are not computer professionals, a deeper and more widespread general fear of technology, particularly of computer technology, may evolve. Such a fear might be evaluated as highly dysfunctional, given our current social and ecological condition. It may be argued, then, that research on the computer network interface (to make that interface more congenial to psychologists) could also render a social service in producing a generally more congenial computer interface for the nonprofessional.

One motive that psychologists probably have for attempting research that could lead to improved network capability for their professional group is the present experience of hard-to-use capability. Even more to the point with reference to networking, capabilities available in any given present consortium of computer users are too haphazard and piecemeal, i.e., too segmental for the full range of computer-based resources to which psychologists might wish access. For example, psychologists may well be interested in networks, not only for access to major empirical research data bases and/or to subtle analytical programs and/or to complex simulation and modeling resources, but also for simpler forms of

information exchange and interpersonal professional communication. J.C.R. Licklider helped popularize a notion of research stimulus and interaction under the heading of "the on-line intellectual community." One aspect of an on-line intellectual community is access to its own scientific and intellectual accomplishments. The American Psychological Association has done more than many other professional organizations (as have the physicists) to use the computer in conjunction with the management of bibliographical information relating to research. One capability of a virtual network for psychologists that would be of interest to other research areas would be a more comprehensive national information system available over a computer network, including access to both full text information and bibliographical control.

The interest of many psychologists in national networking certainly also includes network access to artificial intelligence projects; that interest is shared by many computer scientists who work on machine intelligence. Artificial intelligence (AI) projects characteristically are both expensive and difficult to develop and maintain, as is true of various kinds of psychological modeling. Many of these elaborated AI efforts involve components not amenable to being transported, including special hardware-dependent developments, special languages, and operating systems. Currently it could be contended that the development of AI research is held back by the psychological community's inability to gain easy access to extant AI systems. When such access is available, it must be provided in a way that protects the integrity of each AI system as it operates at any given site. At the same time, the system must be available to those who wish to critically inspect details of it with a view to independent validation. It has been contended that the specifically scientific character of psychology is in some measure being prejudiced by the isolation within which much artificial intelligence and computer modeling of psychological functions is done. That same issue emerges, of course, with respect to other disciplines' network needs; for instance, it has been argued that greater accessibility to the details of certain general circulation models in the field of meteorology might have contributed to their improvement.

Thus, a major argument for networking in a number of areas of research specialization is that, given computer-based research of a highly elaborated sort, the traditional sound mechanisms in science for correction through critical access to what is going on at specialized sites is not readily available. It has even been said that at some major research sites the researcher's conduct begins to somewhat approximate that of a hieratic "priesthood," rather than to approximate the normative ideal of a scientist. No matter how sound their intentions, when network access is not available, their scientific peers are

not in a position to examine critically what otherwise is presented to them, necessarily, in an abbreviated, interpretive mode.

Perhaps it also should be emphasized that the increasing mathematization of psychology is an inherently powerful argument for psychologists' interest in networking. That is the case in part because the upward stabilization of the quality of mathematical software is not likely to be realized in many instances except through the use of the network and over a network. Statistical learning theory, stochastic modeling, game theory applications, artificial intelligence, Monte Carlo methods, and nonrandom psychological models are developments that are indicative of the growing dependence of psychology on sound mathematics, sound statistics, sound algorithms, and their adequate realization in computer software.

Not so many years ago there was far more optimism than there is today concerning the satisfactoriness of canned routines in processing research data. There have always been nonstandard experiments and nonstandard observational procedures leading to special-purpose statistical programming, but, for many research designs, analysis using any one of a number of standard statistical program packages was deemed acceptable, by and large. Now we are not only more aware than previously of inadequacies in such software but are also cognizant of the further problems that are going to be posed by the more ready availability of large-capacity, yet cheap, mini-computers at research sites.

The limitations we know of in available software will grow to be a more serious problem when that software is run on a great variety of minicomputers. Networks are needed for some aspects of the software validation process itself; networks also can help provide us with some checks, if not guarantees, as to the adequacy of the mathematics or statistics, the algorithms and their software realizations, and their appropriateness for the applications chosen for them. Inherently less isolation and more research community interaction is made possible by a network, and those properties of the network are favorable to rigor with respect to these issues.

As our society moves toward greater dependence on science and technology, the significance of such psychological research as the interaction of people with such artifacts as the programming process, programming languages, and other facets of full system networks grows in importance. Hopefully these areas of investigation will attract more professional psychologists. It may be argued that the social sciences as a whole have failed to adequately come to grips with the significance of science and technology for the societies that they tend to study most. Within computer science as a discipline, the importance of some of these issues is now beginning to be apparent. For instance, some computer science departments are

becoming interested in the psychology of various styles of program generation management and the psychological dimensions of the human being in relation to the science and technology of computers. Thus, as is true repeatedly in other contexts, network capability available to people in one discipline is also of research importance in another discipline, e.g., the joint interests between computer science and psychological science. The internetworking potential of networks and virtual networks is repeatedly shown to be a highly desirable property.

