INFORMATION TECHNOLOGY: Beyond the Campus Network:

Desktop Computers and Support

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Report of the Advisory Committee on Information Technology

May 22, 1996

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I Executive Summary of Recommendations and Priorities

Yale must act quickly both to raise the baseline level of information technology across the entire University and to empower departments and schools to take responsibility for meeting their own additional needs. That is the conclusion that emerges from the Information Technology Advisory Committee's yearlong effort to assess the current information technology infrastructure at Yale and its peer institutions.

> **The Information Technology Advisory Committee recommends that for Yale to remain competitive with peer institutions and continue to excel in research and education, it implement significant additions to existing information technology infrastructure.**

A Plan for Improving Information Technology at Yale The Committee recommends a plan to enhance development and implementation of information technology at Yale. This year's recommendations build upon last year's effort involving the campus network, and are centered upon desktop computers and user support. The recommendations are intended to apply to the entire community, but the Committee has only developed a specific plan to implement them for Yale College and the Faculty of Arts and Sciences. The Committee expects that this plan, intact or in some modified form, will have merit for other segments of the community as well.

The Committee's recommendations are summarized below and detailed in the remainder of the Report.

- **Computer access for faculty and academic staff**

  > **The Committee recommends that the University commit to a goal of having a networked computer on every faculty (or faculty proxy) desktop by September of 1998, with similar access by academic staff.**

  The student body has generally outstripped the faculty in its knowledge and use of information technology. While approximately 97% of the students in Yale College are on-line, many fewer faculty are. (See Section IV.1.)

- **User support**

  > **The Committee recommends implementation of a distributed support system for maximizing adoption and maintenance of information technology at Yale.**

  Without adequate support at all levels—planning, installation, education, training, maintenance, and troubleshooting—many desktop computers will be unused or under-used. (See Sections IV.2 and IV.3.)

- Funding

  The Committee recommends that the University ensure that funding is available within every department to sustain a baseline configuration of hardware, software, and user support. This may require selective reallocation of funds currently provided to a particular department, and/or incremental funds to ensure that existing services are not compromised.

  It further recommends that the University ensure adequate funding of institutional programs for integration and support of the department-level activities.

  The cost of information technology is not low, but the Committee is convinced that the cost of inadequate infrastructure to support it is higher. (See Section V.)

- Integration of Services

  To maximize the effectiveness of existing and proposed software applications, the Committee recommends that the University provide access to the appropriate components of these systems for faculty, staff, and students.

  It further recommends that electronic mail be adopted as an official means for communicating information that is not sensitive or confidential.

  Yale can stimulate effective use of networked computers by moving to assure that administrative functions occur mainly through electronic means, that information technology is a valuable component of teaching and learning, that innovation and initiative in using the technology in these areas will be rewarded, and that quality in the information technology environment is valuable for attracting faculty and students to Yale. (See Section III.)

- Policy

  The Committee recommends that the University adopt the Information Technology Policy contained in Appendix A, which was designed by C&IS in consultation with Yale's General Counsel and this Committee.

  Information technology brings with it enormous and complex moral, ethical, and legal responsibilities for users and for the University. (See Section VI.)

- Evaluation

  The Committee recommends an ongoing assessment of the use of information technology at Yale to guide the implementation of existing and future programs.

  It is essential that an oversight mechanism be created to evaluate and modify any plans for enhancing the use of information technology at Yale. (See Section VII.)

II Significance and Urgency: The Importance of Information Technology at Yale

An investment in information technology at Yale is urgently needed if Yale is to remain competitive with peer institutions and to retain its leadership in research and education. Information technology is pervasive in every aspect of modern life, and the university is no exception. Education and research—the two key missions of a university—are changing in the face of it. There are an increasing number of resources which exist *only* in electronic media. Scholarly conversations, research publications, and information resource management are now often purely electronic in form [1, 3, 4, 5].

For many years, educators have argued that information technology greatly enhances the educational and research processes. Today the argument is stronger: the lack of information technology is seen as a serious hindrance in achieving even basic objectives of education and research.

The Committee conducted a survey (attached as Appendix B) of peer institutions to determine the extent to which other institutions provide direct support for information technology. The results of the survey indicate that many peer institutions have already made substantial investments in information technology, in several cases with plans for expansion in the near future. Yale's current level of investment is decidedly lower than the average, and thus it is easy to argue that Yale needs to invest in information technology to keep up with the *status quo*. This is a weak position, however, for a University that prides itself in being at the forefront in many areas of education and research world-wide. For Yale to retain this leadership, it should *excel* in the effective use of information technology. Aside from direct gains in the quality of education and research, investment in information technology at Yale will bring advantages in the recruitment of new faculty, students, and staff, and in attracting new grants, contracts, and alumni contributions.

The Committee submits this report with the aim of identifying a realistic minimum level of investment below which the University cannot afford to fall. To remain competitive, Yale must commit itself to implementing *at least* these basic proposals. Yale's leadership in higher education may make a higher level of investment desirable, but the Committee has limited its recommendations to what it regards as imperative.

The Committee also feels that the baseline level of investment recommended in this Report will serve as an incentive to further enhance information technology at Yale. Many departments will have needs that exceed the baseline requirements specified here. The Committee urges the University to work with departments toward satisfying those needs.

III The Status of Information Technology at Yale

In the past several years the University has taken a key step toward ensuring the effective use of information technology at Yale: the installation of a campus-wide network. Last year's Information Technology Advisory Committee made specific recommendations regarding this measure, including a charge-back funding strategy recently endorsed by the Provost [6]. This year's Committee is happy to report that progress on the network has proceeded on-time with no major snags.

The University has already begun to demonstrate the usefulness of the campus-wide network through the implementation of major changes in student registration and grading, finances, purchasing, and library access. But there are many benefits yet to be realized.

