Introduction

"If you want to make enemies," said Woodrow Wilson, "try to change something." Yet the rapid evolution of computer technology makes change an inevitable companion to users of computers. Does this mean that those who manage computing facilities are destined to acquire enemies? We think not. In this paper, we consider the implications of rapidly changing computing environments for those who use computers as tools in business, education, and research. We discuss resistance to change in computing environments, and propose suggestions for facilitating change, both for end-users and for those involved in making decisions about and implementing change.

The term "computing environment" has traditionally been used to refer to the hardware and software of mainframes and minicomputers — multi-user systems which operate on a time-sharing basis, and are usually controlled by a few, mysterious individuals who speak a language foreign to most. Changes to this type of environment vary widely in nature and degree and are usually based on the decisions of an individual, department, or committee charged with responsibility for such decisions. For example, in August 1983, the Tulane University Provost appointed an Ad Hoc Committee for Academic Computing, charged with the "reassessment of Tulane's institutional strategy for academic computing." The committee recommended that academic computing be decentralized and that an IBM System 370 replace the two existing Digital Equipment Corporation DECSystem 20s as Tulane's central mainframe system.

In December 1984, Tulane Computing Services installed an IBM 3081 GX mainframe for all administrative and academic computing. Almost two years later, in September 1986, the academic DEC 2060 was removed from service. (The administrative DEC was removed three months later, in December 1986.) In December 1987, a second IBM 3081-class mainframe computer was installed, and academic and administrative data processing were separated, each operating independently on separate IBM 3081s.

While Tulane's mainframe systems were undergoing the metamorphosis from DEC to IBM, microcomputers began to populate the campus and many computer users seized the opportunity to become independent of the central computing facility. Microcomputers permitted users to modify their own computing environments — or, more important to some, not to modify them. Since then, the number of microcomputers on campus has increased by several hundred percent, local area networks and workstations have proliferated, and, as in many organizations, there is a growing need to standardize the use of microcomputer hardware and software and communications protocols. Today, even the independent microcomputer user is a potential victim of change.

In this discussion, the term "computing environment" refers to computer hardware and/or software in a single- or multi-user system. Examples of computing environments in this context include a small local area network administered by a member of the department in which it is installed; a mainframe computer system maintained and supported by a department of "information systems"; a department or organization which requires its members to use a particular type of hardware or software; a faculty member teaching a course in which students utilize a particular type of hardware or software; and offices in which a particular computer system is used by all members of the staff.

Many types of changes are possible in these varied computing environments. For example, an organization's department of "information systems" can replace one mainframe computing environment with another, either as the result of an autonomous decision, or upon the recommendation of a committee or consultant. An individual or office might update to a new version of a word processor or spreadsheet, or an existing version of a major software site license (e.g., the SAS® system) can be updated. Other examples of changing computing environments include installing a campus-wide network; substituting a local area network for independent microcomputers in an office or department; implementing software standards where there had been none before (for example, providing support only for a particular microcomputer word processor); and separating sales, delivery, and repair of microcomputers from other microcomputer support services, where these services had previously been combined.

In each of these examples, changes to the end-user computing environment can occur without the involvement — or sometimes even the knowledge — of the end-user. In each example, at least one individual other than the end-user has some degree of responsibility for and control over the computing environment. In each case, the change may
impair the progress and productivity of the end-users.

The considerations described in this paper are independent of specific hardware and software. The topic addresses change in all types of computing and networking environments and are relevant in industrial, educational, and research settings. The information is likely to be of particular interest to those who have responsibility for the use of computers by others, and for users of computing systems which are controlled or regulated to some degree by individuals other than themselves.

There is a fine distinction between remaining up-to-date with the rapidly changing advances in computer technology, and providing a stable computing environment which enables its users to conduct their work efficiently, using computers as tools. The nature and degree of change which will be accepted by users depends on a number of factors and is likely to vary over time.

The purpose of this paper is to initiate discussion about the positive aspects of changing computing environments and how changes can be made palatable both to the users of a system and to the implementors of change. Beyond the scope of this paper, although certainly of considerable influence in the "success" of such change, is the decision process underlying the initiation of change. For the basis of this discussion, the reasons for change are presumed valid and the change will be assumed to bring some significant advantage to the overall productivity and success of the organization.

