Technical note

The WATINFO face server and associated utilities

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WATINFO is a TCP/IP server that operates at the IBM Thomas J. Watson Research Center, Yorktown Heights, New York, to provide VM-based information about services and personnel at the IBM Yorktown Research site. Client programs have been written for Operating System/2® (OS/2®) and Advanced Interactive Executive™ (AIX®). An advanced feature of WATINFO is the display of images, when appropriate, in combination with other data. The images are supported by a face server, which fetches image data from a library of face images. The format of the face images is small—256 by 256 by one bit—and is transmitted rapidly to a variety of displays. The face library can be used for other purposes: inclusion of images in documents, the preparation of image labels, and the construction of an image telephone book.

In the chapter entitled "Personal Worth and Self-Esteem," from his book *The Farther Shore: A Natural History of Perception, 1798–1984*, Don Gifford writes:

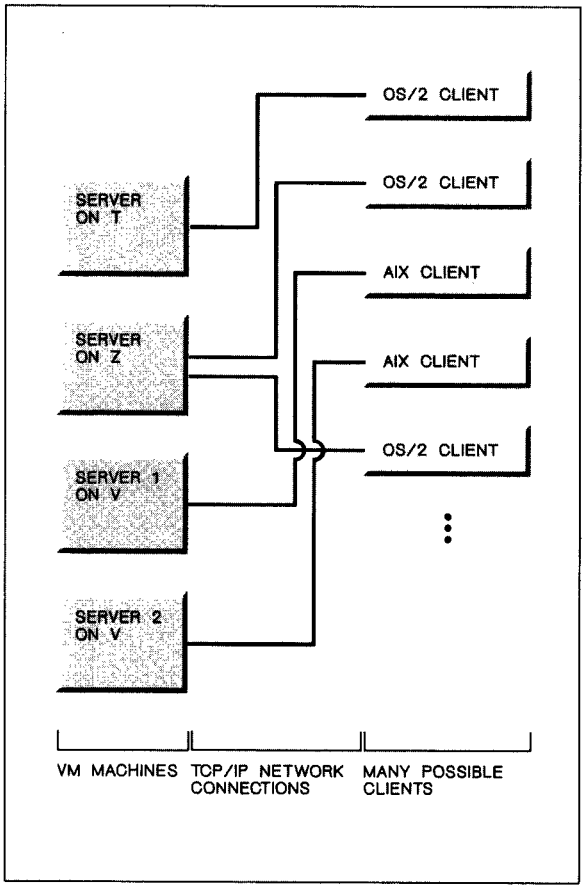
> . . . it is as though the self were being defined so that it can be imitated by a computer, as though the whole tangled question of artificial intelligence were to be resolved not by creating a humanly intelligent and responsive machine but by turning a human being into a machine so that it can be imitated by a machine. It's Alan Turing's game in reverse: trying not to create a computer that can fool a human being into thinking it human, but trying to create a human being who can fool another human being into thinking it is a computer.[1]

Don Gifford is a professor of English and American literature at Williams College, Massachusetts, so his comment may be taken as a humanist view of our computing milieu. Professor Gifford is one among many social commentators who have observed the increasing alienation of people in an industrial society and the subordination of the individual to systems.

Computerized communication facilities, such as network-accessible bulletin boards and computer conferencing, are evolving and becoming essential components of industrial enterprise as well as media for social interaction. A particular example of a system for computer conferencing, the IBM Personal Computer (IBM PC) conferencing facility, has been described by Davis Foulger. One of Foulger's observations follows:

> Today's computer conferencing systems are generally strictly digital in form, but so are many other media, including journals, books,

Figure 1 General arrangement of WATINFO servers and clients



> newspapers, dissertations, and love letters. The analogic semantics of relationships, feelings, and emotion may not translate as readily to words as does the digital world of actions and things, but it still translates to a certain extent. What doesn't translate, moreover, can frequently be communicated in the context the words create: the experiences recounted; the images described; the words selected and the way they are used together.[2]

The next step in the evolution of computer communication is the integration of graphics and images with text. The introduction of all points addressable displays as the primary media and the spread of fast compatible networks have made the transmission of images as comfortable as that of text. Images and graphics are difficult to create extemporaneously, but the use of image data libraries is possible. An image library of people's faces, supported by a face server, for example, could have immediate wide use.

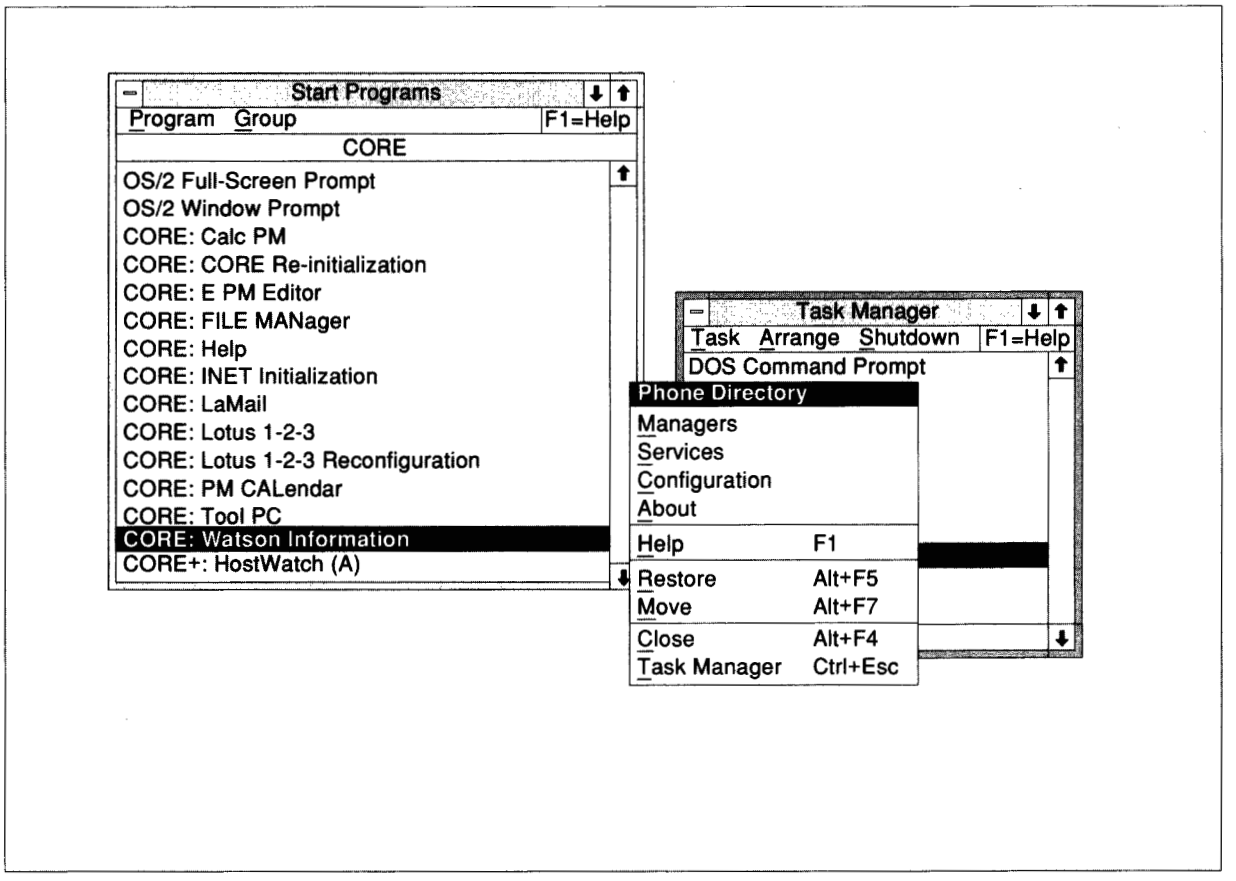
What is a face server?