> **To maximize the effectiveness of existing and proposed software applications, the Committee recommends that the University provide access to the appropriate components of these systems for faculty, staff, and students.**

Examples include access to student grades by faculty and (on an individual basis) students, inquiries regarding grant or contract finances, and on-line clerical or laboratory supply orders.

> **The Committee also recommends that the University move toward establishing electronic mail as an official means for communicating information that is not sensitive or confidential, and that the electronic mail infrastructure be improved to include means for transferring non-text-based information.**

Electronic mail has obvious advantages over paper correspondence and/or voice mail: it is quicker, is asynchronous, permits effective archiving, and allows both narrow and broad distribution (including effective communication between students and faculty). Other administrative functions will also improve when transferred into electronic form. Concomitant with these advantages are potential savings in paper costs, mail and phone service, filing, and other clerical tasks.

The Committee notes that these recommendations require that individuals either use these tools or arrange for a proxy to do so.

Almost all undergraduates now access the campus-wide network from their dormatory rooms, campus workstations, or clusters. The faculty, however, remain largely disenfranchised. Equipment has been purchased haphazardly, according to individual need and whim, and in many cases is outmoded and inadequate to fulfill research and teaching needs. While some existing equipment may be capable of being integrated into the campus network, only a department-by-department census can assess current needs.

IV A Plan for Improving Information Technology at Yale

The Committee's recommendations for improving information technology at Yale are based on increasing computer access and improving user support. The Committee recommends improvements in computer access through *desktop computers* aimed at providing baseline hardware and software for all faculty. It recommends improved support through a *distributed support system* aimed at providing support at the desktop, yet integrated effectively into a University-wide organization.

IV.1 The Desktop Computer

The Committee feels that, in order to use information technology effectively, all members of the academic community must have access to a *desktop computer* with a baseline configuration consisting of at least the following components:

1. An entry-level PC, Macintosh, or equivalent computer.
2. Email compatible with campus standards.
3. A World Wide Web browser such as Netscape Navigator or Microsoft Explorer.
4. A word processor.
5. Access to printing facilities.
6. File back-up capabilities.

This baseline reflects current needs and conventions in the academic computing environment. Aside from the pervasive reliance on electronic mail, for example, many activities are moving toward Web-based interfaces: a Web browser is simply an indispensable tool in today's academic world.

The detailed specifications for the baseline hardware should be established by C&IS and updated at least on a yearly basis, to be reviewed by this Committee. Peripherals such as printers and file-backup options should also be specified, as well as alternatives to the desktop; in particular, the laptop computer. The goal of such a specification should be a promise to users that purchase of such a computer will guarantee interoperability with standard University software applications for a period of 4 years (which is the period recommended by the Committee for the maximum life-cycle of hardware acquisitions), with no required or possibly only minor enhancements (for example, a modest increase in memory).

The Committee also expects the baseline software to evolve as needs and conventions change and as the technology improves and becomes more economical. For example, group scheduling software is becoming increasingly effective and popular, and could become a standard tool within individual departments or throughout the whole University.

The Committee recommends that the University commit to a goal of having a networked computer on every faculty (or faculty proxy) desktop by September of 1998, with similar access by academic staff.

See Section V.1 for a discussion of the costs involved in achieving this goal.

The Committee recognizes that some faculty members will prefer not to have desktop computer access. Yet if the University is to conduct official business on-line, the Committee feels that such faculty need to arrange for proxies (e.g. clerical staff) to serve as an interface to the on-line services.

IV.2 Support

While the desktop computer is a necessary element of any information technology plan, it cannot function effectively without *support* at many levels. The coordination of desktop equipment and software with the existing (and expanding) campus network will require ongoing support for every aspect of implementation. The Committee consulted several sources of information about the complexities of support, most based on industry or business models which have qualified application in the university environment.[1] The Committee has modified those assessments in tailoring a support model which it believes will best serve the needs and interests of the Yale community.

The desktop computer and the user support structure are inseparable. The capital costs for hardware and software are relatively small components (<20%) of the total costs of end-user computing. The bulk of the costs reside in a combination of support by the institution and time wasted by the end user. Technical support (planning, training, advice) must be funded at a level which will help integrate desktop computers with all aspects of university activity. Without this support structure, investments in the desktop will not be cost effective and will not enhance research or education; in brief, the machines will not be used, or if they are, they will be disappointingly underused.

A simple way to look at the support issue is to graph the return on investment against dollars spent on support. Though concrete numbers are hard to come by, the shape of the graph may be conjectured as shown in Figure 1. This shape is consistent with experience gained in C&IS, and is confirmed by analyses of business practices.

The message in this graph is that investing in computing infrastructure does not produce effective results until some threshold is passed, but that at some point further investments yield little gain in performance. The best level of investment lies somewhere on the high-side of the curve (near the position marked "X" on the graph). There is no magic formula for finding this point, but being aware of the curve will help the University fine-tune support processes in an evolutionary manner.

[1] The most informative, yet alarming, of these sources is the well-known *Gartner Group Report* on *End-User Computing Total Cost of Ownership* [2]. The model used in the Gartner Report is not entirely applicable to Yale, because some of the costs identified are not formally accounted for in a university, and savings in end-user operations are not directly reflected in the University's "bottom line," which is best measured in quality of research and education rather than dollars. On the other hand, even research and education is ultimately measured in dollars, since the quality of these products determines the ability of the University to gain research funds, justify tuitions, and attract alumni contributions.

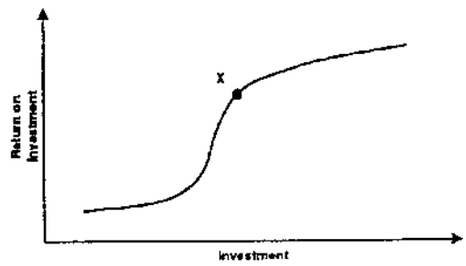

Figure 1: Return on investment in support of information technology

The following subsections describe three categories of support for effective use of information technology: planning and installation, education and training, and troubleshooting and maintenance. Later sections offer specific recommendations for realizing this support, including a specific funding strategy.

