User orientation in networking*

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INTRODUCTION

Motivation

The virtues and drawbacks of computer networks are well known. A number of significant networks are already in existence,[1] and their effects and potential in the area of resource sharing are unquestionably important. Confirmation of this fact is indicated not only by the relevant literature on the whole,[2] but also by various NSF-sponsored research efforts[3,4] and special NSF initiatives.[5,6]

But real success in computer networking, totally aside from the question of economic justification, has been quite difficult to attain. This is not to say that important partial successes have not been scored. The ARPA Network, for example, represents a significant achievement in application of communication technology to networking.[7] But the communications subnet was not the only goal. The network was to be used—resources were to be shared.[8] Although some actual "users" have by now gotten involved, and the network implications previously described by Roberts promise considerable growth in usage,[9] indications are that the user was inadequately taken into account during initial network design stages. Only after the sophisticated communications network was established were detailed questions about network usability seriously raised and confronted. The latter were partly initiated by users themselves[10] and have also resulted in a network users group which meets periodically to discuss user problems and suggestions.

In stark contrast to the ARPA network, an Educational Information Network (EIN) was also started several years ago. It has left some lingering lessons behind.[11] EIN was also to enable sharing of computer resources. Much related discussion and planning resulted in an organizational framework within which a user could utilize the catalogued resources of member institutions. But the means of communication provided for EIN was not a telecommunications net. Users were to transmit their data by mail or courier! For this and other reasons, the users were obviously not attracted to EIN. Hence, in spite of the interest in sharing resources displayed by EIN member institutions, very little use was made of the network.[12]

In a sense, we have had a peculiar dichotomy between widespread interest in sharing of computer resources and adequately advanced technology to supply the essential telecommunication means and methods. We must endeavor to bridge the gap. To do so, we do not require substantial additional technological breakthroughs. Instead we need major advances in tailoring the available computer/communications technology to become more amenable to and suitable for human use. Regardless of how efficient a computer network might be, it must be approachable and usable in order not only to appeal to prospective users, but also to retain the current usership.

Therefore, user-orientation in computer network design and implementation is crucial. But how can it be achieved? First, it is necessary to recognize that the objective requires interdisciplinary attention. If the user is of genuine concern, psychological and sociological considerations must immediately enter the picture. Furthermore, network management must be involved. It must bring its directives and policies to bear. In past years, local computer center management frequently left design decisions affecting the user-computer interface to the whims and wishes of local computer programmers. That was serious enough in a local environment. But it must be viewed as intolerable in the context of a nationwide computer network.

Study context

This paper is one result of a recent NSF-supported study.[13] That study was purposely restricted to the major user-oriented considerations which should concern management. The broader roles in network management,[14] though recognized, were not addressed. Just how management itself is organized and distributed geographically was only questioned on the basis of effects (if any) on user services. Logically, the user sees (or should be able to see) management as centralized, regardless of actual organizational structure and location. Consistent with this, the currently popular attempt at stratifying networks into wholesale/retail functions,[15] is considered to be another manifestation of a kind of management which, on the one hand, might show a potential for facilitating services but which, on the other hand, the user "could care less about."

STUDY FRAMEWORK

Global view

There is a time for specialized or stratified approaches to studying a major problem area. This is especially true when a highly complex system is involved, for which some kind of total view may be overly ambitious and in fact counterproductive. In view of the significant progress that has been made, particularly with respect to network-related computer and communications technology, the time is now ripe for putting it all together on behalf of the consumer of network-based services.

We have therefore tried to confront the complexity of user-oriented network considerations at a more global view and higher level of abstraction. The intention was to

1. observe, conceptualize and organize the characteristics and problems of the computer network and its environment which are significant to the user, and
2. systematically utilize the results and other pertinent knowledge for the specification of those network features which should not only eliminate or at least alleviate user difficulties but actually provide a favorable network posture to the user.

All of this has been considered with the view that network management must ultimately be responsible. Much can be said about what is idealistically desirable. But, unless effective means and methods are made available for incorporating desired user-oriented features in network design and operation, and unless network management is properly motivated and has appropriate policies and procedures at its disposal, the desirable network characteristics will remain just that: desirable and seemingly unattainable.

Interdisciplinary approach

As long as a computer network is intended to attract and benefit the human consumers of its services, it must not only be designed and managed for technologically efficient operation; it must also capitalize on the expertise importable from other disciplines, particularly those which can facilitate human interactions or dealings with the network. The increasing sophistication of computer science and technology, as it is exhibited through the presently available as well as planned computer networks, justifiably enthralls computing professionals. However, we must not ignore the (probably) detrimental consequences for the present and prospective network user.