Since 1984 a face server has been in operation at AT&T Bell Laboratories, Murray Hill, New Jersey. Pike and Presotto described this system at the summer 1985 USENIX conference.[3] The operation of the face server is a vivid demonstration of the effectiveness of network operation. The phrase "face server" is an interesting amalgam of an essential part of a person and the UNIX® name for a widely available network system resource. About three times a year, a video capture system is set up for people to add their faces to the system. They may record and save color images in a bit map of 512 × 480 × 24 bits, but only 48 × 48 × 1 bits and 512 × 512 × 8 bits are used for the face server. The standard network workstation is a Teletype DMD-5620 with monochrome graphic capability, so almost everyone can use utilities that use the face server. Applications usually require only the 48 × 48 × 1 bit images. One application shows a small face on a display when mail has been received from the owner of the face. Another application of the computer center face server is to print images on the cover sheets of printouts and to print a small image at the top of printed pages. The Bell Laboratories' face server is a variation of the network file system. The images are stored only on one machine, but they are as easily addressable as if they were stored on each machine. The inherent structure of the network permits standard UNIX system utilities to access, control, and use the image database.

The Bell Laboratories' face server is probably the first of its kind and has the following essential characteristics of a face server:

- A readily and network-wide available collection of facial images
- A means for rapid access to the images
- A variety of client programs to display or print the images in conjunction with other utilities
- A means for maintenance of the image collection
- A very large variety of displays and printers that can show the images

Figure 2 The initial menu for the WATINFO client running on an OS/2 machine



A true face server is ubiquitous, versatile, and fast.

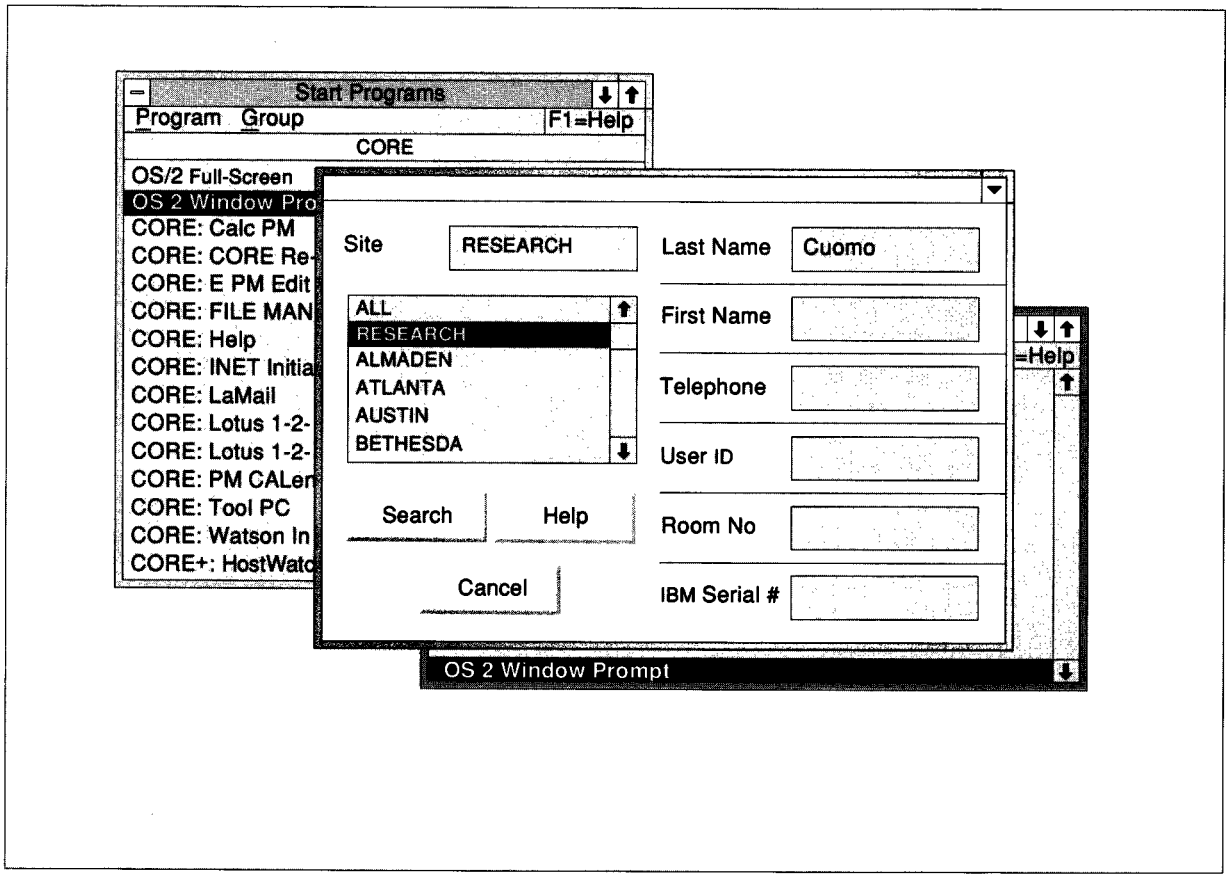
A special feature at USENIX conferences over the past few years has been the digital photographing of attendees. The images are processed in a few hours and an illustrated roster is printed. Image labels are also provided. The system for recording the images makes use of video digitizing equipment mounted in a microcomputer and an image file management package. Images are appended to the collection maintained on the Internet. (For an explanation of Internet, see the following section.) This service is called *FaceSaver*.[4] Various programs have been donated so that the images can be displayed on a variety of graphic systems. Typical of these is xface,[5] which draws images on a color X11[6] display. This system is not a face server because the images are not in a format or a state of rapid addressability. The images may be copied and added to a face server library, however.