When reading the following subsections it is important to leave the horse before the cart. The fundamental purpose of a support program is not to optimize planning, installation, etc., but to optimize teaching, learning, research, and publication.

IV.2.1 Planning and Installation

The Committee recommends that planning for the use of information technology begin at the department level, with an assessment of needs specific to each discipline. In this way targeted decisions can be made regarding information technology investments in hardware and software, with careful consideration of long-term needs for installation, maintenance, and replacement factored in from the start.

Many departments need advice and assistance on selection and installation of desktop equipment, network access, and core software. More important, they need an understanding of how information technology can be used to improve their educational, research, and administrative missions. The Committee feels that a centralized University facility needs to lead the campus with a proactive dissemination of information, including seminars and demonstrations within individual departments.

Pre-purchase consultation should aim to identify needs and ensure that appropriate and compatible products are obtained. Such consultation is cyclical: it is needed after the initial purchase whenever hardware and software is upgraded. Pre-purchase support should serve a planning function for the individual, the department, and wider institutional levels.

Many department-level activities can be automated (with spreadsheet applications, databases, group schedulers, etc.) but departments need assistance in understanding exactly what can be put on-line, what advantages accrue, and what it will take to do the job.

Planning should be distributed throughout a system's life-cycle. A key issue in the use of information technology is retirement, replacement, and upgrade of technologies. Departments will need as much help in making these decisions as in formulating an initial plan.

Installation of desktop computers includes delivery, unboxing, connecting to the network, installation of baseline software, verification of proper functionality, and initial guidance in proper use. If installation is done at the department level, a well-planned "swat team" approach is recommended to ensure efficient use of manpower and to minimize user inconvenience.

IV.2.2 Education and Training

Investments in education and training can greatly reduce the learning curve for many individuals and improve their effectiveness in the use of information technology. Courses representing this level of support include those for specific software packages, discipline-oriented applications, network technology, and multimedia applications. Many of these courses can be conducted centrally (for example in the Library or in C&IS), but department-level seminars on either generic information technology or topics of special interest to the department should also be considered. Particular attention should be given to the needs of those interested in *applying* software technologies to special uses, such as the development of curricular materials or research results.

The Committee applauds the effectiveness of an ongoing collaborative relationship between C&IS and the Library to help academic departments improve teaching and research through the incorporation of networked-based information technologies and services. The "division of labor" between the two organizations depends on the task: technology-specific tasks are handled by C&IS, content-based activities are handled by the Library. The Committee recommends an increase in these activities to meet the ever-growing needs of the university community, including proactive marketing strategies to make these services known to all.

In addition to traditional training, Yale should provide opportunities for users to learn new skills on an individual self-help basis. C&IS already maintains an extensive library of on-line documents which teach users how to help themselves. These documents include frequently asked questions (FAQ's), brief articles from Omnibus, one-page guides on specific topics, and more complete "how to" guides for Yale-specific services. As these documents will be useful only to the extent that users know of their existence and whereabouts, it will be important to maintain communications between providers and users and to provide effective indexing and search tools. Beyond static documentation, Yale should explore the use of interactive on-line tours and demonstrations and even computer-aided instruction to provide basic orientation and training for faculty, staff and students.

IV.2.3 Maintenance and Troubleshooting

Computers break; software dies; viruses invade. These are the realities of information technology, and proper support is necessary to ensure the integrity and effectiveness of investments. This category of support includes:

- Hardware maintenance: when hardware fails, it needs to be fixed or replaced quickly and effectively.
- Software maintenance: software can fail too, due to improper installation or configuration, inherent bugs, etc. Software needs to be fixed, replaced, or upgraded as the need arises.

Hardware and software can malfunction because they are poorly constructed, are put to uses that exceed the limits of their design, or are configured with other components in inappropriate ways or with other components that are themselves malfunctioning. Individuals often need help diagnosing these problems and implementing appropriate solutions. We call this category of support:

- Troubleshooting: regular support is needed as individuals encounter problems using the technology. Problems may arise from lack of experience, or from the hardware or software problems mentioned above. Troubleshooting is the process of narrowing down the problem for proper disposition.

IV.3 The Distributed Tiered Support System

To meet the broad range of support needs addressed above, the Committee recommends implementation of a *distributed tiered support system*.

Yale is an extremely diverse community. This diversity is reflected in the many different ways information technology is used across campus, and these differences are likely to persist. It is unreasonable to expect information technology to be used similarly across academic disciplines, or to expect computer skills to be consistent across the campus or even within departments. The support structure must take this diversity into account and address the needs of the entire community.

The kinds of maintenance and troubleshooting problems that arise also vary considerably, from trivial problems concerning application-specific issues ("How do I create a personal mailing list?") to difficult systems/networking issues ("Why is our TCP/IP connection dropping packets when user load exceeds 20?"). Different support skills are needed to handle these different kinds of problems.

The Committee feels that the diversity of support needs can be effectively addressed by a *distributed tiered support system*. In principle, a *tiered* support structure is hierarchical, with the lowest level of the structure dealing with the simplest and most discipline-specific issues, and the highest level handling the most difficult technical and discipline-independent issues. A *distributed* tiered structure is one in which the lowest levels of the tier reach into individual departments, providing personal support at the desktop level. Such a system has the advantage of being both centralized and distributed: it reaps the economy-of-scale benefits of a centralized structure, while delivering the individualized, discipline-specific attention of a distributed structure. For simplicity we refer to the overall system as a *distributed support system* in the remainder of the Report.

