THE INTERNET AS COMMUNICATIONS LAB
by Jerry Michalski

The Internet is an immense, fertile Petri dish for communication concepts. Ideas propagate across the medium and grow where they find nutrients. They combine and recombine, often with unpredictable results. Some strains die or are supplanted by more successful variants. There are viruses and symbiotic relationships. Sometimes creatures created for one purpose work for another, with surprising results. The creatures that survive aren’t always beautiful, but they show surprising resiliency and usefulness.

The phone network doesn’t have the luxury of hosting such uncontrolled activity. It’s a global production system that is constructed, not grown: Change comes slowly, after rigorous tests and under central control. Only a few companies write the software that runs the phone-system switches, and it takes them ages to test and load it. Meanwhile, corporate LANs and WANs are focused within company boundaries. The LANs are hard to interconnect and often run different protocols, so wide-area experimentation is difficult. What can we learn in the Internet Petri dish, and how can we use those insights to improve our communication infrastructure?

Last month we described some of the Internet’s building blocks, as well as some organizations that use these elements to offer products and services that improve access to the Internet, such as Qualcomm’s Eudora, NCSA Mosaic, Spry’s Internet-In-a-Box and the New York-area service named the Pipeline. This issue of Release 1.0 looks beyond today’s products and services. It focuses on modern experimenters and explores the broad range of capabilities that will emerge from Internet-style connectivity.

The Internet’s agar is the community that develops and continually improves TCP/IP (the Transport Control Protocol/Internet Protocol) and its affiliated protocols, formats and utilities. TCP/IP is not perfect: For one thing, it sacrifices latency (packet travel time) for reliability (guaranteed packet transmission), which makes it difficult to work with streamed information types that require low latency, such as real-time voice or video. But its ubiquity on the Internet has led many experimenters to do things that previously seemed beyond the Internet’s capabilities.

The examples we cover range broadly: Nathaniel Borenstein at

DON’T FORGET TO REGISTER!
Bellcore has adapted a scripting language called Tcl to do some Telescript-like functions (see below); Ehud Shapiro's team at the Weizmann Institute of Science in Israel has gone a step beyond mail-enabled applications with Active Mail, which can carry not only complex documents, but also Internet port addresses that set up real-time collaborative-work sessions between participants (page 8); and Carl Malamud's Internet Multicasting Service has been broadcasting digitized radio shows across the Internet (page 10). He also offers a way to send faxes to distant places without making long-distance phone calls.

Blurring the boundaries

Portions of the Internet are blazingly fast and getting faster all the time (read about the MBONE, page 14) and researchers are working hard to create next-generation protocols, but the Internet is not likely to be a ubiquitous, end-to-end, real-time, multimedia transport anytime soon. Yet there are ways in which it can perform many functions that are just shy of that goal, such as the radio multicasts mentioned above.

The experiments covered in this issue explore, test and cross the boundaries of what appears to be possible. They show us the Internet's utility and flexibility. The experiments help us imagine how different types of communication might merge: computers and telephones, broadcasts and interactive sessions, and real-time and deferred messages.1

These capabilities are all complementary and intertwined. They have not been assembled in any organized fashion yet. In many cases they are raw and barely past prototype stage, but they presage deeper changes. In fact, many combinations remain unexplored. As the data, voice and video worlds collide and merge, these Internet experiments should offer valuable insights for the design of the emerging infrastructure.

Tcl, Tk and Safe-Tcl

It seems that every time developers create new PC applications, they also create accompanying, original and proprietary scripting or macro languages. People who want to use several powerful applications have to learn these languages, which seldom share syntax or interoperate. And the OS command languages seldom have access inside applications: They can only invoke applications, pass them parameters and wait for them to execute. Now Microsoft has put its marketing and technical muscle behind OLE2 and Visual Basic, and Apple is working with much of the rest of the industry on OpenDoc, which includes the Open Scripting Architecture (see box, page 7).

At the same time, General Magic is working to deliver a different kind of scripting environment. General Magic's Telescript allows companies to build distributed, collaborating communication platforms that exchange and host smart agents that have limited script power. The agents' power must be limited because they move between platforms and can't be trusted.

1 The Release 1.0 issues on unified messaging (12-92 and 1-93) and personal data interchange (9-93) address these issues from other perspectives.

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Unlike PC applications, Unix applications rely heavily on utilities to get work done. People typically write shell scripts (similar to DOS .bat files) to link the tools or scripts. To write prototype Unix applications or utilities, developers often extend the scripts and string them together, creating new and inconsistent sets of primitive functions each time. So far, Internet developers haven't written an application that is equivalent to General Magic's Telescript, though Safe-Tcl, which we describe below, can serve some of the same purposes.

Enter Tcl

UC Berkeley computer science professor John Ousterhout created a generalized scripting language that he called Tcl (the Tool Command Language, pronounced "tickle") because he was tired of writing a new scripting language or shell each time he wanted to prototype a Unix application. Tcl, which Ousterhout has distributed freely, has become very popular in the Internet community.

Tcl is a programmable, extensible and distributed language. It includes several dozen commands that run Unix utilities and provide file services and if-then-else-style control structures. It exists as a library of C code that can be embedded in applications; those Tcl-enhanced applications can use it to communicate with each other while they are executing (as opposed to invoking applications serially and piping inputs and outputs, as Unix shell scripts do). With Tcl it becomes possible for a script written in a single language to communicate simultaneously with several applications and make them work together.

Thus, Tcl offers developers more granularity of control than traditional shell scripts. It's also easier to write Tcl scripts than to mess with Unix primitives; the resulting scripts are also more portable than conventional shell scripts (though mostly within Unix environments so far).

For X Windows fans, there's Tk

Tcl doesn't handle user interfaces. For that, developers must use an interface-specific library such as Tk, also written by Ousterhout, which helps them build Motif-compliant front-ends with scripts instead of C code. Also, a simple shell called Wish lets users and developers issue GUI commands in Tk and Tcl interactively or as shell scripts.

A taste of Tcl and Tk

Here is a sample Tk script:

```
button .hello -text Hello -command "puts hi"
```

The "button" command is part of the Tk toolkit and creates a new button widget; the other terms are passed as arguments. The ".hello" is the name for the new button's window. "Hello" is the text to display in the button itself, and "puts hi" is the command to execute when the button is pressed. It prints the word "hi" to standard output.

Tcl and Tk are in broad use across the Internet and even in commercial applications. For example, several million households in the UK are on the Internet.
British TeleText system, which uses Tcl. Tcl is popular in vertical industries: It is used for molecular chemistry simulations, oil well platform control and system administration and installation. One company created an X Windows presentation package that combines Tcl scripts, MIME compound-document elements (see box) and custom C code. The program includes a feature called power text, which allows fields to update dynamically from sources across the network as a presentation runs. Separately, Don Libes of the National Institute of Standards and Technology has used Tcl to automate the user's end of Unix terminal sessions. The front-end, called Expect, is used by thousands of Internet denizens.