An image system that is not a face server is the Polaroid® ID-2000, which is a typical digital security and identification system.[7] This system uses special-purpose displays and identification card printers for security management, and while it may be operated in conjunction with a face server, the basic operation is application-specific.

WATINFO overview

WATINFO is a client/server utility that allows access to certain services on a VM host from a workstation without being logged on to the VM host. The motivation behind WATINFO was to be able to access some of the information resources available on VM hosts from a workstation without having to separately log on to a VM session through

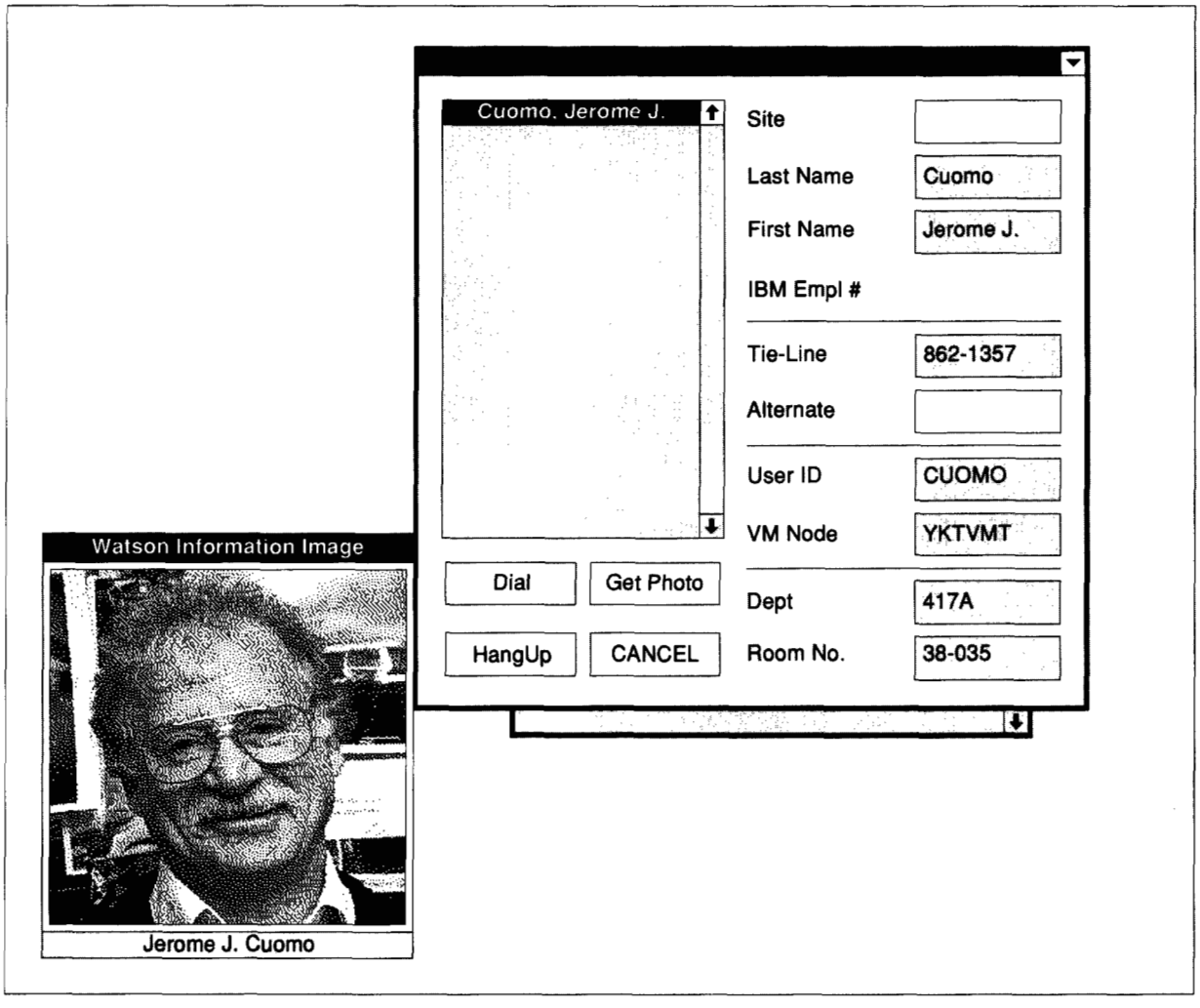
Figure 3 Phone search in WATINFO running on an OS/2 machine



a terminal emulator. It was desired, for example, to be able to access the phone directories. At IBM Yorktown, servers run on each VM host and currently provide access to the CALLUP (internal phone directory) database, which is updated daily for phone number queries and other personnel information. The VM MANAGER exec for management chain queries and the SERVICES exec are also supported. MANAGER fetches information about the management chain for an employee. SERVICES provides a list of services, such as book ordering or benefits, and provides a phone number or some ancillary information. These VM system execs are used because they are considered the most useful, but it is possible to add new utilities. There are clients for Operating System/2® (OS/2®) as well as for Advanced Interactive Executive™ (AIX®), which enable the servers to be accessed from a number of different hardware platforms.