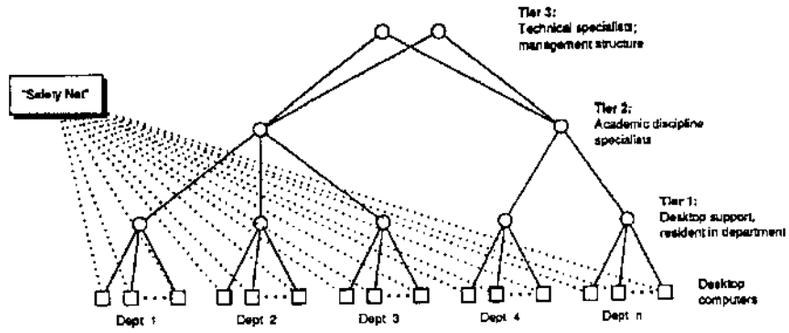

Figure 2: Distributed support system, showing tiered structure

Figure 2 shows a distributed support system with three tiers, anchored in the academic departments. The first tier of support would be an individual or small staff identified with, and usually residing in, each department; the goal for this first level of support would be to respond quickly and ably to a large majority of the support needs in the department. The second tier of support would be existing C&IS discipline support organizations (for example, in the social sciences, the Statistics Laboratory); the goal for this level of support would be to train and coordinate the first level staff as well as to address discipline-specific questions or issues. The third tier of support would be central staff at C&IS providing common elements to the entire support program, such as system documentation and highly specialized technical expertise to address difficult questions or issues. The first, second and third tiers must collaborate closely and complement one another well.

Some departments, such as Computer Science, have already invested heavily in internal information technology support services, but it is still desirable that such services be effectively integrated into the distributed support structure. Being well-integrated benefits all parties involved by identifying common concerns, leveraging the utility of common solutions, and providing a better migration path for expansion or contraction of services as needs evolve.

Other departments will wish to arrange first tier support in the department or across a group of collaborating departments, with a C&IS discipline support unit providing training and supervision of that first tier staff as well as software licensing, file and print service, and/or other services.

The distributed support system posits the existence of experts at or near the department level. These may be part-time graduate student employees or full-time employees, depending on the resources available to the department. C&IS should have responsibility for training, supervising, certifying and regularly evaluating these local experts, who are presumed to be able to respond to 70% or so of the support needs in the department. The second tier of discipline-based support staff organizes and supports the department level experts at the first tier, and are presumed to be able to respond to approximately 20% of the support needs. Standing behind the disciplinary experts is a third tier of technology specialists, who have an institutional view and account for

approximately 10% of the support needs.

The Committee notes that recent efforts by C&IS to introduce support structures in Sociology, History of Art, and Chemistry could have benefited from closer alliance to the distributed tier-structure and moderately more funding. In addition, results from the survey of peer institutions contained in Appendix B reveal that some other institutions use a similar support structure.

IV.3.1 A Safety Net

A disadvantage of the distributed support system, especially at the most sparse regions in the hierarchy, is that one's "first line" of support—the person at the lowest level in the tier—may not be immediately available to handle a critical problem. Thus the Committee recommends supplementing the distributed support structure with a "safety net" that works somewhat like the traditional "help desk." Designed especially for troubleshooting, this safety net would provide a direct point of contact in cases where the distributed system cannot provide a timely solution to a problem.

IV.3.2 Support for Advanced Computing

The Committee recommends that support for advanced users—for example those using UNIX or NT workstations—be accomplished with the same distributed structure that we have described for baseline support, but with either more or higher-skilled staff to provide the additional support needed for such systems. The funding established for a department to cover baseline needs would be supplemented by other sources to fully fund this more sophisticated operation.

The Computer Science Facility, for example, supports information technology for both research and education in Computer Science and, partly, in other departments. This organization should be tightly integrated within the distributed support system, as should any reorganization of it based on expanding use of information technology in the Engineering Departments.

We emphasize that it is beneficial to integrate all computing at Yale into the campus infrastructure, and to encourage cooperative efforts between departments and the University. The distributed support system is intended to provide autonomy at the department level while ensuring effective integration in the whole.

IV.3.3 Phased Implementation

It is both imprudent and impractical to implement the proposed support programs all at once and immediately. A phased rollout of the programs would allow all parties—C&IS, the Library and the academic departments—to identify in detail the organization and resources needed for supporting faculty and students well in their use of information technologies and services. A phased approach also provides opportunities for practical evaluations of the program, in which participants can experiment without fear of costly mistakes and can identify and correct flaws in the program design.

The Committee feels strongly, however, that effective implementation of support for particular groups of users must include all aspects of support and must conform to a University-wide plan.

V The Cost and Funding of Desktop Computers and Support

In making recommendations for a funding strategy, the Committee took the following as guiding principles:

1. Equity is important across schools and departments. Regardless of whether teaching faculty have research grants or not, they should receive equal consideration for baseline support of teaching and administration. (Government regulations do not allow equipment purchased for research to be used for education without special permission.)
2. Support and network costs must be viewed as essential components of cost when building investment in desktop computers.
3. There must be incentives to ensure that investments in information technology for faculty are well-used and that there is a means to allow for investment in high-end machines as well as in the baseline.

Adequate funding is essential to the success of information technology at Yale. Unfortunately, it is unlikely that many FAS departments can afford the minimal investment level without additional funds being supplied to their budgets. The combination of networking, hardware and software capitalization, and support creates a significant financial burden which the University must recognize.

> **The Committee recommends that the University ensure that funding is available within every department to sustain a baseline configuration of hardware, software, and user support. This may require selective reallocation of funds currently provided to a particular department, and/or incremental funds to ensure that existing services are not compromised.**
>
> **It further recommends that the University ensure adequate funding of institutional programs for integration and support of the department level activities.**

The Committee considered various funding strategies, such as creating individual entitlements, grants awarded in response to proposals, and matching-fund programs. The Committee feels that the best strategy is one focussed on *academic departments*, because that is where the greatest commonality of interests is found, and because departmental funding structures are already in place.