The unique position of the authors of this paper is worthy of note. For the past two years, both have held administrative positions of responsibility in the central computing facility at Tulane University. Prior to that, both experienced computing at Tulane from the other side of the proverbial fence: Diem, as a faculty member in mathematics and biostatistics for 20 years, Hartman as a recent Tulane Ph. D. in psychology. Each had significant computing experience at Tulane; much of it laced with frustration. The ideas they held about implementing change were based largely upon their experience as users of computing facilities, rather than as managers.

Eighteen months after the IBM 3081 had been delivered and installed, and two months before the DEC 2060 was to be removed from service, Diem and Hartman accepted positions in the academic computing division of Tulane Computing Services. There they faced the challenges involved in the final preparation for and support of a transition which was highly significant to the University's missions of education and research.

**CHANGE**

The Psychology of Change

Psychologists who favor "consistency theories" of attitude and behavior propose that humans work to maintain psychological consistency in their beliefs, attitudes, and behaviors. In the present context, these theories suggest that once people begin to use a new computer system, their attitudes toward that system will automatically improve in order to maintain consistency. In other words, using a particular system while continuing to think that it is unsatisfactory or inadequate will produce an uncomfortable state of cognitive "dissonance" or "imbalance." The theories postulate that humans will work to reduce or eliminate this dissonant state, either by changing their behavior or changing their attitudes about the behavior. Thus, psychological consistency theories imply that those in positions of implementing change should develop strategies which make it easy for users to retain, or at least appear to retain, their current beliefs, attitudes, and behaviors toward a particular computing environment.

"Functional approaches" to psychological theories about change argue that an individual's attitudes are resistant to change because they serve specific purposes or functions for the individual. According to this view, attitudes help us maximize future rewards and minimize future punishment, understand and interpret events that would otherwise be difficult to explain, protect self-esteem, and express our uniqueness and identity. Thus, to change another's attitude (it should be noted that in this context attitude change is considered a prerequisite to behavior change), the needs that the attitudes satisfy must be addressed. In the present context, before one can be content with a new computing environment, he or she must be sure that the new environment will meet his or her current and future needs. Consequently, those managing change in computing environments should extol the virtues of the new system in concrete and pragmatic terms.

Resistance to change

Psychologists believe that when long-term change is involved, it is usually more effective if the target of the change — the person or people who are to be affected by the change — regards the change as a consequence of his or her own choice. Further, if the target regards the change as externally motivated, then the person or group doing the influencing must continue to exert effective external forces in order for the change to remain acceptable.

Sometimes it is possible to use a very subtle reward or punishment and still get the target to make the change. When this happens it is a powerful strategy because the target may not realize that the change was produced by an external.
force and instead see the change as being a consequence of his or her own choice. Research ... has shown that when people make a change that is perceived to be internally motivated, they tend to develop beliefs and attitudes that justify the change and help to maintain it.¹

Changes to computing environments vary in their nature and degree, and the degree of resistance to the change will be influenced by many factors. Interestingly, changes which appear minimal to the end-user may require hundreds of person-hours in planning, preparation, and implementation for those involved in effecting the change. On the other hand, changes which appear minimal to a system programmer can be major impediments for end-users of a system.

The degree of resistance to change in a computing environment will vary along a continuum depending on a number of factors:

- the specific nature of the change;
- the understanding held by users of the reasons for the change and the long-term positive benefits which the change will effect;
- the users' perceptions of the knowledge and expertise of the training and support staff;
- the positive publicity used to influence users both before and during the change process;
- the manner with which users and staff are educated about the new system;
- the size of the organization and the number of people involved;
- idiosyncratic reasons specific to a particular organization, for example, a sense that the computing facility has never been responsive to users' needs.

