American industry rushed to adopt the personal computer during the 1980s, but it is not clear that they were wise in doing so. As that decade ended, economists were perplexed to discover that the information age had not brought with it any discernible increase in productivity (David 1990; Roach 1987; Bailey and Gordon 1988). The expectation that computers would save time, money, and paper had been largely unfulfilled. In a maxim attributed to Robert Solow of the Massachusetts Institute of Technology, “We see computers everywhere but in the productivity statistics” (Harrison 1996).

During the early 1990s, the privatization of the Internet and the inception of the World Wide Web (Web1) have taken place. Why has there been so much excitement and hyperbole surrounding these 2 developments? Perhaps because computers are finally beginning to fulfill earlier expectations. Although final judgments about productivity are premature, these 2 developments are already allowing a large number of workers to benefit from computer applications in a very direct and visible way. This article examines ways in which an institutional animal care and use committee (IACUC1) might use electronic mail (e-mail1) and the Web to enhance productivity.

PRODUCTIVITY OF THE IACUC

What exactly is the “productivity” of the IACUC, and how should it be measured? Although the IACUC must review a certain number of protocols in a given year and must inspect and evaluate a certain number of animal facilities and programs, these numbers are beyond the control of the IACUC and are not a reflection of productivity in any case. The IACUC at a given institution will review the same number of protocols in a given year whether it is efficient or inefficient. The true efficiency of an IACUC should be determined by the quality of its reviews and the speed with which protocols can be approved.

The quality of an IACUC’s reviews is a function of the thoughtfulness and thoroughness of the review process. Is the protocol well-conceived? Are the techniques optimal? Have the needs of the animals been fully considered? Certainly it is difficult to measure such quality, which does not lend itself to automation. The IACUC’s deliberations will require thought and insight—characteristics not possessed by computers. The best approach to ensure quality is to provide IACUC members with complete and accurate information in a timely manner and to adequately train them for their responsibilities.

Speed or turnaround time is 1 element of the protocol review that can be improved by automation. Consider a hypothetical IACUC with an average turnaround time of 30 days (an entirely reasonable, and in many cases optimistic, time). The investigator submits a protocol on day 1 and receives final notice that the project has been reviewed on day 30. An examination of records for the 30 days reveals the following:

The protocol was first prereviewed by IACUC staff and perhaps by the institutional veterinarian. Each of them spent 1 hour reviewing the document and communicating with the investigator regarding points of clarification (totaling 2 hours of constructive time). The document was then copied to the full IACUC, whose members collectively or in total spent 1 hour studying the protocol before the meeting (this investment of 1 additional hour totals 3). The IACUC then met as a convened quorum and spent another constructive hour discussing the project and voting to approve it (now totaling 4 hours). Finally, the IACUC staff used another hour to notify the investigator that the project had been approved, issued a letter of verification to the granting agency, and filed appropriate paperwork in the IACUC office. This protocol has received attention for a total of 5 hours in various venues.

The investigator may ask, “If my protocol required only 5 hours to review, why did it require 30 days for approval? In the 30 days (176 working hours) that have passed, what was happening to my protocol during the other 171 hours?” The answer, of course, is that for the other 171 hours—97% of the turnaround time required for review—nothing was happening to the protocol. Instead, it was sitting on desks, being sent through the mail, or stacked in a pile on a copy machine. This 97% of review process time when no useful activity occurs might be called “dead time.” It is this segment of time that one should seek to shorten by automation.

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1Abbreviations used in this paper: e-mail, electronic mail; IACUC, institutional animal care and use committee; OPRR, Office for Protection from Research Risks; PHS, Public Health Service; Web, World Wide Web.
A productive IACUC should review every project within a short time, sacrificing neither quality nor thoughtfulness.

**APPROPRIATE TECHNOLOGIES**

The 2 Internet-based technologies most likely to be of assistance to the IACUC are e-mail and the Web, both to gather and disseminate information.

**E-mail**

E-mail is the descendent of the quill and ink pot, the ballpoint pen, the typewriter, the telegraph, and the word processor. Both faster and less expensive than either printed correspondence or telephone conversations, e-mail also eliminates the time wasted in attempting to telephone someone who is not available and removes the limits of communication imposed by voice mail. The most important advantage of e-mail is that it allows conversations to be carried out asynchronously. A question can be posed at 8:00 a.m. and the answer given at midnight without any awkward waiting or scheduling. Neither the person posing the question nor the person framing the response has to wait for the other person; the next round of correspondence is on his or her desk, waiting for that person’s time to attend to it.