This funding strategy should serve not only to establish the minimal baseline level of information technology, but also to provide incentives to further enhance information technology at Yale. Indeed, the Committee recommends that funding for a specific department be contingent upon approval of a plan for use of those funds. Many departments will also have needs that exceed the baseline requirements specified here. The Committee urges the University to work with departments toward satisfying those needs.

The overall funding strategy recommended by the Committee consists of two pieces:

1. *Baseline department-level funds* to provide baseline hardware, software, and ongoing support. Hardware and software capitalization should be amortized over the life-time of the equipment to provide a single, yearly figure for overall baseline support at the department level. This baseline should be the foundation upon which departments can build information technology infrastructure tailored to their specific needs. (See Section V.1.)

2. *Institutional funds* to support the upper levels of the distributed support system, including centralized education and training such as that currently provided by C&IS and the Library. (See Section V.2.)

In some cases the baseline funds may be realized through reallocation of existing department-level funds, such as funds currently allocated for other kinds of educational resources, or those allocated for phone service. These reallocations should reflect savings accrued from the use of information technology. Beyond the baseline, it is expected that some departments will supplement their total information technology investment through grants and contracts. It is important, however, that the overall computing system realized by these sources of funding be as well integrated as possible, to maximize the effectiveness of information technology at the department level. Nearby departments may wish to pool their resources for maximal effectiveness.

Other advantages of this department-oriented funding strategy are that it gives departments freedom to manage resources across different faculty needs, encourages "trickle down" of machines from power users to other faculty, and can be linked to the development of department plans that encourage the effective use of technology that meets institutional standards. An overall department plan for information technology is likely to involve a combination of baseline desktop computers, laptop computers, higher-performance computers or file servers, and peripherals such as printers and scanners.

In the following two subsections we attempt to estimate the costs of baseline desktop computing and support within the FAS.

V.1 Baseline Desktop Computing Costs

The cost of establishing department-level baseline computing capabilities can be estimated based on the size of each department. The Committee tried to identify a dollar figure that would place the University's investment on the upper part of the graph in Figure 1. In doing so, the Committee considered two kinds of department-level costs: hardware and software capitalization, and department-level support. Each of these is addressed below.

Baseline Hardware and Software Capitalization At the department level, the cost of placing personal computers on faculty desktops can be estimated as follows. Let N be the number of teaching faculty in a particular department, l the projected life-cycle (in years) of the desktop computer, c the cost of a baseline desktop computer as described in Section IV.1 (including an l-year warranty), and r the residual value of a desktop computer after l years of service. Then the average yearly baseline cost of desktop computers in the department would be $N(c - r)/l$.

The Committee recommends no more than a 4-year life-cycle. With the additional assumptions of a desktop computer cost of $2,500, an additional $250 for software, a residual value of 12% of purchase price, and 700 teaching faculty, the total cost to the University would be $423,500 per year for faculty desktop computers. Note that this does not include equipment for other instructional or academic staff, nor does it include printers or other peripheral equipment.

Baseline Support Costs The corresponding steady-state cost of tier-one department-level support can be estimated as follows. Let N be the number of teaching faculty in a particular department, s the hours of support needed per desktop computer per week on average, and w the hourly wage for a tier-one employee. Assuming a 48-week work-year, the yearly baseline cost for support of desktop computers in the department would then be $48swN$.

For example, to provide 1/2 hour of support per week for each of the faculty's 700 machines, hiring graduate students working at a rate of $10 per hour would yield a total cost to the University of $168,000 per year. The Committee recommends this as a minimum level of support; any investment less than this would jeopardize the effectiveness of information technology at Yale.

The Committee believes that the use of graduate students for tier-one support is consistent with the "distributed tiered" structure, in that it locates support personnel (who may work part-time) within departments, and satisfies the goal of using personnel familiar with the academic discipline. It does require, however, effective training to ensure competent support.

For comparison, assume that a full-time professional would cost approximately $50,000 per year, including salary and benefits. The budget needed to hire graduate students to support 700 individuals in the Faculty of Arts and Sciences would fund approximately 3.4 professional staff, or 1 professional for every 208 supported individuals. Although this ratio compares favorably to the ratio of 1:200 in the Medical Center, by industry standards this ratio is quite low: ratios of 1:50 are more common. In addition, it does not have the advantages of personnel distribution and discipline expertise.

V.2 Institutional Support Costs

C&IS and the Library already allocate considerable resources for the support of information technology and services. Both organizations intend at this stage to reallocate existing resources to develop comprehensive support programs within their units. As noted above, the needs and aspirations for information technology use differ widely across academic departments: some departments already have such support, some smaller or contiguous departments will share support staff, while some larger departments may need more help.

Though the Committee applauds the relationship between the Library and C&IS, it questions the benefits of the charge-back cost-recovery strategy used to finance technical support in C&IS, in contrast to the central funds strategy used to finance Library support. The Committee believes that such services should be centrally funded, in order to encourage users to take advantage of them. Missed opportunities for proper training result in hours of end user time spent in unproductive and inefficient activities and self-training.

The Committee also recommends increased investments to support the upper two levels of the distributed support system. This should include the technical specialists, discipline specialists, the "safety net," and the management structure needed to coordinate, supervise, and train the various personnel.

VI Policy on the Use of Information Technology

Information technology makes it possible to distribute and examine a vast array of material with unprecedented speed and accuracy. In the rapidly changing area of information technology one requirement remains constant: all uses of information technology must fully respect the rights of the University and its Community members. Most uses of information technology parallel familiar activities in other media and so existing University policies already provide guidance. Communicating using electronic rather than written means, for example, does not fundamentally alter the nature of the communication, nor will it alter the guiding University policies which already apply to freedom of expression, privacy, and so on.