We mentioned MIME, the Multimedia Internet Mail Extensions, in Release 1.0 12-93 and 1-94, but explained it only in passing. MIME extends the Internet mail function to permit messages to contain enriched (marked-up) text, images, audio, video, multilingual documents and much more. MIME includes a general mechanism for including multiple kinds of data in a single message. For example, a MIME message might contain the same text in plain ASCII, RTF, Microsoft Word and FrameMaker formats (or English, Spanish and Russian).

MIME depends on the availability of viewers and interpreters. The MIME kernel (or the MIME-aware application) acts as an internal dispatcher, recognizing inbound messages with MIME parts and forwarding the sections to the appropriate viewer or interpreter. MIME is highly extensible to support additional data types (some examples are the subjects of this newsletter). To prevent damage to these highly variable enclosures, MIME provides robust encoding that preserves the integrity of arbitrary data through any mail gateway currently known.

There are three levels of MIME subtypes. To allow for broad experimentation and customization, anyone can define a subtype as long as she gives it a subtype name that begins with an "X". For a more official definition, she must submit an explanation and public specification to the Internet Assigned Names Authority, which registers the subtypes and guards against name conflicts. Finally, making the subtype an Internet standard requires a lengthier standards process.

Add a dash of security...

Now enter Nathaniel Borenstein, a whirlwind of ideas and projects. After earning his PhD at Carnegie-Mellon University in 1985, Borenstein led the development of CMU's notable Andrew Messaging System. In 1989 he joined Bellcore (the research arm of the regional Bell operating companies) and generalized the active-message aspects of the Andrew system in ATOMICMAIL, which featured a Lisp-like language that provides secure and portable active-messaging capabilities. In the process, he created two ancillary elements that have survived ATOMICMAIL: Metamail and MIME. (An active message contains a program, which the recipient can execute upon receipt. Metamail is a portable MIME implementation designed to be called by mail-reading programs. It is bundled with many public domain and commercial mail systems, and brings them multimedia capabilities.)
Borenstein wanted to go beyond ATOMICMAIL's capabilities, but the language it used was limiting, and he was loath to write a new one. When he found Tcl, he was happy to adopt it.

However, Tcl's power presents security problems for a system that transmits applications across networks to execute on foreign platforms. It's the same design problem that Telescript faces. So Borenstein and Marshall Rose adapted Tcl to a messaging environment, limited its functionality so that errant or mischievous Tcl programs carried within messages wouldn't go around wiping out others' hard disks or causing other calamities, and called it Safe-Tcl.

"It must be possible to read a message from your mortal enemy without that message doing you any harm."

-- Nathaniel Borenstein, Bellcore

Borenstein defined two new MIME content types for Safe-Tcl. One allows a Safe-Tcl call to be embedded anywhere in a MIME message, which is the default way to send Safe-Tcl scripts. The other is a two-part MIME package with a Safe-Tcl script and a MIME-compliant document. That way if there is a Safe-Tcl interpreter, everything works as it should, but if the interpreter is missing or the script is unreadable, the MIME document still makes it through. (Incidentally, this turns Safe-Tcl into a good front-end development tool for things such as multimedia viewers.) Also, a separate Safe-Tcl script can make use of any available MIME objects.

Putting it all together

Here's the process in a nutshell. A message arrives in your in-box. Your MIME software detects that it contains a Safe-Tcl script and passes it to the secure Safe-Tcl interpreter, which might find instructions to take action on arrival, or to wait until the message is opened. At the interpreter, the script looks for local interface choices. If Tk is available then it's easy to generate a Motif interface; otherwise, the script can fall back to a generic plain-text interface, which is guaranteed to work on all platforms. Then the Safe-Tcl interpreter gets to work.

Safe-Tcl allows for user extensibility. For example, a user can specify that certain authenticated senders can put files, including executable code,

2 Rose is an Internet veteran. His contributions include the MH message handling system, MIME, X.500 directory services, SNMP and other areas of the Internet protocol suite, about which he has written several books. He runs Dover Beach Consulting and spends half his time working on public-domain projects. Rose is now the area director for network management in the Internet Engineering Task Force.

3 Tcl is currently available for Microsoft Windows, but with a generic interface. Safe-Tcl has not been ported to Windows, but it should be relatively simple to do. Nobody has written Tk-equivalent user-interface modules for Macintosh and Windows clients...yet.
in a certain local directory. To safeguard against unauthorized tampering, Safe-Tcl uses two interpreters that communicate through a carefully defined channel: an unrestricted one for local commands and messages from trusted sources and a restricted one for the rest. This gives trusted outsiders the ability to extend a user's Safe-Tcl system from a distance. The idea is to permit messages from authenticated trusted sources to do things you wouldn't let other messages do.

Is this Open Telescript?

Although Safe-Tcl and Tk have much in common with General Magic's Telescript and Magic Cap, they embody different visions in different environments -- and are at different stages of maturity. General Magic's world is a high-function, broadly defined but centrally designed communication environment with an integral transaction capability, specifically optimized for portable end-user platforms. It can connect through to the Internet, which it treats as a generic message transport. But despite its strong data-messaging focus, its roots go deeper than e-mail and into online services, phones and cable tv. (For example, an electronic mall is difficult to emulate using an e-mail model. Of course, Active Mail could add such capabilities to Safe-Tcl and more -- see page 8.)

Telescript is a tool with which vendors and service providers can build commercial platforms targeted -- but not limited -- to novice users. It includes transaction concepts such as "permits" that allow smart software agents to consume local resources.

Safe-Tcl, which is freeware and not a commercial offering, has the benefits and drawbacks of the Internet's culture. Safe-Tcl is open and broadly available, but you can't always get help when you want it. Where General Magic and its partners have to build a whole world, Safe-Tcl can leverage everything on the Internet, including emerging directory services, encryption and search tools, as well as unsolicited innovations. If a secure transaction model emerges on the Internet, Safe-Tcl can adopt it.

General Magic's work is commercial. The Internet is slowly being adapted to commercial use, but already has a critical mass of participants with a strong sense of community that General Magic will have to build. Important mobile devices such as PDAs don't fit well into the Internet yet; such support will lag.