There is nothing inherent in the use of e-mail that will either reduce or enhance the quality of what has been written. Just as a pen may be used to write something trivial or something profound, e-mail may be used to distribute a message of substance or drivel. The quality is a reflection of the writer, not the medium.

A further enhancement of e-mail is the mailing list or list server. Individuals who are members of a mailing list agree to share mail about a given topic. (This topic is also discussed in “Introduction to the Internet and the World Wide Web,” in this issue.) When one sends a comment or a question to a list, one sends it to all members of the list simultaneously. Replies are also seen by all members of the list. As members of a list come to know each other, the discussions on a mailing list tend to become fluid and conversational. When one looks at the transcripts of an active mailing list, conversations that took place over days or hours read as though they were part of a single, synchronous dialogue.

**Web**

If e-mail is the descendent of the quill and ink pot, the Web’s ancestor is Gutenberg’s printing press. The Web comprises many computer functions much as a library, photocopier, or fax machine operates with paper. By placing a document on a Web server, you can allow other individuals of your choosing to view, copy, print, or perhaps even edit your document, whether they are in the next building or on a different continent.

The following narrative describes a typical experience that may have occurred in 1993. A professor gives a lecture at a national meeting. He brings 100 copies of a 10-page handout but, to his dismay, sees that there are 400 people in attendance, all of whom would like a copy of his handout. Five years ago the professor would have said, “I don’t have enough handouts to go around, but if you put your name and address on this sheet of paper, I’ll mail you a copy after the meeting.” On returning home, the professor would dutifully copy the required 3,000 pages, stuff them into 300 envelopes, address the envelopes, affix 300 postage stamps, and drop them in the mail. The attendees would receive their handouts days or weeks later.

Today, however, the same professor would say, “I’ve run out of handouts, but I’ll post the information on my Web page at this address.” The attendees returning home after the meeting can access the document immediately from their own personal computers. They can print a copy if they wish, and the professor is spared the burden of copying and mailing the documents. The cost is negligible, and the time spent is inconsequential.

The Web may also be used to distribute color graphics, sounds, video clips, computer programs, and so forth. One can use the Web to collect data, by allowing remote users to complete forms on their own personal computers in their own offices. The data can be recorded directly on the distant computer. The Web may be used as a “remote control” for programs on a remote computer; specifically, it may be used to search for information in remote databases. The Web provides a common bridge between computers of different types, allowing a computer of any type to search for data on another computer, even though the operating system and language of the distant computer might otherwise be incompatible.

A very recent development is the Web-based conferencing system, which combines the Web interface with some of the conversational elements of e-mail mailing lists. Typically, conference members are given a list of discussion topics, and they may read the comments of others about a topic and may post questions or responses of their own. The “conference” is organized with a point and click graphic user interface, which can be navigated with ease by even an inexperienced computer user. In the case of an IACUC, discussion topics might be particular protocols or agenda items of a programmatic nature. A conferencing system has the conversational nature of e-mail but is far superior in its ability to organize and group comments around particular topics.

Both e-mail and the Web owe their origins to the Internet, although their use does not require a connection to the Internet. Small corporations and schools commonly establish internal networks or “intranets” within their own borders. An intranet provides all the functionality of the Internet but lacks any connection to the outside world. Intranets are particularly useful for organizations that either cannot afford the cost of a full-time Internet connection or are extremely concerned about data security. Even institutions with a full-time connection to the Internet can restrict access to particular users. Using the Web does not mean that information will necessarily be made public to the wide world.
IACUC USE OF CURRENT TECHNOLOGIES

Each institution must decide how to most effectively use computer technology. Internetworking the IACUC is likely to be most cost-effective in large and physically dispersed institutions in which IACUCs have a heavy administrative burden. Several possible ways to use current technology are presented below.

Communicate with E-mail

Give the nonaffiliated member an e-mail account. For the IACUC to use e-mail effectively, all IACUC as well as nonaffiliated members should have their own e-mail addresses. Most institutions can do this at essentially no cost, allowing the entire IACUC to participate in on-line activities and even to express appreciation to nonaffiliated members for their contributions.

Set up a list server for IACUC members and staff. This will allow every member to share comments and concerns with other members and to maintain the continuity of the discussion.

Distribute agendas and meeting announcements to IACUC members by e-mail. Every use of e-mail to distribute information saves 2 days of dead time.