The client and server communicate via a Sun™ RPC (remote procedure call), which in turn uses TCP/IP (Transmission Control Protocol/Internet Protocol). Sun RPC provides a relatively high-level interface to TCP/IP. It hides the hardware level interface and provides a network-based machine-independent data format—XDR (external data representation). TCP is a communication protocol or standard for the reliable transmission of information over networks. The protocol consists of a collection of packet switching networks interconnected by gateways managed by standardized rules and software that allow them to function logically as a single large, virtual network called an *internet*. The basic unit of information passed over an internal protocol (IP) network is an IP datagram. The *Internet* (with an uppercase I), refers to the specific collection of networks and gateways, including the ARPANET, MILNET, and NSFnet,[8] and attached commercial and educa-

Figure 4 A typical response to a phone search

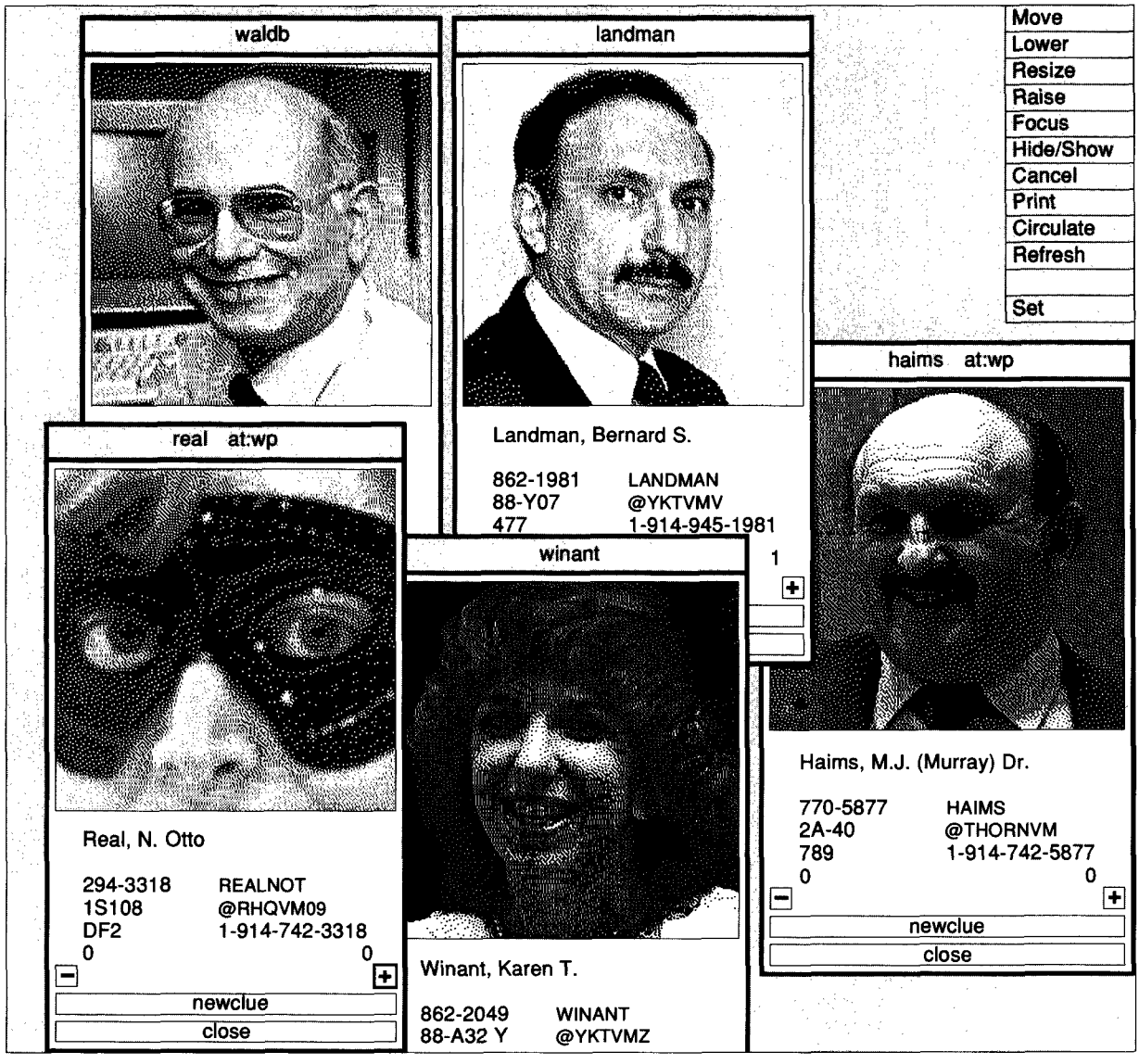


tional networks, that use the TCP/IP protocol suite. The Internet protocol suite is referred to as TCP/IP because IP is one of the two most fundamental protocols.[9]

The WATINFO servers are autologged on VM so that they will start automatically when the system is brought up. The server registers with the port-mapper, which manages the mapping between the sockets and ports and then is on hold and waits for requests. The reply to each request is saved on a stack and is then sent to clients. Due to the non-multitasking nature of VM, the WATINFO server must handle requests in a serial manner. At IBM Yorktown, however, we have four disconnected servers running on different VM hosts to handle the various server requests. The servers keep logs and statistics on requests to monitor traffic.

In time, WATINFO will be general enough to run at different sites. Currently there are only local servers but remote clients; for example, IBM Research at Almaden can access the IBM Yorktown servers.