A sense of place

The differences between the two systems are most apparent when one compares the front-ends, Tk and Magic Cap. Tk is a Motif GUI builder: It doesn't offer any of Magic Cap's visual features such as hallways, streets and buildings. The electronic environment created by Borenstein and Rose with Safe-Tcl enhances traditional applications and messages in useful ways, but doesn't develop a geographic metaphor or other way for users to conceptualize the space. Others may well write interesting services atop the Safe-Tcl platform, but such work is nascent now. In contrast, many vendors have dedicated resources to create an environment using General Magic's technology that communicates a sense of place and offers a way of embodying users' personal preferences in smart agents.
There are many similarities between Safe-Tcl and Telescript. Both are robust, extensible languages, not crippled scripting systems that can only do high-level stuff. Both allow developers to write applications in a combination of a conventional programming language such as C or C++ and the scripting language. Both use tunneling to ship their programs safely to destination platforms and interpreters to deal with them when they arrive. At the user-interface level, both offer third parties opportunities to create new interfaces for new audiences.

SuperScript?

One key opportunity is to build a link between the communication-oriented scripting languages we have just described and the PC-environment scripting languages that are under development (see box). If Safe-Tcl or Telescript were linked to the Open Scripting Architecture efforts, it would allow developers to treat a wide variety of applications across many platforms as a single programmable entity.

The battle for universal scripting

In the past year, scripting has gained new prominence in the PC world. Two competing efforts (Microsoft vs. nearly everyone else) are underway to simplify and connect the hodgepodge of scripting and macro languages in use today. Microsoft is working to incorporate OLE2 support into all of its applications, and to rewrite all the old macro and scripting languages into Visual Basic, which can be tightly integrated with the applications. (OLE2 is Version 2 of its Object Linking and Embedding technology. It permits documents to contain nested elements controlled by other applications.) Visual Basic is the centerpiece of Microsoft's scripting strategy; OLE2 provides object registration and connection services.

In the other camp, Apple, IBM, Lotus, Novell, Sun, Taligent, WordPerfect and Xerox are collaborating through a membership organization called the Component Integration Lab. CIL's goal is to promote a common, interplatform software-component architecture. Its farsighted compound-document API, called OpenDoc, is built on technology contributed by various vendors, including IBM's System Object Model, a dynamic linking mechanism; Apple's Bento, a portable object storage library; and Apple's Open Scripting Architecture, which supports application-independent scripting and distributed automation. OSA lets developers pick their scripting language among those that comply with its standard, rather than having to use just one. This distinction is significant, since many religious wars have been fought over the choice of programming languages.

CI Lab stands a good chance of transforming the way software is designed, created, distributed and used. OpenDoc documents don't belong to any application, and can include components (called parts) from any compliant applications. The components are all scriptable, and can use that power to move themselves around a network or to bring information to them.
ACTIVE MAIL > MAIL-ENABLED APPS

One of the promises of LAN-based e-mail packages is mail-enabled applications. Specifications such as MAPI, VIM and the Common Mail Calls recently set forth by the XAPIA greatly enhance e-mail by turning it into a transport for complex documents, queries and transactions. These specifications integrate mail more naturally with applications and help them communicate. For example, MAPI makes e-mailing a spreadsheet simpler than printing and faxing it. However, the store-and-forward nature of those e-mail systems and their weak inter-enterprise connectivity limit this approach.

A team working under professor Ehud Shapiro at the Weizmann Institute of Science in Rehovot, Israel, has taken a step beyond these limits by using the Internet. Their system, called Active Mail, uses an e-mail message to open a direct real-time link between participants, typically by connecting their client applications to the same server application.

For example, Zoe can request a collaborative-work session with Phil by sending an Active Mail message that ends up in Phil's in-box (Zoe could just as easily send the message to several people at once). If Phil accepts the request, instructions in the e-mail message connect his client application to a port on a server application, having done the same for Zoe. Once they connect, the two can use the Internet as a real-time pipe -- even though the pipe really passes through a server application. They can share documents, post notes and add other people to the session as needed. The system's architecture makes it very easy to add participants.

Through sleet, snow or clogged gateway...

Shapiro's team has implemented several different applications (which they refer to as agents) for Active Mail. Using the conversation agent (a chat facility), Zoe can write her comments, which are sent to all the other participants when she hits the carriage return key. Or she can take the floor and publish a document using the shared-document agent, effectively uploading it to the server application, which transmits it to the other parties. Phil can solicit the floor and upload a document of his own. (Active Mail maintains a FIFO queue of floor requests. The floor holder is notified when another participant makes a floor request. Active Mail uses the Unix revision control system to keep track of shared-document versions.)

Meanwhile, in another window Zoe can monitor the conversations she is taking part in, and who is active or inactive in each. Zoe and Phil can use Active Mail to plan when to meet again, using the meeting scheduler agent, or play online games such as go or chess.

Shapiro was motivated to create Active Mail by his interest in computer-supported collaborative work. He knew of Borenstein's ATOMICMAIL, thought it was an interesting angle on asynchronous e-mail and wanted to extend it into the real-time realm. He was specifically bothered by the intrusiveness of many real-time multi-user applications, which use startling pop-up boxes

4 The X Window API Association, which is involved in much more than X Windows work. See Release 1.0, 9-93.

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to present invitations to work together. The e-mail in-box seemed like a less intrusive and more appropriate place to field requests, since users are already paying attention to it for traditional messages.

Mail present and future

Active Mail's use of the e-mail bin to establish real-time communication sessions is important because it crosses the often impenetrable boundary between real-time and store-and-forward communications.

To do this, Active Mail makes use of concepts from concurrent-logic programming languages, which Shapiro and his team have researched for about a decade. (Shapiro, who has bachelor's degrees in mathematics and philosophy from Tel Aviv University and a PhD from Yale, developed Concurrent Prolog in 1982.) Such languages are capable of spawning and tracking many processes and communication channels and are often used to program parallel computers. Better still, they allow the developer to send communication ports embedded in messages. (Active Mail piggybacks on existing e-mail as a special MIME message type.)

There are several desirable things Active Mail currently can't do. It doesn't allow real-time viewing of a document as it is being marked up or pointed to with a cursor by a remote party; it simply refreshes each user's screen with the new version when the controlling user hits the carriage return. It doesn't let participants share a document created in a different application. Nor does it support non-X Window clients.

It would also be useful to have a voice session alongside the chat and document-conferencing sessions, either in-band via the Internet or automatically invoked out-of-band. Participants must currently place a manual telephone call, but a computer-telephone link could invoke a parallel telephone session automatically.

A Ubique opportunity

Shapiro recently founded Ubique Ltd., a venture-backed Israeli start-up that has licensed Active Mail and related technologies from the Weizmann Institute of Science. Ubique's mission is to provide a software architecture that incorporates Active Mail as a foundation for Internet-based groupware and Internet-based online services provided by third parties. Shapiro says, "The Internet has a vast potential for interpersonal collaboration that can be unlocked by the right software architecture. We believe we have it."

Ubique will offer APIs and an open architecture that allow third parties to turn desktop personal-productivity applications into Internet-wide groupware, add similar groupware functions to existing client-server applications, enhance remote conferencing with interactive media applications, and put innovative customer-service centers on the Internet. They are also developing real-time document-viewing and audio communications capabilities.