Ask questions before meetings. Ask IACUC members to e-mail staff any questions or concerns they have about particular protocols before the meeting takes place. The staff may then collate these questions and obtain additional information from the investigator. An e-mail listserver might be an excellent way for the IACUC members to share their questions before the investigator is contacted and then to see the investigator’s responses to all of the questions. Hopefully most concerns could be addressed before the meeting takes place, and the investigator could avoid having his or her protocol tabled “for further information.”

Send draft minutes via e-mail. Circulate draft minutes to IACUC members and obtain corrections, all by e-mail. It will still be necessary to approve minutes at convened meetings; however, final corrected copies can be brought to meetings, eliminating the time required to discuss minor corrections.

Send all correspondence to investigators via e-mail. Use e-mail to send requests for clarifications or additional information to investigators. When the questions have been answered, e-mail the answers back to the members. If portions of the protocol require editing or expansion, exchange proposed revisions with the investigator via e-mail and obtain the investigator’s consent for any necessary revisions. I have found that investigators are very appreciative when time is saved in this way.

Publish on the Web

One clean original

Because of the changing nature of forms and policies, it is sometimes difficult to know whether a printed document is current. Any institution that ever changed a form or a policy has been haunted by outdated versions of documents that simply never seem to go away. Institutions can prevent this by posting the final, current version of all IACUC documents, policies, and forms on the Web. Institutions can then train staff, investigators, and IACUC members to look first on the Web for the authoritative version of any document.

Fast-breaking news

Use the Web to post information about events as they occur: inspection schedules, upcoming meetings, legislative issues—anything that would be of interest to your members or investigators. Whereas a printed newsletter is costly to distribute and may be current only the day it is printed, a Web newsletter can be modified at a moment’s notice.

Lengthy documents

Many documents connected with animal care and study are lengthy and very expensive to print in large numbers, such as the National Institutes of Health Office for Protection from Research Risks (OPRR1) Animal Welfare Assurances, standard operating procedures, federal regulations. At large institutions, distribution of such documents is a daunting task, and a large percentage of copies of mass-mailed documents may be discarded unread. An institution can distribute large documents on the Web or link to them if they are published elsewhere. By doing this, the documents will be available when needed, they can be printed at users’ discretion, and the institute will be spared the cost and waste associated with mass printing.

Informational documents

Use the Web to distribute handouts of anesthetic doses, descriptions of techniques, life-cycle information about animal species, instructions for ordering controlled substances, and other information commonly requested. Any type of information typically sought through office communication is worth putting on a Web page since that form of information retrieval will enable staff members to free up their telephones and to save paper.

Interactive training materials

The Web can be used as an interface to other types of computer-based instructional materials. Obviously, it is not possible to learn a mechanical skill from a Web page, but certain training materials can be used very effectively over the Web.
Compared with a training videotape, for example, the Web has the advantage of interaction with the student. A Web-based instructional program can ask a question, solicit an answer, and respond based on the answer that was given. Web pages can actually force the student’s participation in a way that is not possible in a videotape.

The Web is not a perfect medium for computer-based training materials. Also available for interactive training are fixed media computer programs distributed on diskettes or compact disk read-only-memory (CD ROM) versions. These fixed media can economically include much more data (such as sound and movies) than can be delivered over the Web by current technologies. The disadvantage of fixed media materials is that they must be reproduced and delivered to the user and they must be installed on a compatible remote computer by the user. The distribution and support costs can be high. The Web is more limited than fixed media in what it can deliver, but it can deliver its package across platforms and at distances beyond those that can be reached with fixed media.

Protocols on-line

It is possible to provide the protocol form entirely as a Web page, without the existence of any printed document. The investigator could complete the form on-line and could use a keystroke to write the entire protocol into a database in the IACUC office. Several immediate advantages would result: (1) Separate forms for different computers and word processors would not be needed. (2) Data would not have to be reentered since the protocols would be entered directly into a database at the IACUC office. (3) The protocol document would not have to be returned to the investigator for subsequent minor edits because the document could be edited by IACUC staff directly in the IACUC office, saving many days of turnaround time. (4) If the document were being revised in collaboration with the investigator, both the IACUC staff and the investigator could view the document, each from their own workstation, while the edits were being discussed over the telephone. (5) IACUC members could read and review newly submitted protocols or amendments as soon as they were submitted, asking questions as they arose, discussing the protocol with other IACUC members via the list server, and understanding others’ concerns about the project, perhaps even before the IACUC staff were aware that the new protocol had been submitted.