"Non-computer specialist" computer users have had and still do have a multiplicity of problems in trying to cope with past and present computer service modes. The very nature of a geographically distributed set of interconnected service centers presents the real danger of leaving the normal kind of user even further "removed" from what is going on and where to get help. Unless we are will-

ing to suggest or concede that the consumer should learn to live at the mercy of hardware and software and be forced to adapt accordingly, we must deliberately start to take the requirements and preferences of users, whenever reasonable and feasible, into account in computer network design and subsequent management. To determine and understand what the user needs or wants, it is desirable to take advantage of the people-oriented disciplines of psychology and sociology.

Accordingly, our study has been carried out in a distinctly interdisciplinary manner. This should be apparent from the following description of the study procedure and various resulting behavioral considerations.

Three-phase procedure

Toward achieving the objective of developing a framework of consumer-oriented considerations in network design and management, a procedure was followed which consisted essentially of three phases:

1. Descriptive modeling
2. Structured reasoning, and
3. Policy mapping

These are successively characterized below.

Descriptive model

Without any externally imposed network design constraints, a suitable computer network configuration had to be specified as an exemplary model. A realistic and useful network configuration, based both on precedent-setting examples among existing networks as well as on conceptions of what a nation-wide network for science might be like, had to be hypothesized. The study results should then have particular reference to the modeled network.

To hypothesize a network of national scope, without the benefit of any surveys or estimates on who might participate, from where and what for, obviously requires a number of assumptions. These are characterized in conjunction with Figure 1. As that figure shows, the conceptualized model configuration is decentralized. Its nodes are considered to be located at preselected, geographically distributed sites and they collectively involve some set of heterogeneous, medium- to large-scale computer systems. The internode communications facilities are assumed to be adequate for accommodating the reasonable requirements of the network users.

This leads to the next level of our descriptive model: the user population which is necessary to render a network viable. It is depicted by the arbitrary pattern of U symbols in Figure 1. With our primary objective of consumer-oriented network design and management, this level is of course at the heart of concern. What are the possible problems confronting the average user who is trying to access and utilize network facilities from one of the indicated locations? They are not insignificant; they may

be very frustrating if not altogether intolerable. The user is faced with a broad spectrum of questions or potential problems, ranging from whether and where the resource of interest is available, to how to get access to it and utilize it, and how to take care of various administrative matters such as authorization of system use. Throughout this range of user problems, a variety of psychological considerations enter the picture. These are dealt with more closely in a later section.

Having settled on a particular technological configuration for a model network, and having superimposed a required user population for whom, after all, the network services should be intended and designed accordingly, we are ready for the third and final level of our model. It is precipitated by asking whether the network capabilities in terms of hardware and software are viewed to be in themselves sufficient for serving the user successfully. In spite of the aforementioned laudits for technology, the answer is a definite no. Whether we like it or not, people are still required—even in the context of a sophisticated computer network. Hence, as indicated in Figure 1, the user may need to acquire assistance or advice from geographically distributed network staff members or perhaps even other users of the network. Furthermore, the users as well as staff members may have to directly or indirectly relate to or communicate with network management, whatever form the latter might take.

Consequently, we actually find that all of

1. a user population,
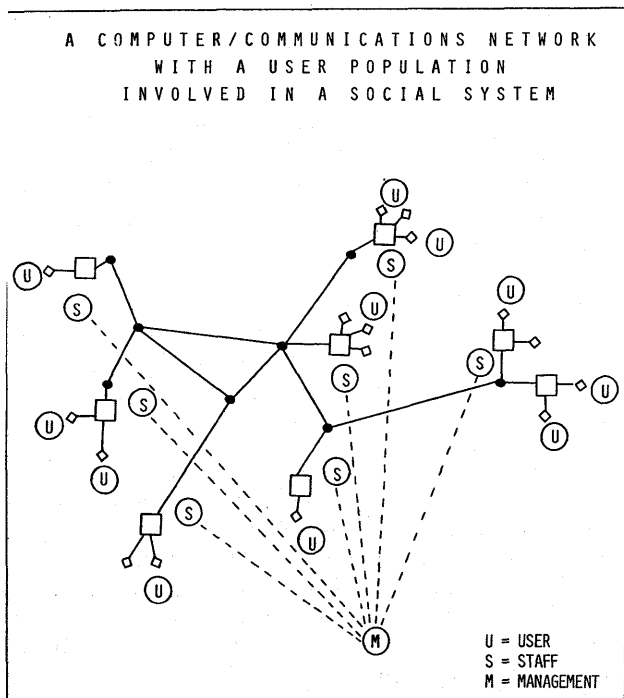2. a supporting staff, and
3. the management personnel