Many factors are likely to influence the "success" of a change — that is, the degree of resistance to the change and the facility with which the new environment is integrated into the organization. Changes in computing environments assume a number of specific forms, including differences in nomenclature, user interface, syntax and command structure, file handling capabilities, memory and storage mechanisms, documentation, and underlying operating system philosophy. On the positive side, however, the change is assumed to have both long- and short-term advantages to the overall success and productivity of the organization. Examples of the types of advantages a new system may hold over a previous system include:

- greater speed and power;
- more cost effectiveness;
- increased reliability;
- more effective long-term strategic move;
- easier to use;
- support for software previously not available;
- facilities (e.g., laser printing, vector processing, and access to national networks) previously not available;
- better technical support and documentation; and
- industry standard for specific discipline (e.g., UNIX for scientific and engineering computing).

In 1984, the Tulane University faculty decried the inadequate computing environment on campus and made a plea for change. The consensus was that the DEC 20 environment placed Tulane researchers at a competitive disadvantage. Specific complaints expressed at the time included slow response time (not merely an inconvenience but a serious impediment); frequent system failures; lack of sufficient disk storage; delays in the acquisition of software and software updates which required conversion in order to run in the DEC TOPS-20 environment (e.g., SPSS™, BMDP); unavailability of the SAS system and other products which did not run under the TOPS-20 operating system; inadequate tape, graphics, and printing facilities; and insufficient terminal access.

In spite of the consensus of the faculty and administration that the computing system was inadequate and required change, when the IBM system was installed in December 1984 it was severely underutilized and required change, when the IBM system was installed in December 1984, it was severely underutilized. Also in 1984, the Tulane University faculty decried the inadequate computing environment on campus and made a plea for change. The consensus was that the DEC 20 environment placed Tulane researchers at a competitive disadvantage. Specific complaints expressed at the time included slow response time (not merely an inconvenience but a serious impediment); frequent system failures; lack of sufficient disk storage; delays in the acquisition of software and software updates which required conversion in order to run in the DEC TOPS-20 environment (e.g., SPSS™, BMDP); unavailability of the SAS system and other products which did not run under the TOPS-20 operating system; inadequate tape, graphics, and printing facilities; and insufficient terminal access.

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Although both faculty and administrators had input into the decision to move to an IBM mainframe environment, there was (and still is) resistance to the change. The resistance stemmed from the following factors:

- many individuals resented the need to learn a new system, a task seemingly not directly related to their primary responsibilities;
- the nomenclature which accompanied the new environment was foreign;
- certain utilities and functions available on the old system were either not available or did not operate in exactly the same way in the new environment;
Facilitating the Change: Reducing the Resistance

The types of changes which have been discussed in this paper are generally the result of decisions external to the end-user of a particular computing environment. As a result, one can assume that there are likely to be degrees of resistance to such changes. There are, however, a number of ways in which change can be facilitated and by which the resistance to change can be reduced. Certainly, the suggestions enumerated below will apply to different organizations and situations in different ways. Not all of the techniques will be relevant or appropriate in a particular environment or for a particular change. The type and size of the organization, the number of people involved in the change, specific degree and nature of the change, and to a certain extent the reasons underlying the change will all affect the implementation of a particular change.

The following considerations may be useful in facilitating change and in assisting users in adapting to the new environment:

1. Involve end-users in the process of change. As much as possible, include those who will be affected by the change in the decision process and implementation. As described above, individuals who perceive that a change has been internally motivated will tend to more readily adapt to and accept the change. Even after the decision has been reached, providing information to the targets of the change about the positive reasons underlying the decision to move to a new environment will help these individuals integrate the change and will provide incentive to accept the new environment.

A committee of users can provide an opportunity for those who will be affected by the change to communicate with those involved in its implementation. Such a committee should be kept informed throughout the process.

2. Launch a public relations campaign. A "campaign of propaganda," beginning well in advance of the scheduled change, should describe the advantages of the new system. It may also be useful to explicitly enumerate the shortcomings of the previous system in demonstrating the advantages of the new. Such a campaign can assume many forms; for example, a series of "readable" (i.e., not too technical) newsletter articles to provide information about the status of the change and to identify staff expertise and training (especially since new staff may have joined the organization in preparation for the change). End-users should be confident that there will be at least the same level of expertise available to them for the new system as there was for the previous.

