NYNEX Portholes: Initial User Reactions and Redesign Implications

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ABSTRACT

The prevalence of audio and video options on computers, coupled with the promise of bandwidth, have many prognosticators predicting a revolution in human communications. But what if the revolution materializes and no users show up? We were confronted with this question when we began deploying and studying the use of a video-based, background awareness application within our organization. Repeatedly, new users raised strong concerns about self-presentation, surveillance, privacy, video snapshots, and lack of audience cues. We describe how we addressed these concerns by evolving the application. As a consequence, we are also redesigning the user interface to the application.

Keywords

Awareness, audience, collaboration, design, glance, portholes, privacy, reciprocity, surveillance, Web.

INTRODUCTION

We are at a juncture in technological development where the decreasing cost of desktop audio/video hardware, the commercial availability of media space applications, and the ease of linking people enable physically distributed organizations and individuals to pursue richer communication options. These advances make it possible to examine the use of these media space technologies within a broader base of users. More importantly, they provide an opportunity to study and address the issues that limit the widespread acceptance of such technologies. Poor acceptance of such technologies can limit the research on and the potential for technology to facilitate the formation of virtual work communities. As well, if we are not aware of the barriers to user adoption, we risk building group tools that few will use.

Over the last three years, our group has explored the use of media spaces to improve communication and facilitate a shared understanding among physically distributed groups in our organization. This effort includes creating a group awareness tool to maintain group ties and to support opportunities for communication and interaction. This tool, known as NYNEX Portholes, is a Web-based extension of the Xerox Polyscope and Portholes systems [3, 5]. We chose this service because of the positive experiences at Xerox with using it to facilitate and support awareness and communication among distributed work groups. We developed and evolved NYNEX Portholes by closely involving our users and proactively seeking their input at every stage. By developing Portholes as a Web application, it is easily accessible to distributed individuals through the Web.

Several groups, inside and outside of NYNEX, are using this system. However, despite its availability, we have found that gaining universal adoption by all group members or recruiting whole new groups remains difficult. We must address repeatedly the initial reactions to the system. These reactions center around the use of cameras and video images to provide information for group and collaboration awareness. Understanding and addressing these reactions is critical to the adoption of the system and to being able to assess the value of the technology.

This paper presents the five user reactions that we have encountered and our experiences with understanding and resolving them. We first describe the current state of Portholes. Then we describe the methodology we used to deploy the system and to obtain user input for evolving the system. A profile of the various user groups that were exposed to and/or used the system is presented. This is followed by the presentation of the five recurring user reactions, the issues underlying them, and the resolution approaches and their effectiveness. Before concluding, we reflect on our experiences and discuss two additional contributions of our work, aside from our findings, which shed light on how video-based, background awareness tools should be deployed and how to redesign the system to support a number of crucial but missing properties for portholes-like awareness tools.

NYNEX PORTHOLES

NYNEX Portholes integrates and builds on past efforts to develop a tool that allows distributed work groups to access information related to general and peripheral awareness [2, 3, 5, 6, 13, 15]. Such awareness tools have principally used video and video images to inform people. They have largely come in two flavors: portholes and glance [15]. Portholes-like tools provide an overview of a community through a matrix of video images. This peripheral or background sense of group awareness is facilitated by periodic automatic updates of the video images. Glance-like tools provide electronic analogues of users strolling down a hallway and intentionally glancing into people's offices. They differ

GROUP *97 Phoenix Arizona USA*

from portholes-like awareness tools in that users must explicitly initiate brief reciprocal glances in order to obtain awareness information (i.e., active rather than passive approach).

NYNEX Portholes (see Figure 1) shares many of the features of the original Xerox Portholes system [5] but differs in ways related to the needs and requirements of our user base. Reasons for these differences and for the additional capabilities will be apparent when we discuss user reactions and our resolutions in the User Reactions section. In the remainder of this section, we provide an overview of the system to establish a context for the key capabilities of Portholes. These key capabilities include:

1. disclosure of awareness information,
2. membership in virtual groups,
3. informal and spontaneous communication,
4. image quality options,
5. lookback — approximating reciprocity,
6. ubiquitous access to Portholes, and
7. remote sites in Portholes.