A COMPUTER/COMMUNICATIONS NETWORK
WITH A USER POPULATION
INVOLVED IN A SOCIAL SYSTEM

U = USER
S = STAFF
M = MANAGEMENT

Figure 1—Three-level descriptive network model

are involved in what can be viewed as a "social system" superimposed on the computer network. The sociological considerations relevant to this level of our descriptive model will be highlighted later.

It should be apparent from the description thus far that the nature of this study is indeed interdisciplinary. In addition, since all of the above should be understood, directed and facilitated by network management, appropriate policies and procedures must be established.

Structured reasoning

With reference to the descriptive network model, specific network features now had to be identified along with any corresponding recommendations for management. To accomplish this in a deliberate and thorough manner, an organized structure was imposed on the search for or reasoning out of those network characteristics which are deemed to be consumer-oriented.

From the outset, this structured reasoning phase stratified the network considerations[16] into those pertaining to

1. Usability,
2. Sociability, and
3. Accountability

The term "usability" was employed to encompass those network features and capabilities which have a significant bearing on the user's fundamental inclination and ability to interact with the network to take advantage of its available resources. "Sociability" was selected to include those network features and capabilities which facilitate or enable the establishment of various cooperative links or colleagueships, in the interest of better utilizing available resources. Thirdly, we used "accountability" to refer to those network features and capabilities which permit the user's direct or indirect interaction with management in accounting for network access, use, billing and other related problems.

The three categories of consideration are clearly interrelated in a number of ways. Nevertheless, each area is significant in itself and warrants some separate attention. In this paper, however, emphasis can only be given to the first two because of space limitations. The third category, accountability, and implications of all three categories for network management, will be treated in a separate paper.

Our "structured reasoning" entailed one additional step: the establishment of a framework according to which the desired network features could be determined more systematically. This framework is an array. For each of the usability and sociability (as well as accountability) strata, the framework was employed, as will be seen from Tables I and II, toward finding a desired set of factors in response to each of the following three questions which are indicated by row labels of the array:

1. What is the availability of appropriate resources?
2. Is the user-network interface suitable?

Table I—Usability Factors

NETWORK CHARACTERISTICS AND FEATURES	USER KNOWLEDGE AND PREPAREDNESS	DIAGNOSTIC OR FACILITATING FACTORS
1. Availability of Appropriate Resources: (a) Hardware Facilities (b) Software Capabilities (c) Data Bases (d) Directory to Resources (e) Other	1. On Resources: (a) Awareness of Available Resources (b) Willingness to Find Out about Them (c) Need to Use Them (d) Other	1. With Regard to Resources: (a) Market Survey (b) Publicity (c) Regular and Prompt Updating of Information about Resources Available (d) Other
2. Suitability of User-Network Interface: (a) Terminals (b) Interactive Languages (c) Procedures and Rules (d) Documentation (e) Other	2. On the Interface: (a) Experience with Different Interface(s) (b) Willingness to Learn How to Use It (c) Willingness to Study Documentation (d) Other	2. With Regard to Interface: (a) Training both On-line and Off-line (b) Preparation and Distribution of Appropriate Documentation (c) User Feedback Leading to Potential Redesign (d) Other
3. Level of Network/Interface Performance: (a) Accessibility (b) Reliability (c) Responsiveness (d) Data Security (e) Other	3. On Performance: (a) Realistic Expectations (b) Reasonable Tolerance (c) Willingness to Accept Blame when Appropriate (d) Other	3. With Regard to Performance: (a) Continuous Evaluation (b) Security Checking (c) Quality Control (d) Other

3. Are the network resources as well as interface performing properly?

Further structure is imposed via the dichotomy portrayed by the first two columns of the array. In spite of the frequently mentioned advocacy of user-orientation in this paper, that is not to imply a totally one-sided relationship between user and network. The user does also have certain, minimal obligations. While the network must supply the necessary resources, the user must at least show enough interest to be minimally informed and prepared. Thus, for each network characteristic to be listed in the first column of the array, one or more corresponding obligatory factors in behalf of the user are implicitly sought in the second column.