In the case of Tulane’s conversion from DEC to IBM mainframe computing environments, the benefits of the new environment included the SAS system and many of its components, the finite element analysis program MSC NASTRAN, the Numerical Algorithms Group (NAG) library of FORTRAN and Assembler subroutines, the general-purpose circuit simulation program IG-Spice, access to BITNET, the world-wide network of academic and research institutions, the ability to run large-scale, computer-intensive programs, and a base of powerful computing systems upon which the university could grow in the 1990s and beyond. In addition, response time was decreased, online help was increased, and access to computing grew by several orders of magnitude.

3. Plan the education and training of staff and end-users. Staff members who will be responsible for implementing and supporting the new system must receive proper training early, before others begin to use the system. Users do not want their support staff to learn along with them. They require qualified professionals who can effectively deal with questions and problems which arise, especially during the early stages of the transition. Plans for training users on the new system, for example, with short courses or tutorials especially tailored to specific groups of users, should be widely publicized. Computer-aided tutori-
als, if available, should also be publicized.

4. Provide high-quality local documentation in addition to vendor documentation. Both vendor-provided and locally-written documentation about the new system and about migration from the old system to the new should be prepared before the new system is made available. Documentation may well be the most important component of a successful change, especially if the organization involved is relatively large, precluding one-on-one interactions and individual instruction on the use of the system. Local documentation of the most fundamental aspects of the new system (for example, accessing the system, keyboard configurations, running base SAS software, and compiling and executing programs) is crucial to permit the support staff to concentrate on the solution of complex problems. Locally-written documentation should facilitate the execution of tasks that were second nature on the old system (e.g., printing files, editing text, compiling and executing programs, sending mail). Documentation specific to the organization and environment should describe the available facilities (e.g., impact printers, laser printers, and hard copy graphics output devices) as well as provide instruction on their use.

The Tulane Computing Services Consultants Bureau, which is responsible for all technical documentation for the central academic computing services, has adopted a model of "briefs" for its locally-written documentation. Briefs are short documents, usually two to ten pages in length, which describe topics of interest and importance to both mainframe and microcomputer users at Tulane. The two-page Software Briefs in CMS on the IBM 3081 and SAS in MUSIC on the IBM 3081, for example, instruct users on the construction of simple SAS data sets and execution of the SAS system in the local environment. Briefs are successful in widely disseminating information because each brief covers a single, specific topic, eliminating the need for users to read entire manuals.

The ready availability of vendor documentation is also important. To the extent possible, pertinent manuals should be on-hand for users before the system becomes available. Those involved in implementing the change should make recommendations to individual users or departments about documentation they might wish to purchase and about how they can do so.

5. Publicize timely progress updates throughout the process of change. To facilitate the integration of a new computing environment into an organization, those affected by the change must understand the reasons for the change and the long- and short-term advantages of the new system to the overall productivity and success of the organization. They must also have ready access to support for the new system and for moving from one environment to another.

Change in a computing environment is likely to involve a great deal of planning and labor, depending on the nature and degree of the change. Since it is unlikely that everything can be accomplished at once, there should be a published timetable for the availability of new facilities. Providing consistent, timely information about the process and progress of the change will increase the likelihood that the change will be seamlessly integrated into the organization and that users will view the change in a positive light.

Conclusion
The rapid evolution of computer technology makes change in computing environments a concern for nearly all computer users. In this paper, we have described the implications of rapidly changing computing environments for those who use computers as tools in business, education, and research. We have considered some of the psychological factors involved in changing behavior and attitudes, and have proposed suggestions for reducing resistance to change.

Changing computing environments will affect each individual and organization in different ways, depending on a number of factors. Regardless of the nature and degree of the change, however, for the change to be successfully integrated into the existing organizational structure, those who will implement the change must prepare and execute a marketing strategy. Careful planning and timely implementation of technology will help those affected by the change, the end-users, to accept the change and adapt to the new environment without significant delay of progress, impairment of focus, and loss of productivity.

Those with responsibility for the decision to change and those who actually implement the change must put themselves in the position of the end-user in considering how a given change at a particular time will affect the productivity and success of the individual and of the organization. Users, too, have responsibilities in effecting a successful change. These responsibilities include reading documentation and update information which is provided, and utilizing the available mechanisms for expressing their needs and concerns before and during the process.

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