Figure 5 Responses to WATPHONE on an RT operating in X11 under AIX

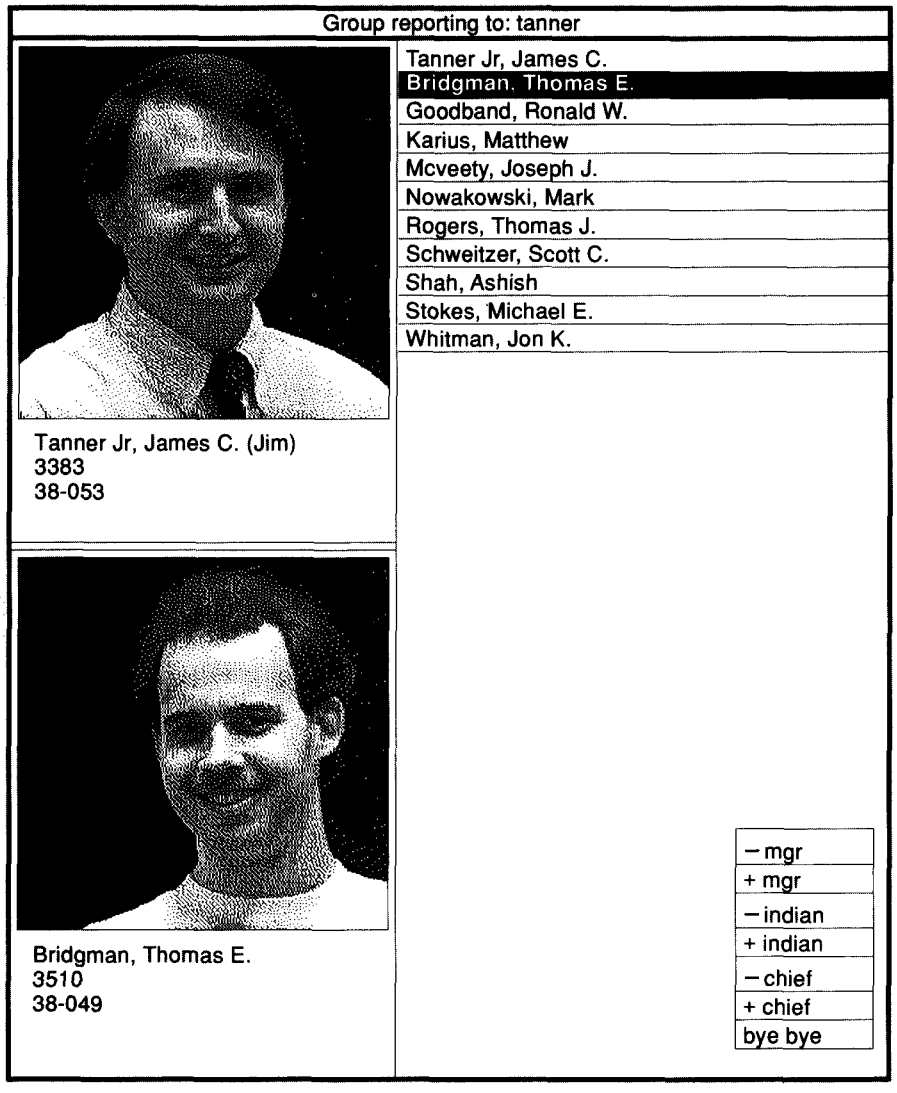


OS/2 client

There are currently both OS/2 and AIX clients. An illustration is given in Figure 1. The OS/2 client has a Presentation Manager™ graphical interface allowing simple interaction with a mouse. After invoking the OS/2 client, the user is presented with an icon. One click of the mouse presents the user with a menu (Figure 2) from which to pick the desired function; a double click invokes the phone query option (Figure 3)—the most frequently used function. With each function the user is presented with a query window allowing specification of the query; the resulting server response (Figure 4) is displayed in a separate window that can be depicted as an icon for later use. The following functions are currently supported:

- Phone queries (showing telephone and location information)

Figure 6 Response to WATPHI



- Manager queries (showing the management chain for a given individual)
- Service queries (showing provided services and useful information)

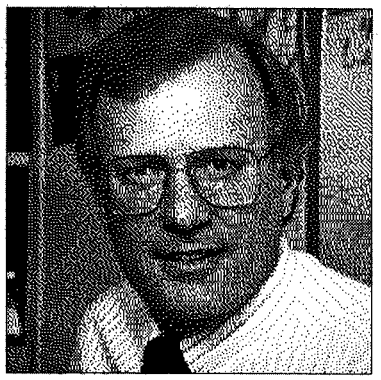
For a telephone query, the user specifies the location directory and individual information, typically a last name. After the query is made, a phone information window is displayed that further allows the user to retrieve an image of the individual and to have the workstation dial a phone number from a list of three possibilities—internal tieline number, alternate extension, and external number. The serial port of the workstation is attached to a ROLM® 244PC phone which has an RS232 connection enabling the worksta-

Figure 7 Typical page from an image phonebook

Bednowitz, Allan L.
BENWITZ
862-1529
88-Y01

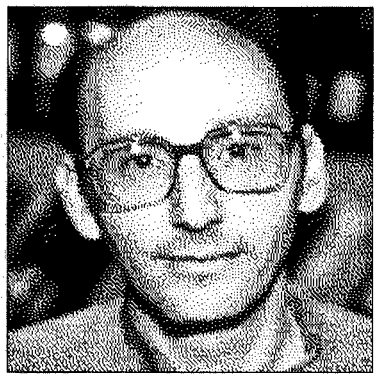
Cuomo, Gennaro A.
GCUOMO
862-2189
32-006

Danner, David A.
DDANNER
862-3736
05-255



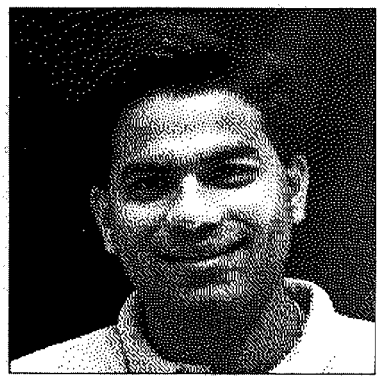
Crow, John D.
CROW
862-2624
38-123

Curtiss, Kim M.
KIMMY
862-1776
35-160



Dantzig, Paul M.
PMD
862-2396
88-W09

Cuomo, Jerome J.
CUOMO
862-1357
38-035



D'Souza, Carlton
DSOUZA
863-6631
J2-J10

Datta, Madhav
MADHAV
862-2183
40-025

Figure 8 Typical examples of pixel clumping

tion to send dialing instructions to the phone. The client program is smart enough to know whether to dial a four-digit internal number, get an external tieline and dial the seven-digit number for an off-site tieline number, or get an external line and dial the area code and seven-digit number for an off-site external number. From the manager information window, the user can get phone information for an individual or one of his or her managers, by clicking the mouse on the appropriate entry. The OS/2 client allows one to target a specific server but will automatically retry another server if the targeted one is down. The user can also specify a time-out value for the transaction, which cancels the request if it exceeds the time limit.

The WATINFO face server

Face serving was accepted as a feature in the original conceptualization of WATINFO. The special character of WATINFO face clients is the integration of image display with other utilities. A collection of people's images in various formats is available to client programs for use in conjunction with other WATINFO information requests. Previously prepared black-and-white dithered images identified by employee serial number can be fetched as soon as the serial number has been obtained or is known.

The image collection is kept on a public disk so these may be used for purposes other than WATINFO. Images are stored in pseg38pp format (bit image format for document processing), again identified by serial number, for use in printing. An image phone book can be produced. One other form of image identification is by VM system userid. A test system printed the userid images on the cover sheet of high-speed printer output, typically from an IBM 3825 printer. So far this service has been offered on only one printer and the user response has been very positive. Eventually, this will be provided on more printers.