Policy mapping

If we can successfully identify the significant consumer-oriented network features, then the final question to be addressed is: what should network management do about them, or what policies and procedures should they adopt and carry out?

This third phase of our study procedure can be viewed as a kind of policy mapping. The third column of Figure 2 can be used to define this concept. If the first two columns portray the features to which the network and the user should respectively contribute, what are the factors, or means and methods, which are available toward diagnosis/reinforcement/facilitation of the desired features on the part of management? Furthermore, management must be cognizant of and apply suitable policies and procedures to assure success. Thus, while the factors to be listed in the third column are responsive to "what" is necessary, certain policies and procedures are required to say "how" it is to be done.

PSYCHOLOGICAL CONSIDERATIONS

Usability array

Network usability factors pertain to the user-network interaction. Collectively they represent a kind of idealized profile of man-machine partnership or rapport. The network is expected to provide all those features which carry psychological implications for user attraction to and satisfaction by the network. The user, on the other hand, should be obligated to do comparatively little: gain minimal knowledge and preparedness and display a reasonable attitude toward the network.

These considerations are brought out in more detail through the structured reasoning phase, resulting in the usability array displayed in Table I. The latter is not intended to be exhaustive and entries are only indicated in capsule form.

From the standpoint of interest and welfare of the user, the network is unlikely to attract attention unless it has some appropriate resources to offer. These might include special hardware facilities or software packages which are not locally available, and perhaps one-of-a-kind data bases to which access is sought. And to assure awareness by the user of the available resources, a very important resource in itself is a (preferably on-line) directory to the repertoire of network facilities. But all of that is to no avail if the prospective user does not have a need (or at least a natural curiosity) to become aware of what the network can offer, and to expend the effort toward finding out.

Utilization is promoted if the user or potential user is aware of the resources available and how to use them. This means that adequate steps must be taken to publicize and announce what resources are available, when they are available, where they are available, and how the user can take advantage of this opportunity. Such publicity must

be complete and up-to-date in that it includes the latest changes about each of the resources.

In order to keep the resources of the network attuned to the needs of the user a mechanism for surveying user wants and experiences in utilization must be established. This must be accomplished on a regular basis so that network performance quality can be maintained through improvement of existing resources or by re-design.

Assuming that those first hurdles are overcome and a user-network match-up is potentially in the making, the details of actual interaction with the network gain prominence. Does the network support the kind of hardware terminals, e.g., graphic devices, which the user wants or needs? Is the interactive language, or set thereof, too heterogeneous and confusing? Are the required interaction procedures too cumbersome, and is the related documentation out-of-date or lacking in clarity? Answers which are unfavorable to the user will surely tend to lessen if not eliminate enthusiasm for the network. But even if interface features are favorable, the user is again obliged to play his part. Experience with other interfaces will normally help, although prior conditioning to certain characteristics and expectations can also negatively affect a user's view of a new facility. In any case, the user must demonstrate a willingness to learn whatever is required in order to interact with the network in question. This task must not be too difficult; otherwise, the user will give up.

An individual desiring to use the network's resources should be able to take advantage of an orientation and training program to satisfy his need for basic information about the network. Such a training program may be conducted in both on-line and off-line modes. Distribution of documentation may take place at an off-line training session. However, adequate documentation should be readily available at other times as well.

Finally, with reference to Table I, the basic network resources and interface characteristics may exist and appear to be attractive, but their respective performances may be lacking. A much longer list of performance factors, viewed as desirable from the user's standpoint, could be listed. While some of them, such as reliability, may be deemed more important than others, the overall "usability" of the network is significantly affected by its performance profile. However, as before, the user must do his part. He must be realistic and reasonable in what he expects and what he is willing to tolerate. This is of course to some degree influenced by the user's past experience (and conditioning to other computer services) and resulting understanding of and appreciation for what is realistically possible.

Selected special concerns

Not all the important features are apparent from or even listable in Table I. Instead, some result from various collective treatments or abstractions on those features which are listed. A few of these are highlighted in Table I.