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INTERNET MULTICASTING SERVICE: TED TURNER, WATCH OUT!

So far, our experimenters have focused on e-mail: Safe-Tcl uses mail to carry active messages and Active Mail turns mail into a way of setting up real-time collaboration sessions. This project, the Internet Multicasting Service, goes beyond e-mail into faxes, broadcasting, multimedia, publishing, document retrieval and more.

Carl Malamud likes to question assumptions and try things that others might not think of trying. He’s also in sync with the Internet culture and is a strong proponent of broad information dissemination. These traits have led Malamud to run some of the most fascinating Internet experiments so far, including radio broadcasts, faxes that bypass the long-distance phone networks and a massive letters-to-Santa project last Christmas. The experiments are actually seeds: Most of them take on lives of their own and grow. Some are practical; some are frivolous. All of them illustrate aspects of the Internet’s architecture and culture that deserve further investigation.

ACCESS FOR EVERYONE

The most straightforward of Malamud’s missions is to make governmental and other public information easily accessible to the public. This has not been simple, and not just for technological reasons. Until recently, for example, most US government agencies viewed that information as an asset to be sold to wholesalers such as Mead Data Central, which process and republish the information at substantial cost to consumers. It may have been inertia, too. Other public organizations were reluctant to publish information outside of their normal, limited-distribution channels.

Malamud recently convinced the Geneva-based International Telecommunications Union (ITU) to let him reformat and openly publish standards-committee documents that were otherwise bulky, expensive and hard to get. Unfortunately, when ITU officials understood that their documents were available to millions of people, they got nervous and withdrew their support -- and documents. However, ITU staff has itself taken steps to publish some of the documents electronically since then.

Malamud has had better luck with various US government agencies, including the Securities and Exchange Commission, the US Patent Office, the Federal Elections Commission and the Federal Reserve Board. The NSF recently announced that the SEC is putting its information up for public access; others are in the works (of course, the FCC, which is in the middle of all

5 Malamud made most of the ITU's 18,000-page Blue Book available via FTP and e-mail. This included important packet-switching, modem and telecommunication (ISDN and SS7) standards.
6 Mead’s EDGAR Dissemination Service currently publishes the SEC reports, which include corporate annual reports, 10-Ks and merger filings. The NSF recently announced a grant to New York University and the Internet Multicasting Service which makes the SEC’s EDGAR system available to the Internet free of charge. Initial access will be via the Internet file transfer protocol (FTP) and e-mail; over the next few months, IMS will add World Wide Web, Gopher and WAIS (see Release 1.0, 1-94).
these communications issues, lags a bit behind). Malamud’s intent is not to
compete with the private information wholesalers such as Mead, but to open
access and allow multiple organizations to tailor the information for their
constituencies. Nevertheless, his activities will force these companies to
change, probably toward higher levels of added value.

**FAX DOCUMENTS LONG DISTANCE -- CHEAP!**

Frustrated with the high cost of long-distance faxes and looking for a way
to bring e-mail and fax users closer together, Malamud and Marshall Rose
(page 5) have created a system that could potentially offer low-cost global
faxing via the Internet. The premise is simple: Use e-mail to get within a
local call of the destination fax machine, then switch to conventional fax
technology to complete the last leg of the journey. The recipient gets the
same message. The sender saves money and gets a confirmation e-mail that
the fax was delivered. Note that this is low-cost partly because Internet
access is still subsidized.

One of the insights that led to this system, which Malamud and Rose call
tpc.int,7 is that we don’t expect faxes to get to their destination immedi-
ately, yet we use the phone system, which knows only how to set up an ex-
pensive, real-time circuit between two terminal devices, to transmit them.
Allowing for some latency in the link allows us to use infrastructures and
methods that are far cheaper than the solutions offered by the phone system,
which was designed for conversations that require synchronous circuits.

Malamud has estimated the cost of running an Internet fax cell relative to
sending faxes via the long-distance phone system, assuming the I’ll-carry-
yours-if-you’ll-carry-mine ethic of messaging and news on the Internet. In
volume (to amortize the cost of running a tpc.int site), he calculates short
tpc.int faxes to cost between 5 and 10 cents each, versus 50 cents and above
for conventional long-distance faxes. And tpc.int is distance-insensitive:
A fax to Australia costs the same as a fax to Silicon Valley. Cell opera-
tors may also be able to recoup their costs by selling advertising space on
the cover sheets of the faxes they deliver.

**How it works**

Tpc.int operates as a global cooperative of remote print servers. Volun-
teers operate cells of different sizes, ranging from regions (Australia) or
local calling areas to enterprises (University of Michigan) and even personal
accounts. The cells often map to area codes or local-area prefixes. A
personal cell can be inside a regional one; the Internet’s naming scheme

7 The "tpc" stands for The Phone Company, from the movie The President’s
Analyst, in which James Coburn becomes the psychoanalyst to the president
of the US. The Phone Company plays a pivotal role in the movie’s denoue-
ment, which involves world domination under the masterful eye of TPC’s
president, Arlington Hewes. In a delightful ironic touch, tpc.int, the
coordination point for the Internet fax service, is registered under Ar-
lington Hewes’ name; he also answers all messages sent to <tpc-admin@
town.hall.org>. The "int" part of tpc.int means that the service is inter-
national in scope.
will give preference to the more specific (best matched) one. Prospective operators publish their cells by sending e-mail to Arlington Hewes. Tpc.int has a procedure for bringing new cells on-line.

How do I do it?

To send a tpc.int fax, you compose a normal e-mail message and encode the destination number and addressee in the destination Internet address. Here is an example:

<remote-printer.Arlington_Hewes/Room_403@14159682510.iddd.tpc.int>

All tpc.int fax addresses start with "remote-printer" (this opens the door for future services that address pagers and voicemail, for example). Embedded slashes print as carriage returns. Notice the destination fax number is in international format, starting with the country code (but without the international access code, such as "011" for calls abroad from the US). The "iddd" invokes some software that Malamud and Rose wrote called the international direct dialing designator, which flips the phone number (to harmonize it with the Internet addressing scheme, which places more general entities to the right). Although these addresses seem complex, they are simple to automate with a macro or front-end.

Malamud and Rose launched tpc.int in July 1993. Now it has coverage in the San Francisco Bay area (including Silicon Valley), New York, Boston, Washington DC and individual sites such as the University of Michigan. Abroad, Australia has been joined by Japan, Portugal, Germany, England and the Netherlands. All told, about 245 areas are on-line today, and many thousands of faxes have been sent. Faxes sent to numbers not yet covered will return to the sender with a "service unavailable" message; IMS monitors these requests to see where it should solicit coverage.