Another aspect of networks important to psychologists has to do with data-base access. Social psychologists, epidemiological psychologists, clinical psychologists, and ecological psychologists are among those who require access to large-scale files, with data often collected by persons other than the members of their own research teams. In the establishment, improvement, and maintenance of such large-scale data bases, cost is a major factor; of course, the costs of data transmission are high enough to warrant centralizing such storage and maintenance activities for such large data files. It is often the case, as we increasingly realize, that the ability of a researcher to access such files in an interactive mode is critically important. So, in this instance, for psychologists we look to a networking capability based on an understanding of how to produce easy, reliable, and inexpensive interactive computing. With psycholinguistic research, for example, a network is rich in potential, as with language research activity generally. A network can provide for various special-purpose processors which have access to such other processors as sustain the files proper.

Lastly, given the nature of psychology as a discipline, the processes of education as a whole and the case of teaching psychology itself are of special interest. Once more, then, there are reasons for psychological interest in networks, since for many instructional purposes, large-scale systems seem to be needed, such as, for example, with the PLATO project. If the PLATO project and similar projects were made available over wider networks, their use for both teaching psychology and as a technology to improve its educational adequacy could be of real interest to the national community of psychologists.

Finally, a number of other issues (if time allowed) might be explored more fully. One major question has to do with the motivations, or the driving forces, behind much present concern for networks. No doubt some of our present interest is a function of what might be called technological opportunism. That is to say, networks are of interest and networks are in some cases being built partly because it is now possible to bring them about. But in a world of increasing consciousness of the scarcity of resources and of other more blatant economic pressures within organizations, including academic organizations, it is

certainly also true that economic factors are pushing us to consider the network solution to various kinds of problems. Without attempting to develop any **extensive discussion of the very complex set of issues relating to the economics of networks** (issues that are now being addressed in a variety of contexts at a number of institutions across the United States). I might urge that efforts to assess the economic properties of networks not be confined simply to cost accounting characterizations of networks and their alternatives. While it is no doubt important to determine whether the day-by-day and year-by-year costs of a network option vs. some other option are notably different, what is even more important—and much more likely to be neglected—is to consider the social costs of not doing science as well as we can at a time when our need for scientific understanding of various aspects of our human predicament is greater than ever before. Can we afford to do science less well than we know how, both as a nation and as a species? It seems to me that the answer is clear: We cannot afford to do science less well than we know how. Other priorities must be recognized as less important to our futures; many critical problems which may be otherwise unsolvable have their only hope of practical resolution under present circumstances in a more effective commitment to science itself.

That leads to another aspect of the question of the fuels which fire the network engine. To me, at least, it is clear that one of the great prospective values of networking has to do, not with dollar savings (great though they sometimes may be by comparison with alternatives to networking), but rather with the aid networking can provide for greater collaboration among scientists who profit from interaction. One might legitimately hope that science, well served by networks, would be provided not only greater ease of access to data banks of research information, to

bibliographical control over published scientific research, to analytical programs, and to concept retrieval, but also with a much-heightened level of satisfying interaction among researchers working in, in effect, a distributed laboratory. The scale of such a laboratory could be in some respects that of a network served by the scientists using it.

We might even hope that the use of networking in its scientific applications could spread beyond individual nations and regions to encompass scientists around the world who are seeking to cope with such exigent research areas as the ecological. The computer-based network, as a technique applied in the first instance to the work of research scientists, also **could emerge as an important component in a general technology for social cohesion**. Clearly, the coherent conduct of efforts to solve our common problems is an aspiration that we might all share.

Within the past few years, predictions have become optimistic about how inexpensive very powerful chips may become within this decade. Many of us think that, for all the increase in stand-alone capability provided by great power even at the terminal level, in the long term there will be a growth both in stand-alone capability (aided by inexpensive, physically small computers) and in the amount of network utilization, where the networks are accessed from an ever-wider set of types of sources, and less and less from major university computer centers alone. Interactive usage and graphics capability will be, surely, among the major areas of attention in the developing of such network capacity.

In this emergent network technology and science, there are rich opportunities for constructive accomplishment. It is evident that one way to insure such constructive accomplishment is to have a heavy involvement of people-oriented researchers, i.e., an involvement of, among others, psychologists.