Attracting users

What is it about the psychology of a user which causes him/her to be attracted to a particular service, such as a computer network? Actually both psychology and sociology are involved in the process. To begin with, somebody has to be innovative enough to try it regardless of whether he knows of anyone else having done so. Then, in trying the network, he finds himself faced with an assortment of network features like those listed in Table I, and the questions relating thereto. After a trial period, some particular mixture of favorable characteristics may tip the user's "scale" in favor of network-related success, as op-

Table II—Sociability Factors

NETWORK CHARACTERISTICS AND FEATURES	USER KNOWLEDGE AND PREPAREDNESS	DIAGNOSTIC OR FACILITATING FACTORS
1. Availability of Appropriate Resources: (a) Staff Specialists for Various Resources (b) Specialists Among Other Users (c) Directory to Human Resources (d) Other	1. On Resources: (a) Awareness of Available Human Resources (b) Willingness to Locate Them (c) Need to Use Them (d) Other	1. With Regard to Resources: (a) Identification of Specialists Among Other Users (b) Selection of Staff Specialists (c) Publicity on Availability of Specialists (d) Other
2. Suitability of Interpersonal Interface: (a) Special Communication Software/Hardware (b) Interpersonal Communication Procedures (c) Documentation (d) Other	2. On the Interface: (a) Interpersonal Communications Experience (b) Willingness to Communicate (c) Willingness to Learn Special Procedures (d) Other	2. With Regard to Interface: (a) Training and Scheduling of Specialists (b) Opportunity for Regular Face-to-Face Meetings between User, Staff, and Management (c) Insuring Sensitivity to User Concerns (d) Other
3. Level of Human Network/Interface Performance: (a) Access to Specialists (b) Human Responsiveness (c) Cooperation (d) Other	3. On Performance: (a) Tactful Communication (b) Demonstrated Appreciation (c) Appropriate Credit (d) Other	3. With Regard to Performance: (a) Continuous Evaluation (b) Incentives Program for Staff and User Specialists (c) Instill in Staff that Network is a Means to an End for the User rather than an End in Itself. (d) Other

posed to failure. The mixture does of course vary from user to user, subject to personal priorities, preferences, and again, prior experience.

The important byproduct of successful user experience with the network is that a satisfied user is probably the best catalyst for attracting additional users. The attraction of users in this manner entails basically three steps:

1. Observing or being informed that another user (e.g. colleague) has been successful in using the network and likes it,
2. Actually bringing himself to try it,
3. Experiencing that an adequate combination of network features (in Table I) is favorable and that his required personal efforts (also Table I) are not excessive.

Thus the user has essentially been given positive reinforcement for expectations, personalized to himself, but originating from promises or projections based on someone else's experiences.

Informing users

Another concern, which cuts across the considerations in the second column of Table I, is how much information the user actually needs, or is forced to assimilate, in interacting (or learning how to interact) with the network. The user who really wishes to know all about available resources, access procedures, interactive languages etc. is probably the exception rather than the rule. Instead, at any particular time of being motivated to access the network, the user wants to know only what he needs for successful interaction. And he wants that information to be made available expeditiously and unambiguously.

Ideally, the network should enable the user to learn, on the one hand, as little as necessary and, on the other hand, as much as desirable. Over a period of time, this will cause the user to develop more insight than if initial experiences with the network required the user to learn a multitude of details about the total network. Opportunities for learning as much as desired, when desired, should however be available. The extreme of inundating the users must not be replaced by the extreme of withholding pertinent information or perhaps cloaking it in technical jargon which only specialists understand.

Maintaining users

After a user has been attracted to the network and, then, has been adequately but not excessively informed about the network, what is to make sure that he does not turn into a non-user again? Aside from any economic considerations, the user who needs the particular resources available can be expected to remain a customer either until the network services and performance deteriorate below a certain, personal threshold of tolerance, or until a competitive computer service with better performance becomes available.

So, the key to success in maintaining users lies not only in assuring that those characteristics which originally attracted the user are continued at the same or higher levels of performance; it also requires a certain amount of innovativeness toward improving services, without generating serious disruptive effects. As the user gets more experience and gains a better understanding of what the network can and could do, he probably does not want to stay in a networking environment which is comparatively static. Thus, aside from pure economic and administrative concerns, the user is likely to remain satisfied if the network achieves a reasonable balance between service quality and innovative hardware/software development toward modifying/improving network capabilities.

SOCIOLOGICAL CONSIDERATIONS

Sociability array

The social system of users, staff and management, when superimposed on the technological network, plays a significant role in actually enabling or facilitating network use. The "sociability" concept is therefore not addressed for its own sake, but because of its bearing on "usability", described earlier. The primary concern here is with overcoming the depersonalization which naturally arises in networking where, by design, a network as a "system" is automated to the maximum extent possible consistent with economic and reliability considerations. This means that communication between users, staff and management must be natural and free flowing. Thus, ability to communicate should be an important factor in selecting staff and management personnel. Beyond this, mechanisms to promote communication should be established.