Participating cell operators can refuse service to an originator (to stop abusers), but must agree to deliver to any destination number within their announced cell boundaries. Cell operators can also adjust their cell boundaries, which allows them to back off their commitment if traffic gets too heavy. Others might step in to fill coverage gaps. In this way, cells could subdivide organically and without centralized control, while still offering good coverage.

To operate a cell, you need an addressable Internet node, fax system hardware and spooling software, the tpc.int software, which is publicly available -- and your boss's consent, of course. You're expected to meet accounting and reporting requirements, which help assure a consistent grade of service. A requirement that cell operators not monitor the fax traffic they process helps assure, but certainly doesn't guarantee, confidentiality.
DESKTOP BROADCASTING: THIS IS INTERNET TALK RADIO

Malamud does his work from a small, non-profit agency called the Internet Multicasting Service in a rented office in the National Press Building in Washington, DC. This nondescript office is the home of the first cyberstation on the Internet, where Malamud started broadcasting a digitized radio show last April.

Entertainment and communications conglomerates looking to sell video-on-demand should look at Malamud's set-up: Audio-on-demand is already here! Malamud estimates that 100,000 people from over 30 countries have listened to some of his 50-plus shows. The service is funded by corporate donors in return for publicity and easy access to information about IMS projects.

The Internet Multicasting Service works much like radio, which Malamud considers both a familiar starting point and a springboard for experimentation. It runs two "radio" channels. Internet Talk Radio covers science and technology, and includes Malamud's Geek of the Week interviews of important members of the technical community such as Rose himself, Brewster Kahle and L. Stuart Vance. Internet Town Hall is a public-affairs channel, and has included broadcasts of National Press Club luncheon speakers such as the Dalai Lama, Janet Reno, Steven King, Yassir Arafat, F.W. DeKlerk and Vice President Al Gore. (In exchange for broadcasting rights and a control booth in the Club, Malamud provides access to the Internet, does monthly seminars for journalists and donated some equipment.)

IMS now also syndicates and rebroadcasts (digitally, of course) several shows from public radio and tv, including the audio portion of the tv show Computer Chronicles, and the radio shows Soundbytes, TechNation, Soundprint and a multi-part series on the history of the phone. During a live broadcast multicast of Ira Flatow's Talk of the Nation, Malamud solicited audience questions over the Internet -- and got more than 500.

All things considered

For a slightly more commercial angle, Malamud has struck a deal with HarperCollins to broadcast 4- to 10-minute audio excerpts of famous people reciting their own works, under the name HarperAudio. HarperCollins hopes people will want to order the full tapes.

Malamud is interested in video but is leery of the stress it puts on the Internet (he was not involved in the David Blair movie that was broadcast on the Internet last year called Wax or the Discovery of Television Among the Bees). Malamud is working to let people select the time between when events occur and when they hear about them -- from real-time to on-demand. He also wants to demonstrate that desktop broadcasting is easy and encourage others to follow suit.

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8 Sun Microsystems and publisher O'Reilly & Associates underwrote the initial multicasts and are still sponsors. They were joined by MFS Datanet and UUNET Technologies, which provided a 10 Mbps Internet connection, and most recently by the Interop Company, HarperCollins and Persoft. Malamud wants to cultivate a symbiotic relationship with his sponsors similar to that between the cable tv industry and CNN in its early days.

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Malamud, who started his career as an economist, spent many years building networks and databases for large institutions such as the Federal Reserve Bank, Indiana University and the Lawrence Livermore Laboratories. He also consulted to computer companies and wrote several technical books, plus a technologist's travel guide called Exploring the Internet: A Technical Travelogue. The book is the story of his three trips around the world in six months to visit Internet and policy-making luminaries, some famous, some not. To finance it, he talked Dan Lynch, president of the Interop Company, into covering his expenses in exchange for some publicity on the book cover and a discount to give the books to Interop conference attendees.

Where do I tune my SparcStation?

The multicast bears a more technical explanation. To listen to it, your best option is to be on or near the MBONE -- the volunteer, virtual multimedia backbone formed by powerful Internet nodes linked with high-bandwidth connections and running multicast software (see box). Or you can download the compressed audio files (audiophiles?) and play them at your own leisure. (An hour of compressed audio fills roughly 30 megabytes of disk space.) That means, of course, that you can pause, rewind or otherwise alter the experience to suit your schedule and pleasure. Playing the files doesn't require special software, and the Internet Multicasting Service allows unrestricted copying of the material it creates.

What's the MBONE?

A series of Internet node operators have collaborated to create the Internet Multicast Backbone, also known as the MBONE. Eventually, multicasting will be built into routers (software exists that turns a Proteon router into a multicast node), but today the MBONE consists mostly of SparcStations, DECstations, VAXes and SGI workstations in a mixed mesh and star topology running multicast IP routing software called mrouted (about 900 subnets participate at various times). Sites that want to join the MBONE communicate with local nodes and agree on how to route the traffic.

The multicast is more like radio than an e-mail broadcast in that it has no complete list of destinations. Instead, an interested site can tune in to the data stream and participants can listen or watch, as the case may be, without being on a specific destination list. The Internet Engineering Task Force is currently working on a draft proposal for the Real-time Transport Protocol (RTP), which will offer better control for multicasting, but not guaranteed quality of service or resource-reservation capabilities.

The MBONE machines aren't all directly connected. They communicate by "tunneling" through standard (unicast) routers (they make their packets look normal to intervening routers and reconstitute them at the far end of a hop). Packets from streams that are time-sensitive, such as live audio, are assigned time-to-live (TTL) values, which cause the packets to self-destruct if they haven't arrived at their destination quickly enough. That feature helps alleviate some of the congestion of sending real-time multimedia over the Internet, though many problems remain.
The Internet radio broadcasts are really just large data files, so people have done creative things with them. One company spools them into its voicemail system, where employees can listen on their phones. Several radio stations have downloaded the files and retransmitted them as traditional radio shows. Some people make their own books on tape: They put the files on their PowerBooks and play them on their commute home.

"We like to think we compete with CNN."
-- Carl Malamud, Internet Multicasting Service

ACTIVE-SAFE-MULTICAST-MAIL-BYPASS?

These creative ideas for access to the digital radio files are characteristic of the broader potential for creating hybrid creatures from the media and applications that exist on the Internet and elsewhere. Interestingly, the fact that getting a full Internet connection is difficult is actually one of the Internet's virtues. The effort involved assures that participants can reach each other (because they have unique addresses) and that they can recognize and respond to various protocols and data streams.

In contrast, the phone company has much broader coverage, but simpler functions (i.e., dialtone) that have proven difficult to move beyond. And it doesn't help that the phone-system blueprint for an advanced intelligent network is internally focused: It defines how switching gear exchanges information and requests services, but doesn't include equipment that is outside the phone system, such as your home phone -- or even your PBX (see Release 1.0, 11-93).