Yet the use of information technology can create unique circumstances that require special attention to policies and rights. Information technology brings with it enormous and complex moral, ethical, and legal responsibilities for users and for the University. The Committee has studied these issues and policies, and has worked with C&IS to create an *Information Technology Policy* document that augments rather than replaces existing University policies.

> **The Committee recommends that the University adopt the Information Technology Policy contained in Appendix A, which was designed by C&IS in consultation with Yale's General Counsel and this Committee.**

VII Evaluation

A means of evaluation is needed so that the University can better understand the value of information technology and the effectiveness of the University's technology support structure.

> **The Committee recommends an ongoing assessment of the use of information technology at Yale to guide the implementation of existing and future programs.**

This Committee can and should serve this role, but the committee found it difficult to collect accurate data on the use of information technology at Yale. We recommend that next year's committee work with C&IS and the Office of Institutional Research to collect detailed information such as:

- inventories of sales of hardware and software (for use in establishing standards or in estimating the costs of changes in standards)

- usage of on-line resources (for use in managing resources—which are increasing, which are decreasing—and determining the implications of allocating resources)
- counts of users—faculty, staff and students—using the network and other resources (for use in evaluating our progress toward universal access)
- survey of users to assess needs and satisfaction (for use in introducing new services and improving existing quality of services)

This information should be collected at appropriate intervals and shared with the Committee and with the Yale community.

VIII Future Priorities

The highest priority for next year's Committee should be a careful study of the *use* of information technology at Yale, in particular in enhancing the educational experience. How is information technology currently being used in the classroom? Is it effective, and are there contexts where it is arguably ineffective? Are there emerging technologies that can enhance teaching and learning? What demands will this place on student access to computing resources? These are some of the many questions that need to be answered.

This year's Committee did briefly review the state of student computing at Yale. Students generally have good access to computers, and all students are now automatically given email accounts when they arrive at Yale. Members affirmed the need for distributed computer labs as a way of providing specialized services not available on personal workstations. The labs also serve as a way of ensuring that all students have access to computers, especially those who cannot afford one. However, the amortization period for financing and then replacing cluster machines is presently 7 years; for example, in the current computer clusters managed by ACS, there are still small-screen Macintosh computers in general use. The Committee feels that this replacement cycle is too long.

Further study will be needed, however, to make more concrete recommendations regarding student computing at Yale. The Committee recommends that next year's agenda include careful consideration of all factors relevant to student access, with a sensitivity to economic factors that might create an undesired hierarchy of users and non-users within the student body.

Acknowledgements

The Committee wishes to thank William Stempel for his help in formulating the Policy Document, and the Committee's previous Chair, Jules Prown, for his initial guidance of this year's Committee.

References

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Appendix A: Yale University Information Technology Policies
May 9, 1996

Information technology (IT) has the ability to distribute and examine a vast array of material with unprecedented speed. In the rapidly changing area of information technology one requirement remains constant: all information technology use must fully respect the rights of the University and its community members.

Most use of IT parallels familiar activities in other media and formats and so existing University policies already provide guidance. Using electronic media in the place of standard written correspondence, for example, does not fundamentally alter the nature of the communication, nor will it alter the guiding policies: University policies which already apply to freedom of expression, privacy and related matters apply to electronic expression as well. These Information Technology Policies address circumstances which are new or at least unfamiliar in the IT arena, but they augment rather than replace other applicable University policies.

DEFINITIONS

Yale University Information Technology Systems ("University Systems") include the computers, terminals, printers, networks, modem banks, and related equipment, as well as data files or documents residing on disk, tape, or other media which are owned, managed or maintained by Yale University. For example, University Systems include institutional, departmental and faculty research systems and general access computer facilities. Privately owned equipment is not a University System even if it is attached to the Yale network unless that equipment is managed or maintained by Yale University.

A Yale University Information Technology User ("user") is any person, whether authorized or not, who makes any use of any University System from any location. For example, this definition includes persons who access University facilities via an electronic network or who are present in University computer clusters, as well as those who use a University electronic network to connect a personal machine to any other system or service.

A University User is a user with authorization to access a non-public University System. University Users include Yale students, faculty members, staff members, and alumni or alumnae with accounts on University Systems .

A System Administrator is an individual with the authority to determine who is permitted access to a particular system.

PURPOSE

The purpose of University Systems is to further the research, education, and administrative functions of Yale University.

To achieve this purpose, these policies intend:

- to ensure the integrity, reliability, and good performance of University Systems;
- to ensure that the community of users at Yale operates according to the same conventions and values of the larger Yale community;
- to ensure that University Systems are used for their intended purposes; and
- to establish sanctions and processes for addressing violations.

SCOPE

Yale's Information Technology Policies apply to all University Systems and their use. For example, all use of Yale's network is subject to these policies.

Many particular University Systems (Yale's NetNews and World Wide Web sites, the Pantheon/Minerva system, University email services, individual research lab systems and so on) have service-specific policies which apply in addition to these institutional policies. Please refer to postings available with each system to identify all applicable policies.

The policies described herein are those that the University intends to use in normal operation of its facilities. This document does not waive any claim that Yale University may have to ownership or control of any hardware, software, or data created on, stored on, or transmitted through University Systems.

USE OF UNIVERSITY SYSTEMS

Proper Authorization.

Use of non-public University Systems is restricted to University Users.

Appropriate Use

University Systems may be used only for their intended, authorized purposes. For example, privately owned computers may not host sites for non-Yale organizations across the Yale network without specific authorization.

Commercial Use

Without specific authorization, activities using University Systems for non-Yale commercial purposes are prohibited. This is not meant to restrict normal communications and exchange of electronic data, consistent with the University's education, clinical, and research roles, that may have an incidental financial or other benefit for an external organization. For example, it is appropriate to discuss products or services with companies doing business with Yale or to contribute to Usenet bulletin boards discussing issues relating to commercial products.