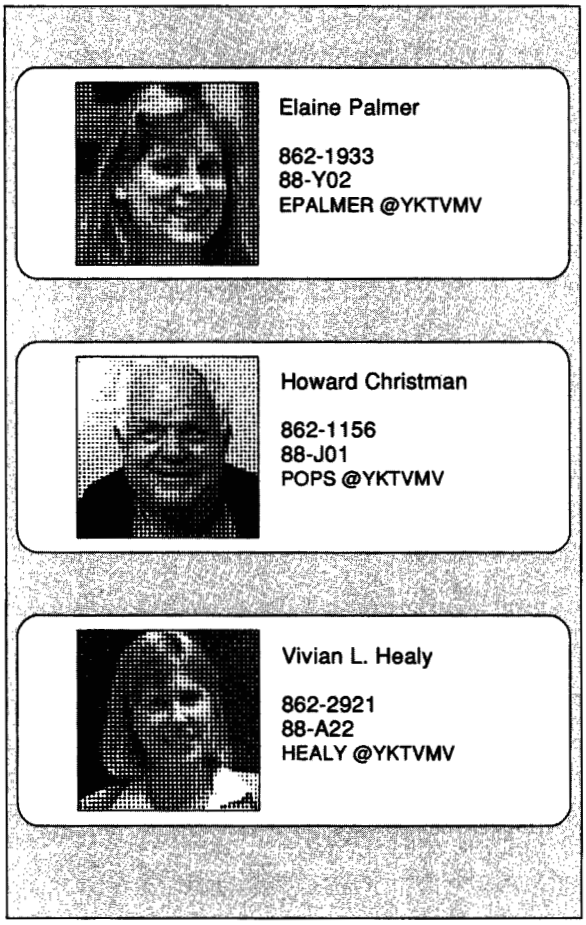
The pseg38pp images identified by userid are available to all users for embedding in documents. Use of images for annotating biographies and visitor schedules has just begun.

The stored images can be increased in size by replication of the pixels. When the pixels are replicated in the x and y dimensions 32 times, the result is an 8192×8192 image which can be drawn on a digital plotter to make a 20-inch square poster. A series of utilities has been written to make such posters. Large posters on one piece of paper are limited by the size of the plotter, but larger posters can be assembled from many pieces of paper.

AIX face clients

Presently, the images can be fetched by WATINFO running on OS/2, or the program's WATPHONE or WATPHI, both running in AIX. WATPHONE shows

Figure 9 Typical image labels



a face (Figure 5) and provides phone and identification information from the IBM Thomas J. Watson Research Center phone directories or other site directories. In Figure 5, there is no image for N. Otto Real, so a masked face is shown. WATPHI organizes image requests by groups reporting to a manager. Figure 6 is a typical display response to a WATPHI query. The menu shown is used to select managers and to move through the organization structure.

Associated utilities

A variety of interactive editing programs have been prepared to facilitate the preparation of dithered images from captured data. IBM IAX (Image Access Executive) and MAGIC (Menu Assisted Graphic Image Conversion) are used for the image processing, but intermediate results are viewed and commands are prepared with X11 programs communicating to an RT workstation from VM.

Basic video images are 256 × 256 in size, dithered in black and white, and utilize 8192 bytes. This small image size was chosen to enable the most rapid transmission over the network, and because some of the displays used do not have very large resolution and do not have pixels to spare. Printed images are reversed and replicated to 512 × 512 from the basic images. These formats can be displayed on a variety of displays or printed on a variety of printers. Images to be saved for printing purposes can be reviewed by using the utilities PRINTBIT, which can print any bitmap, and PSEGBIT, which just saves the bitmap as a pseg38pp.

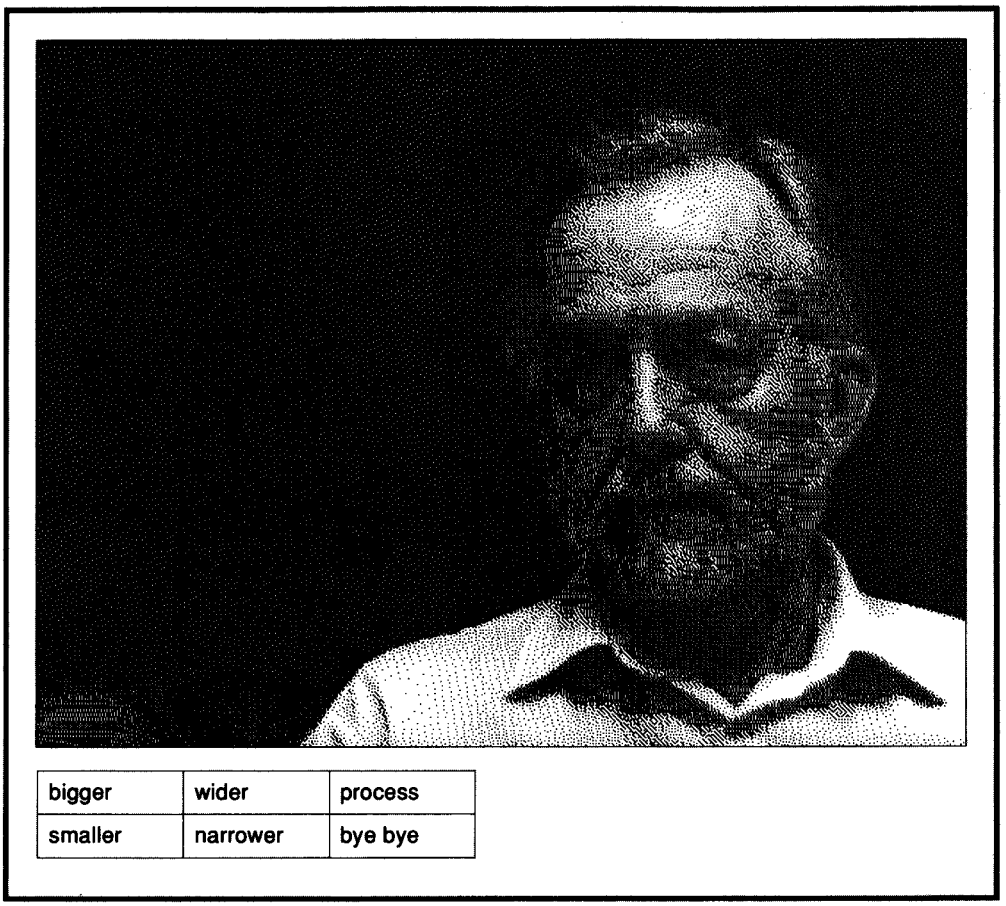
One type of client program is particularly interesting. This client can run in the background and listens for a telephone call through a serial port connection to a phone set. Upon detecting a ring and receiving the phone number of the calling party, the face of the person associated with the calling phone number is displayed at the workstation. The face is removed if the phone is answered, but remains if the phone is not answered. Both OS/2 and AIX versions have been written.