Meetings on the Web

Consider establishing a Web-based conferencing system in which protocols and agenda items can be discussed. An active, participatory conferencing system involving all the IACUC members could replace many IACUC meetings and avoid the dead time required for transportation. OPRR policy delineates several types of business items that may only be discussed face to face at convened meetings of the IACUC. As a generalization, any action of the IACUC that requires an official vote of the committee must occur at a traditional convened meeting. Examples of actions that require a convened meeting include accepting the semiannual reviews and suspension of an ongoing research project. OPRR has issued a further clarification that “polling” or voting via e-mail is not considered to be full committee review and may not be used when full committee review is required.

Interestingly, review and approval of most protocols does not require full committee review and could very well be conducted via a Web-based conferencing system. OPRR policy would allow for an electronic protocol review system as a supplement to a system of review by a designated member. (According to PHS policy, “If full committee review is not requested, at least one member of the IACUC, designated by the chairperson and qualified to conduct the review, shall review those research projects and have the authority to approve...” [OPRR 1986].) Protocols could be distributed electronically to all members of the IACUC, and each member either could allow approval by the designated member or could request that a particular protocol be held for consideration at a traditional convened meeting. The particular procedures each IACUC uses to discharge its responsibilities must be individually negotiated with OPRR as a part of the institution’s Animal Welfare Assurance. OPRR is likely to be favorably inclined toward procedures that increase efficiency, provided the procedures meet both the letter and the intent of Public Health Service policy.

Therefore, each IACUC will still have to conduct regular, convened meetings. A well-conceived conferencing system coupled with the “designated member” format of protocol approval could substantially reduce the number of meetings necessary and shorten the turnaround time for review of projects.

Give it all away

Those in private industry are greatly concerned about the security of their data. The key for data that must be kept secret is to use intranets with no connection to the outside world or to implement systems of restricted access, passwords, and encryption. Public universities often have the opposite problem.

Both the federal Freedom of Information Act (Freedom of Information Act 1966) and the various state public records acts require that certain information be made available to the public on request. Complying with public record requests can be arduous and costly. At the University of California, for example, the IACUC is governed by both the California Public Records Act (California Government Code Sections 6250-6270), which requires that many IACUC documents be made public, and the Information Practices Act (California Civil Code Section 1798), which prohibits certain information (home telephone numbers and so forth) from being made available to the public. In some states, nonfunded grant applications and nonfunded protocols have the protected status of a manuscript in preparation, whereas a funded grant or a protocol in progress must be made available to the public.
At the University of California at Davis, the great number of requests for documents under the California Public Record Act have required individual review and removal of protected documents and portions of documents. Copies have been made, the protected portions blacked out, and the redacted copy photocopied again for distribution to the requester. The University of California at Davis has been known to spend as much as $100,000 to fulfill a single Public Records Act request, and university personnel are prohibited by law from charging the requester for the labor involved.

An institution could fully meet its public access obligations by electronically storing its records on a Web page. Records could be prepared so that only the legally mandated documents were made available to the public, and the protected portions were not displayed. Once an institution had made its data available on a Web page, which could be reviewed at any public library, all additional requests for copies could simply be directed to the institution's Internet address.

Certainly many researchers will object to the suggestion that IACUC documents, such as protocols, be made available on the Web. In response to their concerns, I simply point out that nothing about storing a document electronically affects its availability under a request for public records. The content of the document, not the media on which it is stored, determines whether it must be made public. It is clearly less costly for an institution to comply with a request when the institution stores its data electronically.

**PRIVACY AND PUBLIC RECORDS**

Must all the electronic mail of government employees be made public on request? Would the contents of a list server or Web-based conferencing system be subject to requests for public records? How is an IACUC to fulfill its dual obligations to protect the privacy of its members, yet at the same time provide appropriate public access to public records?

For state-funded public universities, the subject is a complex one, and the final answer varies according to state law. Electronic documents are generally treated no differently than any other sort of document. It is not the medium that makes a record public, but how the originating agency chooses to use the document.

The California Public Records Act excludes from consideration “preliminary drafts, notes, or interagency or intraagency memoranda which are not retained by the agency in the ordinary course of business.” If a state agency, such as a university, discards notes, memos, and e-mail, then these are not considered public records. If the university chooses to retain these documents, then they must make them available on request. Correspondence distributed via e-mail list servers and Web-based conferencing systems may or may not be archived, at the discretion of the operator. If the proceedings are filed or archived for future reference, then it is likely that they could be considered public records.