Contracts

All use of University Systems must be consistent with all contractual obligations of the University, including limitations defined in software and other licensing agreements.

PRIVILEGES FOR UNIVERSITY USERS

Free Inquiry & Expression

University Users are afforded free inquiry and expression consonant with the purposes of the University.

Reasonable Confidentiality

University Users can expect reasonable confidentiality for particular data. Systems Administrators will identify categories of data, such as electronic mail, which will be

managed as confidential on a particular University System and they will make all reasonable efforts to maintain the confidentiality of that data. Confidentiality may be limited, however, by technical issues such as software bugs and system failures. However, limits and risks do apply to confidentiality, due, for example, to technical limitations, software bugs, and system failures. Systems Administrators will take reasonable steps to inform University Users of limits to confidentiality for their respective University Systems. University Users are expected to become familiar with those limits and risks of confidentiality in the University Systems which they use and to manage their confidential data accordingly.

Due Process

University Users have the right to due process in cases of discipline resulting from policy violations. See Enforcement Procedures, below.

Participation

University Users will be represented in the formulation and periodic review of University IT policies and regulations affecting them through appropriate University committees.

RESPONSIBILITIES FOR ALL USERS

Unauthorized Use

Users must not permit or assist any unauthorized person to access University Systems. Non-public University Systems may not be used by any non-Yale organization, for example, without appropriate authorization.

Security

Users must not defeat or attempt to defeat any University System's security, for example, by "cracking" or guessing user identifications or passwords, or compromising room locks or alarm systems.

Unauthorized Data Access

Users must not access or attempt to access data on a University System they are not authorized to access. Users must not make or attempt to make any deliberate, unauthorized changes to data on a University System. Users must not intercept or attempt to intercept data communications not intended for that user's access, for example, by "promiscuous" bus monitoring or wiretapping.

Concealed Identity

Users must not conceal their identity when using University Systems, except when anonymous access is explicitly provided. For example, users must not masquerade as or impersonate others.

Denial of Service

Users must not deny or interfere with or attempt to deny or interfere with service to other users by means of "resource hogging," distribution of computer worms or viruses, etc. Knowing or reckless distribution of unwanted mail or other messages is prohibited.

Specifically, "chain letters" and other schemes that may cause excessive network traffic or computing load are prohibited.

Copyright

Users must observe intellectual property rights including, in particular, copyright laws as they apply to software and electronic forms of information.

External Data Networks

Users must observe all applicable policies of external data networks when using such networks.

Modification of Data or Equipment

Without specific authorization, users of University Systems must not cause, permit, or attempt any destruction or modification of data or computing or communications equipment, including but not limited to alteration of data, reconfiguration of control switches or parameters, or changes in firmware. This rule protects data, computing, and communications equipment owned by Yale University, or any other person or entity. "Specific authorization" refers to permission by the owner or Systems Administrator of the equipment or data to be destroyed or modified.

Personal Account Responsibility

Users are responsible for the security of their University System accounts and passwords. Any user changes of password must follow published guidelines for passwords. Accounts and passwords are normally assigned to single users and are not to be shared with any other person without authorization by the cognizant Systems Administrator.

Users are presumed to be responsible for any activity carried out under their University System accounts.

Responsibility for Content

Representatives of Yale University publish institutional information in a variety of electronic forms. Such institutional information will normally be identified by a statement of the Certifying Authority publishing the information. A Certifying Authority is that University department or individual who certifies the accuracy of an electronic document and its appropriateness for the conduct of University business.

Users also publish information in electronic forms on Yale equipment and/or over Yale's networks. Yale has no intention or opportunity to screen such private material and thus cannot assure its accuracy or assume any responsibility for this material. Any electronic publication provided on or over Yale equipment and/or networks which is not identified by a Certifying Authority is the private speech of an individual user.

Threats and Harassment

Users may not use a University System to threaten or harass any person. A user must cease sending messages or interfering in any way with another user's normal use of University Systems if the aggrieved user makes a reasonable request for such cessation, in the opinion of the cognizant Systems Administrator.

Removal of Equipment or Documents

Without specific authorization by the owner or System Administrator, users must not remove any University-owned or -administered equipment or documents from a University System.

Foreign Devices

Without specific authorization by the owner or System Administrator, users must not physically or electrically attach any foreign device (such as an external disk, printer, or video system) to a University System.

Violations

Users must not conceal or help to conceal or "cover up" violations by any party.

Users are expected to report any evidence of actual or suspected violation of these policies to the Systems Administrator of the facility most directly involved. In case of doubt, the report should be made to the C&IS Director of Academic Computing Services.

UNIVERSITY RIGHTS

Personal Identification

Users of University Systems must show identification including University affiliation upon request by a System Administrator or other University authority.

Access to Data

Users must allow systems administration personnel access to data files on University Systems for the purpose of making backups, diagnosing systems problems and investigating policy violations.

Oversight Authority

University staff are authorized to investigate alleged or apparent violations of University policy or applicable law involving University Systems using whatever means appropriate.

Enforcement Procedures

Systems Administrators are authorized by University regulations to apply certain penalties to enforce applicable policies. Such penalties may include temporary or permanent reduction or elimination of access privileges, which may apply to computing accounts, networks, University-administered computing rooms, and other services or facilities.

When a Systems Administrator believes it necessary to preserve the integrity of facilities, user services, or data, he or she may suspend any account, whether or not the account owner (the user) is suspected of any violation. The System Administrator will attempt to notify the user of any such action.

A University User accused of a violation will be notified of the charge and have an opportunity to respond before a final determination of a penalty. If a penalty is imposed,

the accused violator may request a review by the University Director of Information Technology.

If, in the opinion of the Systems Administrator, the violation warrants action beyond a System Administrator's authority, he or she may refer the case to other authorities, such as to the University disciplinary body appropriate to the violator's status, to an employee's supervisor, or to a police authority.