Image library support

Maintaining an image library is similar in most respects to maintaining any large database. For an image library there must be some additional utilities to make it possible to look at the images and correlate the images with other information. A utility, WATCHECK, was written that runs on an RT workstation that uses the WATINFO server to perform four functions:

1. Verify that the employee serial number belongs to a current employee. There seems to be a 10 to 15 percent turnover.
2. Check that a printable image exists for each display image and vice versa.
3. List obsolete images for deletion.
4. Verify that an image has been associated with the correct person. This is possible only if individuals are shown their image and asked if it is their image. Several times, if an image was captured at a self-service system, the associated image identification was wrong.

Figure 10 Typical original digitized image

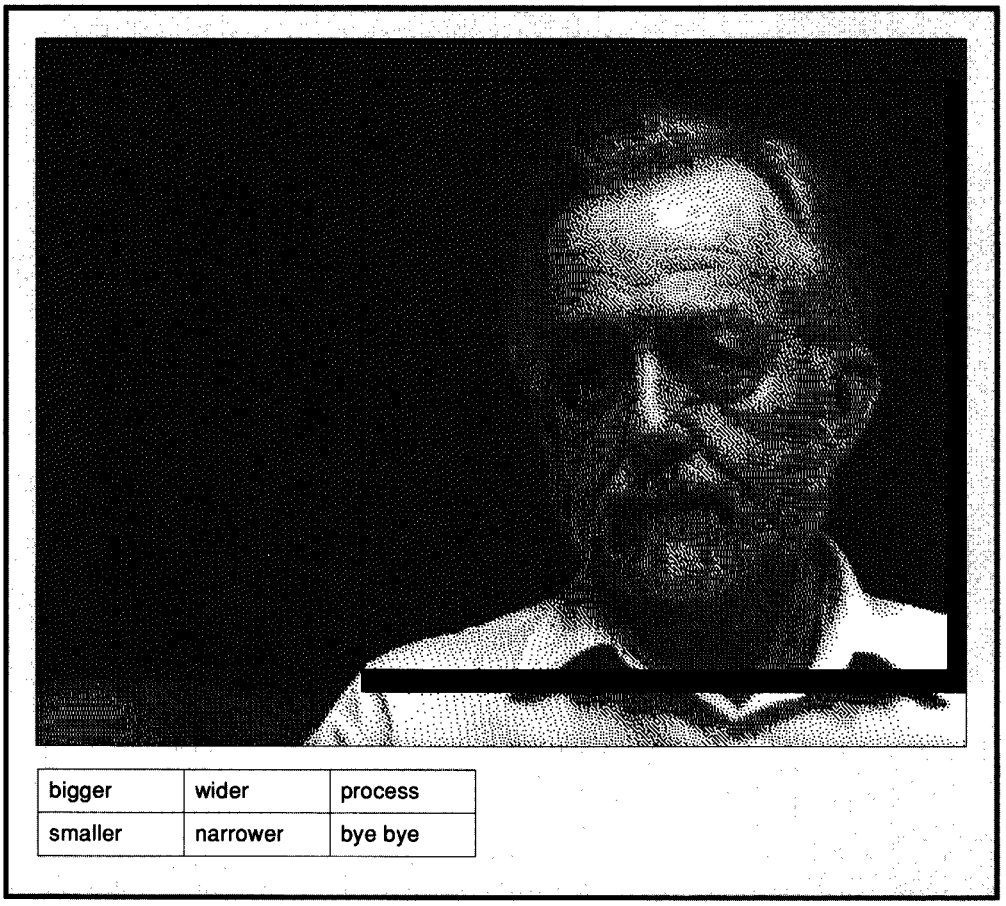


bigger	wider	process
smaller	narrower	bye bye

WATCHECK is provided with a list of image identifications. These are then used for input to the WATINFO server. If the reply for each identification is complete, then an entry is made in a current active list and, if the identification yields an incomplete or null reply, then an entry is made in an inactive list. The active list can be sorted in many ways and serves as the basis for printing an image phone book. The inactive list can be inspected and referenced images can be displayed or printed. Temporary employees can be found in this way and their images can be deleted. A few erroneous identifications have been found. Figure 7 is a typical page in the image phone book. This phone book is not distributed at this time and is used only for checking the images. WATCHECK is run frequently because the image library is continually growing.

One of the services contemplated is the automatic preparation of image labels. A printed label requires a small image, about one-inch square or 256×256 pixels. A printed image at that size does not appear correct because the black pixels expand and patterns in the dithered image bleed together. A dithered small image might be acceptable on a video display because the white pixels bloom and tend to average together. This problem