A public institution setting up a system of electronic records should carefully consider how it intends to use the information. There would be advantages to permanently retaining the electronic correspondence concerning a particular project. For example, past records might provide future IACUC members and regulatory agencies with a more complete understanding of past committee deliberations. The disadvantage would be that by making the discussions matters of public record, one might inhibit frank and open discussion and perhaps invade the privacy of IACUC members. At the University of California at Davis, IACUC members routinely communicate with each other via an e-mail list server; however, no archives or records of these communications are maintained and members rely instead on minutes of convened meetings to finalize committee actions.

The institution should also consider what sort of documents will be archived as the final, true, and official records of the IACUC. Although electronic media can provide great assistance in the conduct of business and in the preparation of written records, the current state of the art is that the paper record is the “real” record. At present, magnetic media are not reliable for more than a few years at best and may be utterly destroyed by a spark of static electricity or a passing magnet. Presently, there is no simple, elegant electronic substitute for the handwritten signatures of the principal investigator on the final, printed version of a protocol or for that of the institutional official on the institution’s Animal Welfare Assurance.

**STATE OF THE ART**

The Web, which only began in 1994 with the establishment of the World Wide Web Consortium, has evolved at a staggering pace. In November 1996, 935 research facilities had Animal Welfare Assurances on file with OPRR. Of these institutions, only 32 were listed by the Washington University St. Louis NetVet information server (http://netvet.wustl.edu), as having some sort of permanent presence on the Web. I surveyed the operators of these sites to characterize the way in which their IACUCs used Internet technologies. Of the 32 institutions, 21 responded. The results are shown in Table 1.

Most of the responding IACUCs indicated that they had active plans for expanding their use of these technologies in the near future. All used the Internet to distribute information, but fewer used the Internet for training. Most, but not all, members of the typical IACUC had e-mail access, meaning that individuals used e-mail to communicate; however, at most institutions, the IACUC cannot be addressed as a body via e-mail.

Although IACUCs appear to be at an early stage of evolution with respect to electronic communication, the progress appears to be rapid, and there is great interest. Based on the inquiries I conducted in preparation for this article, it appears that a greater number of institutions are in the process of setting up list servers and Web pages than are currently on-
### TABLE 1 Survey of 21 IACUCs* with an active Internet presence

<table>
<thead>
<tr>
<th>Question</th>
<th>Response (N=21)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. How often do you use e-mail to communicate with IACUC members regarding IACUC business?</td>
<td>Never - 3, Occasionally - 5, Frequently - 7, Routinely - 6</td>
</tr>
<tr>
<td>2. What proportion of your IACUC Members receive e-mail?</td>
<td>None - 0, A Few - 1, Most - 14, All - 6</td>
</tr>
<tr>
<td>3. Do you use a list server to communicate with the IACUC?</td>
<td>Yes - 7</td>
</tr>
<tr>
<td>4. Do IACUC members ever use e-mail to discuss protocols?</td>
<td>Yes - 11</td>
</tr>
<tr>
<td>5. Does IACUC staff use e-mail to discuss protocols issues with investigators?</td>
<td>Yes - 12</td>
</tr>
<tr>
<td>6. Does your institution provide information about the IACUC via a Web page?</td>
<td>Yes - 18</td>
</tr>
<tr>
<td>7. Does your institution maintain one or more Web pages specifically devoted to the IACUC?</td>
<td>Yes - 14</td>
</tr>
<tr>
<td>8. Does your institution operate a Web-based conferencing system in which discussion of particular protocols occurs?</td>
<td>Yes - 0</td>
</tr>
<tr>
<td>9. What do you provide on your Web page(s)?</td>
<td>• A description of the IACUC and its mission</td>
</tr>
<tr>
<td></td>
<td>• The institution’s Public Health Service Animal Welfare Assurance</td>
</tr>
<tr>
<td></td>
<td>• Policies for the care and use of animals at the institution</td>
</tr>
<tr>
<td></td>
<td>• Blank protocol forms for downloading</td>
</tr>
<tr>
<td></td>
<td>• Static training materials such as handouts, syllabi, etc.</td>
</tr>
<tr>
<td></td>
<td>• Interactive training materials</td>
</tr>
<tr>
<td></td>
<td>• On-line submission of protocol forms</td>
</tr>
<tr>
<td></td>
<td>Yes - 13, Yes - 6, Yes - 17, Yes - 16, Yes - 8, Yes - 2, Yes - 1</td>
</tr>
</tbody>
</table>

*IACUC, international animal care and use committee.

All indications are that both interest and opportunity exist for IACUCs to expand their presence on the Web. It will happen.

### REFERENCES