Certifying Authority: Office of the Provost, June, 1996.

-End of Yale University Information Technology Policy Statement-

(last revision 5/9/96)

Appendix B: ITC Desktop Survey
(Not fully proofed by respondents)

	Brown	Harvard	Princeton	Stanford	Yale Current	Yale Proposed
# A&S faculty	550	900	512	360	700	700
Respondent	Don Wolfe	Frank Steen	Jacqueline Brown (excl Eng School)	Nancy Padgett + (excl science fac)	Philip Long	Philip Long
I. Baseline Configuration?	No	Recommend list	Yes 16MB,>500MB etc	Yes, varies by discipline	No	Yes 16MB,>500MB etc.
II. $ Help?	Yes	Yes	Yes	Yes	Limited	Defined Contrib
II.1 $/yr/desktop	$400				No	$500
% subsidy	100%					100% of baseline
II.2 categories subsidezed:						
II.2.1 Acquisition	100%	100%	100%	80-90%	100%	100%
(notes)		New fac, plus		sciences by grants	New fac only	
II.2.2 Maintenance	100%	fund for	0	100%	No	Yes
(notes)	$50 deductible	existing				
II.2.3 Replacement	100%	faculty	0	80-90%	No	Yes
target life span (yrs)	6 years			3 years		4 years
II.2.4 Other?	yes					
(notes)	Net + std soft					
II.3 Eligibility						
All Teaching faculty?	yes	?K by application	100K by proposal	Yes	No	Yes
New faculty only?			Yes	n/a	Yes	
Instructional staff?	No		No	Sr. Lecturers only	No	Yes
Academic Staff?	Partially	Separate pgm	No	Separate pgm	No	Yes
II.4 Source of Funding	Central	Central	Central	10-20% personal bal from instl grants	Central	Central+dept'l Block grants to depts "per capita"
II.5 Comments?	6 yrs is too long					
III. Incentives						
Discount programs?	Yes	Yes	Yes	Yes	Yes	Yes
Eq & software standards?	Yes	Yes	Yes	Yes	Yes	Yes
Other?			Preconfig, net ready, etc.	Curricular support Faculty review	Preconfig, net ready, etc.	Preconfig, net ready, etc.
IV. Planned changes?	No	?2500 over 5 yrs +? 20 new staff	No	$1M for repcmnt in next 3 years		

Appendix B: ITC Desktop Survey
(Not fully proofed by respondents)

	Brown	Harvard	Princeton	Stanford	Yale Current	Yale Proposed
V. End user support -						
For planning desktops	Yes	Yes	Yes	Yes	Limited	Yes
For initial setup	Limited	Yes	Yes	Yes	Limited	Yes
For upgrads	Limited	Yes	Yes	No	Limited	Yes
For Trouble shooting	student w/tiers	Yes	Yes	Yes	Limited	Yes
For training classes	Full	Yes	Yes	Yes	Limited	Yes
Tutoring	Limited	Yes	Yes	No	No	Limited
Consulting on new apps	Limited	Yes	Yes	Yes	Limited	Yes
Delivery method?	Help Desk	dept'l, div'l & central	dept, disc spclsts w/help desk	dept'l w/tiers	Regional, help desk	Dept'l
Source of Funding	GA	Central	Central fee for hardware	Central	Central	Central+dept'l
Unique comments				1 FTE dedicated to new fac		

Appendix B: ITC Desktop Survey
(Not fully proofed by respondents)

	CMU	Maryland	UNC	Utah	Wisconsin
# A&S faculty	??	890	650	1050	1200
Respondent	Tracy Futhey	Jennifer Fajman	Linwood Futrelle	Ed Sharp	Jack Duwe
I. Baseline Configuration?	No	Yes 16MB,>500MB etc	No	No	No
II. $ Help?	None centrally	Yes	Yes	By Proposal	None centrally
II.1 $/yr/desktop		1:1 match to			
% subsidy		$1,500			
II.2 categories subsidized:					
II.2.1 Acquisition		Yes	100%		
(notes)			New fac only		
II.2.2 Maintenance		No			
(notes)					
II.2.3 Replacement		Yes			
target life span (yrs)		4 yr goal; 6 yr act			
II.2.4 Other?		Yes			
(notes)		Network			
II.3 Eligibility					
All Teaching faculty?		Yes	No	Regular fac only	
New faculty only?			Yes	n/a	
Instructional staff?		Yes (not tutors)	No		
Academic Staff?		No	No		
II.4 Source of Funding		Central	Central	Spcl state allocs	
II.5 Comments?		Very successful			
III. Incentives			No		
Discount programs?	Yes	Yes		Yes	Yes
Eq & software standards?	Yes	Yes		No	Yes
Other?		Site licenses			
IV. Planned changes?	No	No	?All fac via block grants w/ dept+central fund?	Concept discussed No current plans	No

Appendix B: FTC Desktop Survey
(Not fully proofed by respondents)

	CMU	Maryland	UNC	Utah	Wisconsin
V. End user support -					
For planning desktops	Limited	Yes	Yes	Yes	Yes
For initial setup	Limited	Yes	Phone	Limited	For fee
For upgrads	Limited	Yes	Phone	Limited	For fee
For Trouble shooting	Limited	Yes	Phone	Limited	Limited or for fee
For training classes	Limited	Yes	Phone	Yes	For fee
Tutoring	No	Limited	No	very limited	No
Consulting on new apps	Limited	Limited	Phone	very limited	Yes
Delivery method?	Help Desk w/tiers	Help desk, regional & dept'l w/tiers	Help desk w/dept'l	dept'l w/limited help desk	Help Desk
Source of Funding	Central, fee	Central, dept'l	Central	dept'l budgets, limited central	Central

Unique comments