On the Internet, anyone (even a dog) can operate the equivalent of a central-office switch, given enough money and commitment. More importantly, the full power of the Internet's distributed intelligence is available to every participating workstation. The experiments described in this issue are using and expanding that intelligence; other people will almost certainly take elements they have built and use them in unexpected ways.

Here is one example. Ehud Shapiro's Active Mail uses messages to invoke synchronous data sessions, which blurs the boundary between a phone call and e-mail: Active Mail messages look a lot like smart phone calls -- just without the audio link. Imagine Active Mail sessions that use the MBONE's multimedia capabilities to offer in-band phone service, instead of parallel phone calls. Or imagine a multicast that includes smart Safe-Tcl messages that can call any script-compatible PC application. These are the sorts of efforts that will help us reframe and redesign the communications infrastructure and will lead to new kinds of value for end-users.
ARCLAND'S DESIGNPAD: VISUALIZING STRUCTURE

by Esther Dyson

Consider the difference between a model or logical structure, and its representation on screen as a diagram. (Or consider the difference between a genome and its embodiment into a plant or animal.) Transformation between the two is difficult. Clear Software’s allClear (see Release 1.0, 10-90) can translate from a text into a diagram but not the other way. Arcland’s DesignPad does both. The trick is to keep the underlying logical structure separate from the visual presentation (the diagram) -- but still to handle them both. While drawing tools automate the drawing of a diagram, they don’t automate the organization of it, which is the really tough part.

To clarify, consider the difference between LaMarckian evolution and Darwinian. In LaMarckian, you change a physical being (i.e., a diagram), and the changes are inherited directly in succeeding generations. In Darwinian evolution (the "real" way), the changes must occur in the genome (which normally can’t be affected by manipulating the physical body; that’s why we have genetic engineering). But Arcland’s DesignPad by analogy allows you to manipulate the genes (the underlying logical description) by manipulating the body (or diagram). The new body is redrawn from the logical model (or genes), not simply by deforming the previous diagram; thus the change you made in the body is reflected in the genes -- and in succeeding "generations" of the diagram. The redrawn diagrams are clean and logical; the new layout is created from scratch form the underlying logic (without reference to previous diagrams).

Arcland’s DesignPad (shipping mid-19949) looks like a traditional diagramming tool (or even a modern, powerful one), but it has a lot of power under the hood. That power depends on a database, which manages the logical objects and structures that a user creates by drawing a diagram. The product reflects its two founders’ experience in the late Eighties at Bachman Information Systems (see Release 1.0, 12-86), which developed and sells a reverse-engineering CASE tool that can derive database models and generate diagrams from database catalogues -- i.e. the code that defines a database.

The democratization of CASE?

DesignPad has the diagramming power of a multi-thousand-dollar CASE tool, but Arcland will sell it at $495 list to a much broader market of software and system designers, business analysts, quality specialists and plain old thinkers who eschew the complexity, rigor and price of CASE tools. In a sense, the goal is to do for CASE what AutoCAD did for CAD. As business moves faster and faster, the ability to design and redesign new systems (as well as to implement them) will give organizations competitive advantage. It’s too important a function to leave to specialists.

Like any diagramming tool, DesignPad allows you to draw diagrams with nodes and links. You can also create specific kinds of nodes and links -- i.e.,

9 Yes, we know it’s easy to build great vaporware, but the principles here are worth noting. Eager alpha customers, mostly MIS, systems consulting and CASE types, will get copies shortly.

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node and link subclasses in an underlying class library. The items in the palette are objects (or classes); each item in each diagram is an instance of one of those objects.

The class library is managed as a set of database tables. Each class and subclass of nodes or links gets its own database table. (DesignPad’s data structures are proprietary, but they will export/import with Access, among others.) The default columns are the predictable ones: location coordinates, IDs of connected instances; the user can define additional attributes, potentially including executable behavior (methods). The rows in the table are the instances in each model/drawing. (Shape and size are generally attributes of entire classes of nodes or links for a given diagram and are maintained in yet another table that manages the graphical objects in the palette, which in turn represent the logical objects in the tables.)

When you create or manipulate an instance on the screen, that action is reflected by a new entry or new data in the underlying database. When you

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**Historical Perspective**

To understand the value of Arcland’s DesignPad, it helps to consider some other tool categories:

In its time 1-2-3 was highly successful, but it has given way to fancier products with named ranges, high-level macro languages and the like. People realized that although they liked the direct manipulation capability of the spreadsheet, where they could change numbers or formulas individually, they liked the power of a logical underpinning that understands the structure. The logical representation allows for multiplexing multi-dimensional views of the data, quick summarizations and cross-tabs, and the maintenance of multiple versions. That's the signal achievement of Lotus's Improv, among others.

In the same way, Aldus PageMaker helped establish the Mac (as well as Aldus) by using it to provide direct manipulation of text and graphics objects on a page. But now the market has moved towards Quark Xpress, Interleaf and Frame, which understand the components of a document and can generate it in many forms which reflect its underlying structure -- from the distinction between different levels of headlines and body text to the link between text and footnotes or illustrations. More broadly, SGML is a general tool for building such "document type definitions," the model documents that are implemented with specific instances. Thus you can easily restructure a document, or print certain parts of it, with desired formatting and visual cues correctly applied.

What the diagram-tool user really needs is the diagramming equivalent of an SGML tool, which allows the user both to define his own elements and their structure, and then to manipulate them (much as SGML allows users to do with document templates and text objects). The answer, according to Arcland, is a database that handles all the logical objects a user builds, along with a tool that can generate a diagram to represent them and their relationships visually.
redraw the diagram, the system itself selects the best arrangement of the
graphical representations to reflect the underlying model. (Of course, a
user can override that and place an instance where he prefers, by explicitly
fixing it in place. That's represented in the database too; usually the lo-
cation coordinates are dependent variables recalculated during redrawing.)

The existence of the database allows groups of users to develop and share
their own methodology or design conventions. (Aside from managing the con-
tents, the database underpinnings also make it easy to transfer and reuse
the class libraries and instances among users.) President Alec Ramsay,
drawing from his experience as a development manager (responsible for CASE
and methodologies) at Shared Medical Systems after Bachman, says that he
sees a promising market in people who don't want CASE tools but still need
to diagram the systems they are now building with the current generation of
object-oriented, GUI database design tools. Yes, Arcland is already a CODE
(Client/Server Open Development Environment) partner of Powersoft, which
should ultimately mean that you can transfer properly prepared DesignPad
models directly into PowerBuilder.