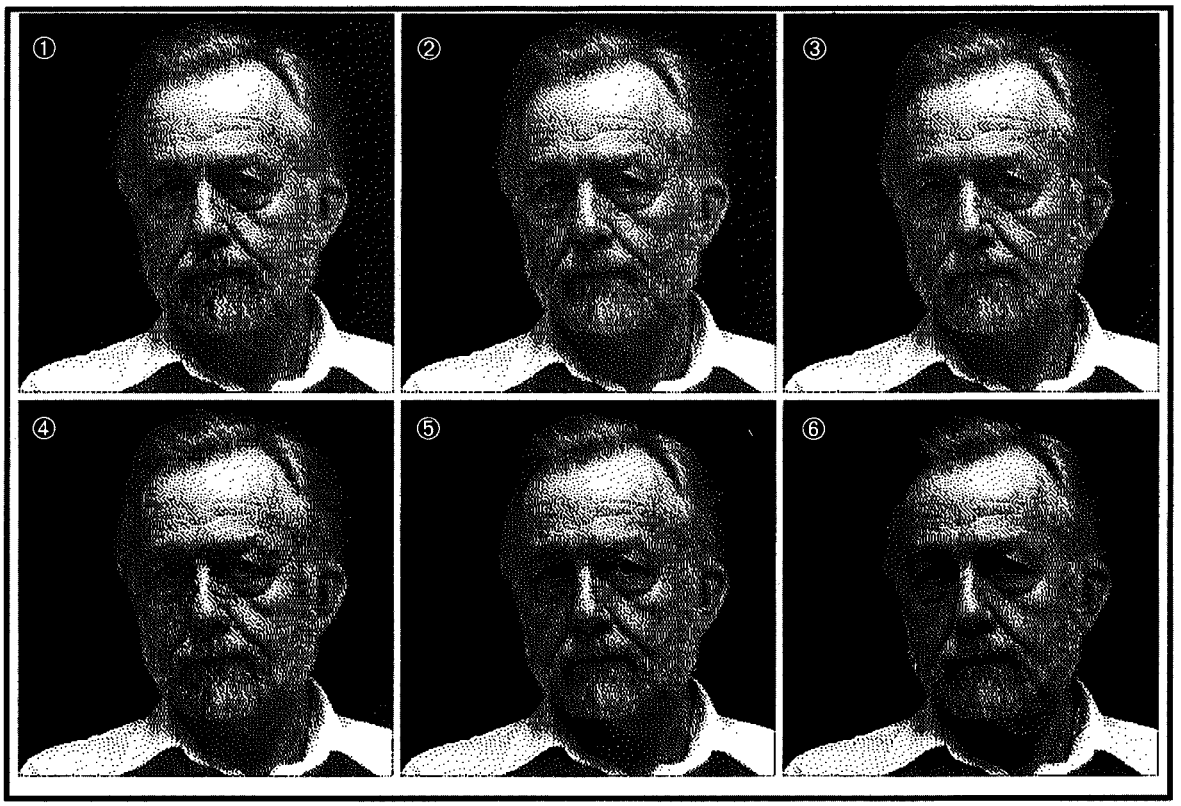
Figure 11 Image showing the best square



bigger	wider	process
smaller	narrower	bye bye

has been discussed by Knuth.[10] Usually the dithering pattern used to convert a gray scale image to a black and white bitmap is determined by the final application; however, in the face server library, the original gray scale images have not been kept, so it is necessary to convert the dithered display images to printable images. Dithered images for printing require that the black and white pixels should be clustered or clumped together. In this way the edge effects, such as ink bleed, are minimized. Many styles of clumping have been tested and the two most successful are illustrated in Figure 8. The picture on the left is the original dithered image intended for video display, the second image shows clumping along horizontal and vertical patterns, and the third image shows clumping on a 45 degree pattern. Generally the horizontal and vertical orientation has the best contrast, while the inclined pattern has the sharpest result. Both must be generated and visually evaluated to determine which will actually be used for the printed image label. Typical image labels are shown in Figure 9. People who donate their images are usually presented with a page of image labels. A page can be copied onto sheets of sticky-backed labels in most copiers.

Figure 12 Variety of possible images



The original digitized images require some cropping and processing to look their best. The best image is usually digitized from the living person with a color camera; an excellent alternative is to digitize a black-and-white photograph. Other sources of images are 35 mm slides or color photographs. Because of the diversity of possible image origins, a system had to be developed to process and standardize the appearance of the final stored image. This is accomplished by a variety of image converting programs and final review at an RT workstation with a monochrome graphic display. Figure 10 shows a typical original image, dithered for the printing of this paper. Figure 11 shows the square chosen as the best square portion of the original image. The square can be made larger or smaller or, if it is suspected that the camera image was distorted, the square can be made slightly wider or narrower. Finally a variety of processing procedures were applied to the square image and are displayed together, such as is illustrated in Figure 12. The upper left image is close to the original, the second image has the dark and light range of image values extended to increase the range of values and improve dither quality, the next two images are similar to the first but are made slightly darker, the fifth image has some gray scale equalization and the sixth image has equalization and some strong edge sharpening. The fifth procedure works best with blond-haired or monochromatic people, while the last procedure tends to improve the appearance of older people. One of these is usually acceptable and is selected to be stored as the subject's face. If none are, then some other functions can be quickly used.

Concluding remarks

The presentation of images with other personnel information has been shown to be feasible and has even been enjoyed by the people at the IBM Yorktown Research Center. The variety of face library services offered has been expanded beyond our original plan. Images have been collected from various sources and can be displayed by over 400 workstations.

Acknowledgments

The authors would like to thank Robert Flavin for contributing the images from the GRAND (IBM internal conferencing system) collection, and Wayne L. Smith for making available the large library of images in the IBM Communication Department collection and for over 300 color slides. Finally, we are indebted to over 200 people who posed live before the video camera.

A project of the diversity described in this paper required the cooperation and effort of many talented individuals. Richard Redpath was helpful in the initial design of bitmap image displays; Edward Clarke, Jr. helped in the early experiments in client/server file communication; Elbert Hu and David Bolen provided much needed advice in the use of RPC and other system utilities on VM and AIX; Scott Schweitzer was most helpful in the design of the AIX server and with interfacing phone communications; Jason Crawford helped in many ways, especially with the design of OS/2 Presentation Manager image display; Gerry Thompson and Carlo Evangelisti were helpful with the design and conversion of bitmaps for printing; Paul Dantzig provided the support for printing face images associated with userids on the cover sheets of printouts; Geoff Carpenter provided essential guidance on C and AIX system programming; Barry Appelman, Matt Korn, and Bill Rubin suggested some improvements to the AIX server; Blake Fitch helped with experiments in printing poster size images on Versatec Plotters.

We thank Peter J. Weinberger, AT&T Bell Laboratories, Murray Hill, New Jersey, for demonstrating the first face server and associated applications, and for many suggestions at the onset of this project.

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3. R. Pike and D. L. Presotto, "Face the Nation," *USENIX Conference Proceedings*, Portland, OR (Summer 1985), pp. 81–85.
4. FaceSaver is copywrited by Metron Computerware Limited, Oakland, CA 94602.
5. xface.c was written and donated to the public domain utilities of the Internet by Jeff Michaud, Digital Equipment Corporation. It was adapted from xgif.c, which was written by John Bradley, University of Pennsylvania, in 1986.
6. X11 is a colloquialism for X Window System Version 11. Programs written in X will run on many types of workstations and personal computers, and the typical applications usually involve network communication. Because X also includes TCP/IP communication utilities, application programs that use X facilitate drawing on displays remote from the operating computer.
7. ID-2000 is marketed by Polaroid Security Management Systems, Cambridge, MA.
8. ARPANET, MILNET, and NSFnet are acronyms for Advanced Research Projects Agency Network, Military Network, and National Science Foundation Network, respectively.
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