Analogous to what was done with usability in Table I, sociability factors are portrayed in capsule form in Table II. It can be seen that the main emphasis is on users "socializing" with the network staff or other users. Network management is assumed as implicit in or behind the staff representatives of the network.

It is interesting to observe that many of the factors listed in Table II are analogous to those in Table I, except that now a human network of resources is that object of attention of the user. This means that on the network side appropriate staff specialists must be made available and identifiable by means of a suitable personnel directory. In addition, for certain highly specialized projects and personal resources accessible via the network, other users might be the best (if not the only) available sources of information. Given their willingness to participate, they can significantly supplement the network's repertoire of human resources. As was true for the hardware and software resources, the user must now play his/her part by gaining awareness of the human resources and then, when necessary, calling on them.

But that is more easily said than done. Given an up-to-date directory of network specialists, the regular telephone call can be employed for a limited amount of interpersonal communication. However, in a reasonably sophisticated network, various (computer) network-supported modes can be expected and are preferred for certain tasks. Voice conversations can of course be maintained in addition to on-line, computer-based communication.

As was the case for the user-network hardware/software interface, the hardware/software-supported interface for interpersonal interaction must be suitable for the user. Otherwise, if it presents too much of an obstacle, he will become frustrated and refrain from any further attempts to get (remotely located) human assistance in the network.

Thirdly, with reference to Table II, the human resources aspect in the network must perform satisfactorily. If specialists are announced to be available at scheduled times, the user should be able to rely on that. Furthermore, once the user-specialists communication link is established, it is not too much to ask that the specialist be as patient, responsive, and cooperative as is reasonably possible. Managers of local computer centers know only too well what problems arise from lack of adequate and sincere user-orientation on the part of staff members. This possibility is most likely to be compounded in attempted communication between a user and a remotely located resource person.

Selected emphasis areas

Within the social system consisting of users, staff and management, it is desirable to give special attention to each of the following pairwise combinations in the network environment: user-user, user-staff, staff-staff, management-management (perhaps multi-level), user-management, and staff-management. The following two sections briefly address only the first two of these; the others will be considered in a separate paper.

Users and users

One important reason for one user's wish to gain the assistance of another was already indicated: the case in which the latter is perhaps the best or only authority on the use of a particular piece of hardware or software or data base. But other reasons may exist.

This leads to a potentially significant sociability feature in a computer network. If the network can maintain some kind of accessible record of usage patterns and related user problems, as exhibited or experienced by individual users, then the capability to search such records could lead to user-user match-ups and subsequent interactions.

Of course the above would not be carried out without expressed user permission. User privacy and the proprietary nature of his software or data must clearly be protected. However, if and when a user determines that the time is ripe for him to share information about either

his newly developed data bases and debugged software packages or his other substantive network-related activities and experiences, he should be able to so indicate, with the assurance that he will be given appropriate credit and can turn this accessibility off when he desires.

Users and staff

One of the serious problems in user-staff interaction is overcoming the certain "in-group barrier" which tends to develop and surround network personnel. The latter are very likely to evolve an esprit de corps, based on the significance and attractiveness of belonging to the network organization, such that they become rather self-centered and regard the struggling users out there as almost alien.

This is, in a sense, not too surprising in view of the normal constituency of a network staff: computer programmers, information retrieval specialists, computer systems analysts and others with similar occupational titles. These persons are naturally inclined to view their common objective, namely the computer/communications network, as the only thing of importance.[17] But regrettably this is done strictly from their occupational vantage points, without attempt to reach out and learn to appreciate what the service consumer at the other end of the network is really trying to do. These users do not normally regard the network as all-absorbing. They tend to be persons from industry, business, government or academia who only wish to use the network as a means to an end, not an end-in-itself.[18]

That gap between staff and users must be bridged. And once the staff members can be encouraged, enticed or ordered to develop greater interest in and understanding of user problems, then they can become more receptive and responsive to user inquiries for assistance. Needless to say, as was indicated previously, the user must in turn demonstrate not only respect, but also the tact and appreciativeness which makes for much better two-way communication among people.

CONCLUSION

A review of the literature on computing indicates a plethora of material on networking. But in this literature there is a paucity of publications dealing with users in relation to a network. The current paper, and the study from which it is derived, contributes to the literature on networking because:

1. It emphasizes user concerns and focuses on certain features which make the network consumer- and service-oriented.
2. It highlights the importance of an interdisciplinary approach in studying one aspect of networking.
3. It displays one structured method of attacking such a complex system.

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