The rest of the world

By contrast, most current pc diagramming tools focus only on the visual rep-
resentation. They help the graphically awkward to produce neat, tidy dia-
agrams. They can redraw links between graphical objects on the screen and
realign them, but they don't maintain the underlying model the graphical ob-
jects represent. They can't really help users rearrange those structures --
just as an old-style word-processor can't renumber an outline automatically,
even though it makes moving text blocks around much easier. Thus they can't
redo the layout of a diagram for the user; they can only make it easy for
him to change it directly. (They let the user make Frankenstein's monster,
but they don't help him build a clean new embodiment of their ideas.)

The point, of course, is that most diagrams don't arise in a person's head
full-blown. As a user, you sketch something out, you change it a bit, and
pretty soon you end up with a mess -- whether on a paper napkin or on screen
with a drawing tool. When you move from version 1.6 to version 2.0, you
probably have to start over. DesignPad lets you take all the scar tissue
from 1.6 and resolve it into a clean new representation; it can make use of
your incremental changes instead of making you start over.10

But wait until DesignPad's Release 2.0

However, the underlying logical representation of the structure in DesignPad
is not yet accessible to the user except through the diagram/drawing inter-
face. In DesignPad's first release the API won't be visible or usable.
However, the underlying database will already be exportable; moreover, it

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10 One program that does this very thing is Clear Software's allClear,
which takes a logical structure description (in dBASE or a certain form of
restricted-syntax-and-punctuation English) and transforms it into a flow
chart. AllClear, however, does not allow direct manipulation of the
diagram itself; you have to change the text that generated the diagram (un-
less you export the diagram, but then you can't make the logical changes
anymore).

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(1) DesignPad offers a way to build the logical structure directly, when you place objects on the screen with a mouse.  (2) Then you can modify it through direct manipulation by placing "Process P.O." in the middle; the other items and links move automatically (unless you turn that function off).  (3) When you add further links, you end up with a mess, but (4) DesignPad can reorganize the whole thing for you, preserving only the logical structure.  (5) Meanwhile, the logical model is represented as tables, as shown.
will be reimportable after changes have been made in, say, Access or possibly PowerBuilder. By the second release, users should be able to work with the DesignPad database directly.

Other powerful features not available until release 2.0 (1995) will include the ability to handle hierarchies of models -- where, for example, a process is represented by a single node at one level, but expands into a complex model/diagram at a lower level. Of course, you can do this now by creating several models and knowing how they're linked -- but the software itself won't know. Likewise, although you can copy sections of a diagram and the underlying structure, classes in the template can only be single objects, rather than clusters (or collective classes). The elements can be grouped by attributes, so that, for example, you could display (or in principle perform any action on) all green circles but leave the red ones alone.

Other approaches

In the mass-market diagramming world right now (as ably pointed out in a December 21 article in PC Magazine) there are easy-to-use drawing tools, and there are some org chart and flow chart tools, but nothing that really lets you construct your own structures/models. That's why, says Arcland's Ramsay, the market was only about $60 million in 1993; he thinks it could be much larger with products such as his own. (Or perhaps you could say he wants to redefine the market.)

On the other hand, there are high-end CASE tools, most of which impose their own particular methodology. They are the equivalent of accounting applications, with their own structures already built in. Then there are high-end "metaCASE tools," which have the flexibility of DesignPad, but tend to be languages rather than direct-manipulation drawing tools. (They're the equivalent of financial modeling languages.)

Meta Software's MetaDesign

Probably the closest competition is Meta Software's MetaDesign, also an inexpensive ($199) but powerful diagramming tool for Windows or the Mac. MetaDesign is the foundation of Meta's extensive line of content- and rule-filled CASE, simulation and workflow tools. Like DesignPad, it leaves the user a lot of freedom without imposing methodology; Meta's higher-end products (for thousands of dollars) provide more support/restrictions around what users build. (Meta also OEMs technology to companies such as AT&T, GE and Sumitomo Bank who use it to build and sell function-specific tools.)

The big difference between DesignPad and MetaDesign is that DesignPad reorganizes as well as tidies up diagrams, and Meta offers more canned objects in its palette/template but doesn't allow the user to create his own or add new attributes (visual or logical). Now in its fourth release, MetaDesign has a lot of functionality acquired over the years, including OLE support (Windows version) and the ability to build hierarchies of diagrams (only a promise from Arcland): A node at one level explodes to a full diagram one level down, while a complex structure can be represented as a single black box (or circle!) at a higher level. Meanwhile, although MetaDesign also has a database underneath, it is exposed only in Meta's higher-end products.
So what's it useful for?

Basically, DesignPad is a communication/thinking/presentation tool. The underlying logic is not executable (as in a simulation), but it's extremely flexible. The user can identify each instance of an object uniquely and attach an unlimited number of attributes.

Applications include business modeling, of course, design of all kinds, and the sort of complex structures of different kinds of links generated by CM/1 from Corporate Memory Systems (where the display is results from direct placement of objects by users; see Release 1.0, 8-92). One value for shared use is that the random or contradictory additions of a variety of contributors are either organized and properly structured -- or exposed as redundant, inconsistent or unworkable. Figuratively, at least, DesignPad can't let you build a maze without an exit.

DesignPad shows its mettle with complicated problems, visualizing complex models and generating clear diagrams, where a designer might otherwise get confused by the profusion of detail and disorganization that arise as a diagram contorts itself through the stages of a person's understanding of a complex structure. DesignPad's layout and routing algorithms can discern the underlying structure and make it intelligible.

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COMING SOON

- Multiplayer games.
- What's a zine?
- Software for education.
- The component guild.
- And much more... (If you know of any good examples of the categories listed above, please let us know.)

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RESOURCES & PHONE NUMBERS

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Carl Malamud, Internet Multicasting Service, fax, (202) 628-2042;  
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John Ousterhout, UC Berkeley, (510) 642-0865; <ouster@cs.berkeley.edu>
Ehud Shapiro, Weizmann Institute of Science, +972 (8) 343327; fax, +972 (8) 469711; <udi@wisdom.weizmann.ac.il>

Software resources:

- Tcl and Tk are available via Anonymous FTP to <ftp.cs.berkeley.edu> in the directory /ucb/tcl;
- Safe-Tcl is available via Anonymous FTP to <ftp.ics.uci.edu> in the directory /mrose/safe-tcl;
- Government publications online are available via Gopher, FTP or the World Wide Web at <sunsite.unc.edu> and <whitehouse.gov>;
- For information about radio on the Internet, send mail to <info@radio.com>;
- For information about tpc.int, send mail to <tpc-faq@town.hall.org>; and
- For information about the MBONE, use Anonymous FTP to retrieve the FAQ (Frequently Asked Questions file) from <ftp.isi.edu:/pub/mbone/faq.txt>;

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Each year, the Forum raises issues that will play out in the year ahead. Last year, our theme was "content is key" -- a theme echoed throughout 1993 as media giants and telecom and computer companies tried to converge with alliances, technology transfers, people moves and the like.

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We have changed PC Forum's full first name from Platforms for Computing to Platforms for Communication -- reflecting computers' changing role in the real world. The focus is no longer person and computer, but people communicating through computers.

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This year, our theme is "Interactivity is two-way!" Our goal at the Forum is to examine -- interactively with you -- the new virtual landscape of the computer industry, from both technical and business perspectives. Specific topics we'll address in general sessions -- and in the corridors, bars, social events and sports facilities nearby -- include the design of on-line video-conferencing salons, the role of traditional entertainment companies in the new world of "convergence," and the impact of government agencies and policies. (Each Release 1.0 subscription -- plus the fee! -- entitles you to two Forum registrations.)

Speakers and panelists include (additions marked *):

- John Seely Brown, Xerox
- Jim Cannavino, IBM
- Steve Case, America Online
- Pehong Chen, BroadVision
- Scott Cook, Intuit
- Maury Cox, CompuServe
- Bob Epstein, Sybase
- Lori Fena, Technology Board of Trade
- John Gage, Sun Microsystems
- Joe Guglielmi, Taligent
- John Hiles, Thinking Tools
- Stacy Horn, Echo
- Bruce Katz, The Well
- Bob Kavner, AT&T
- Scott Kurnit, Prodigy
- Ed McCracken, Silicon Graphics
- Mike Maples, Microsoft
- Ellen Pack, Women's Wire
- Marc Porat, General Magic
- Adrian Rietveld, WordPerfect
- Bruce Sterling, Himself

Company presentations, services and demos will include Collabra, Connext, Data Base Architects, Echo, Excalibur, First Floor, Kaleida, Linguistic Technology, Metricom, nett info, RadioMail, Silicon Graphics, Taligent, TeleSim or SimHealth, The Washington Post on-line and Ziff-Davis Interactive.
**Release 1.0 Calendar**

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<tr>
<td>Mar 1-3</td>
<td>Intermedia '94 - San Jose. Sponsored by Reed International. Call David Bradway, (203) 352-8243; fax, (203) 352-8445.</td>
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<td>Mar 1-3</td>
<td>OpCon West - Santa Clara. Sponsored by Soft•Letter. Call Jeff Tarter, (617) 924-3944; fax, (617) 924-7288.</td>
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<td>Mar 2-4</td>
<td>*Converging technologies conference - St. Petersburg, FL. Sponsored by the Poynter Institute for Media Studies. Call Jennette Smith, (813) 821-9494; fax, (813) 821-0583.</td>
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<tr>
<td>Mar 2-4</td>
<td>Cellular Telephone Industry Association conference - San Diego. Sponsor: CTIA. Call Randy Smith, (301) 694-5599.</td>
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<td>Mar 4-5</td>
<td>Designing for and with people - Santa Cruz. Sponsor: Association for Software Design. A workshop on user-centered design. Call Cynthia Lewis, (510) 841-5808; fax, (510) 848-4721.</td>
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<td>Mar 20-23</td>
<td>***EDventure Holdings PC Forum - Phoenix. Sponsored by us: You read the newsletter; now be interactive and meet the players. &quot;Interactivity is two-way!&quot; Call Daphne Kis, (212) 924-8800; fax, (212) 924-0240; MCI 511-3763.</td>
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<td>Mar 22-25</td>
<td>Seybold Seminars '94 - Boston. Sponsor: Seybold Seminars. Call Beth Sadler or Kevin Howard, (310) 457-8500 or (800) 433-5200; fax, (310) 457-8599.</td>
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March 29-30  @Lap & Palmtop Mobile Solutions Conference - New York City. Sponsor: Laptop Expositions. Call Peter O'Connor, (800) 444-EXPO; fax, (800) 569-LAPS.

April 7-8  Software Marketing Summit/Awards - San Francisco. Sponsor: Soft-Letter. Call Jeff Tarter, (617) 924-3944; fax, (617) 924-7288.

April 12-14  New Media Expo - Los Angeles. Sponsored by The Interface Group. Call Peter Shaw, (617) 449-6600.


April 25-27  @Technology Forum - Boston. Sponsor: Patricia Seybold Group. Call Patricia Seybold, (617) 742-5200; fax, (617) 742-1028.


May 2-6  @NetWorld/Interop '94 - Las Vegas. Sponsor: ZD Expos. Call Lucy Wohltman, (415) 941-3399.

May 4-6  Digital World - Los Angeles. Sponsor: Seybold Seminars. Call Beth Sadler or Kevin Howard, (310) 457-8500 or (800) 433-5200; fax, (310) 457-8599.


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May 24-27  Fourth international conference on principles of knowledge representation and reasoning - Bonn, Germany. Sponsor: GMD. Contact: Christine Harms, 49 (2241) 142-473; fax, 49 (2241) 2472.


June 20-24  Software DevCon - Wiesbaden, Germany. Sponsor: SIGS Conferences. Call Jurgen Tillack, 49 (22) 02302886; fax, 49 (22) 023-2997; James Spencer, (212) 274-0640; fax, (212) 274-0646.


July 6-8  Artificial Life IV conference - Cambridge, MA. Sponsor: Santa Fe Institute. Call Barbara Hodges, (505) 984-8800; fax, (505) 982-0565.

July 24-29  Siggraph '94 - Orlando. Sponsored by ACM. Call Anne Leuck, (312) 321-6830.


August 4-6  First annual conference on the pattern languages of programs - Monticello, IL. Sponsor: University of Illinois, Department of Computer Science. Call Ralph Johnson, (217) 244-0093; fax, (217) 333-3501.

August 8-11  GroupWare & Workflow '94 - San Jose. Sponsored by The Conference Group. Call David Coleman, (415) 282-9151; fax, (415) 550-8556.


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<tr>
<td>September 14-16</td>
<td><strong>East-West international conference on multimedia, hypermedia and virtual reality</strong> - Moscow. Sponsor: International Center of Scientific and Technical Information in Moscow. Contact: Peter Brusilovsky, fax 7 (095) 943-0089; e-mail, <a href="mailto:plb@icsti.msk.su">plb@icsti.msk.su</a>.</td>
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<td>October 22-26</td>
<td><strong>@GSCW '94</strong> - Chapel Hill, NC. Sponsor: ACM. Call Kevin Jeffay, (919) 962-1938; fax, (919) 962-1799.</td>
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<td>December 5-7</td>
<td><strong>IT Services '94</strong> - Santa Clara. Sponsor: Creative Expos and Conferences. Call Cherif Moujabber, (508) 660-7099; fax, (508) 668-2416.</td>
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**1995**

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Please let us know about other events we should include. -- Denise DuBois

*Events Esther plans to attend.*

@Events Jerry plans to attend.

Lack of a symbol is no indication of lack of merit.
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