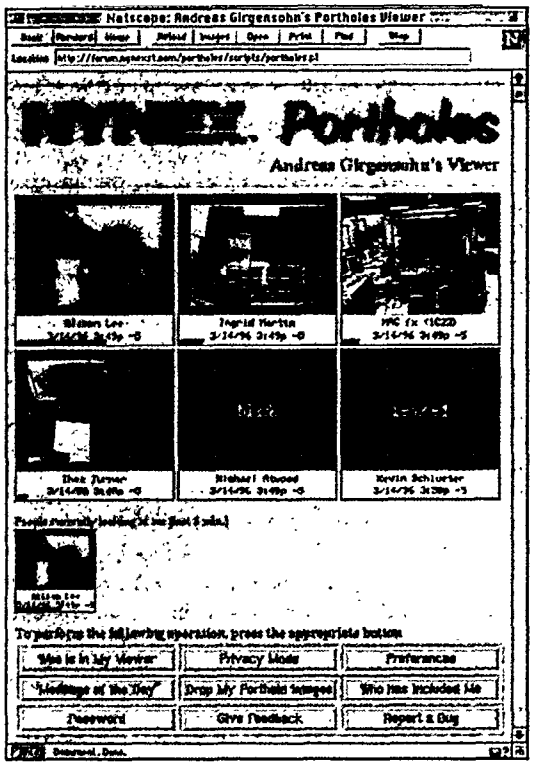


Figure 1: Portholes Viewer

Disclosure of Awareness Information

We used video images to explore the awareness information available through the visual channel that individuals can disclose with little effort. Experiences with Xerox Portholes [5] indicate that sightings, presence and availability are some information that users seek out. In addition to video images providing awareness, we link the images to other possible forms of group and collaboration awareness information for the individual through the user's Communicator page (see Figure 2). This page provides a flexible framework for exploring the *variety of group awareness information* that people find useful. Currently, it includes *formal* information like:

1. the group (i.e., physical group and project group) that the person belong,
2. phone and fax number,
3. office address,
4. email address, and
5. meeting calendar.

Also, the page includes *informal* information disclosed:

1. in their home page,
2. in their message of the day, and
3. in an integrative view of their activity for the last hour (from crude time-lapse animation and activity graph).

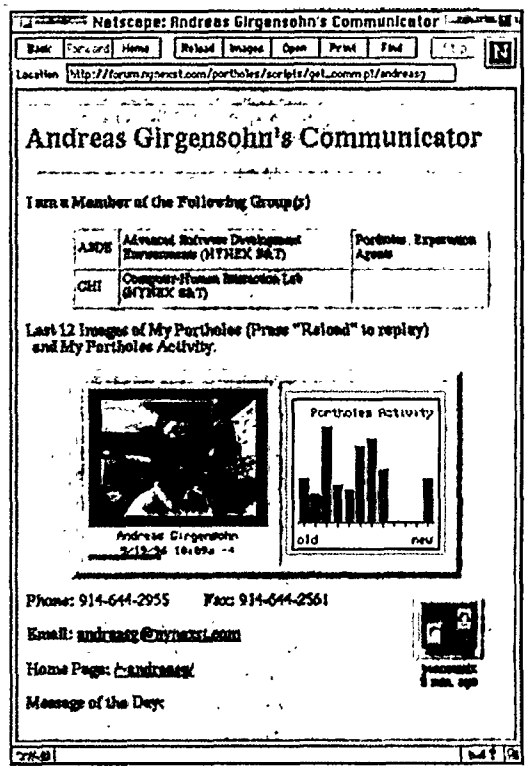


Figure 2: Andreas' Portholes Communicator

Each user has control over which information they wish the system to disclose to other users when their image is selected (see "Portholes Actions that I Allow" in Figure 3).

Membership in Virtual Work Groups

Users are members of an organization's group as well as one or more project-related groups. This group information is relevant as a piece of group awareness information as well as a means for controlling which information Portholes discloses to other users. Users can regulate the potential set of video snapshots that other users may access. All users within a group can access the video snapshots of their group members. They choose the images from a list that is partitioned into the groups that the user belongs to (see "People

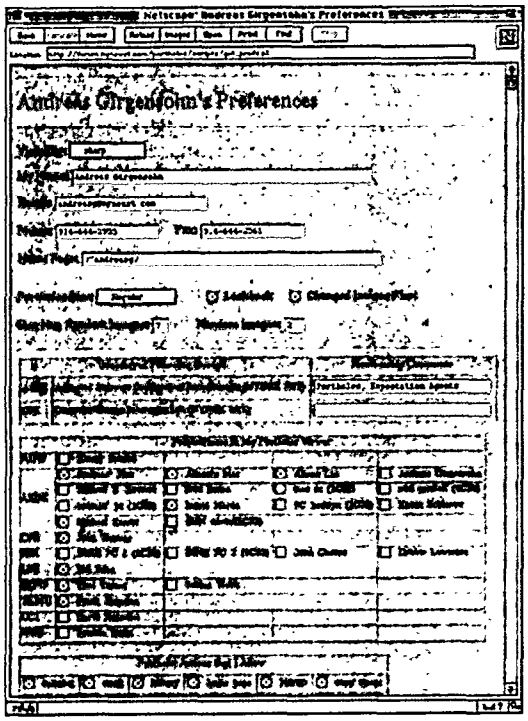


Figure 3: User preferences for Portholes.

in My Portholes Viewer" in Figure 3). Also, users can designate which other groups may view their images through the settings made in the "Groups I Export to" option in their Preferences page (see Figure 3).

Informal and Spontaneous Communication

Portholes allows users to initiate spontaneous informal communications with another user through the other user's communicator page. Users can send electronic mail, export their Portholes image to their home page, and obtain phone, fax numbers, and if the users have the capability, desktop video and audio conferencing initiated at a click of a button.

Image Options

Users can inspect the images and replace any embarrassing or inappropriate ones by "removed" frames (see Kevin Schlueter' image in Figure 1). Also, users desiring more privacy may control the amount of image detail disclosed in the Porthole Viewer (see Alison Lee's image in Figure 1). The images also contain a red horizontal bar along the bottom part of their label. This bar is derived from an activity sensing function which measures the amount of change between two successive video images [10]. Users can look for images with long red bars if they wish to quickly ascertain activity in their colleagues' offices. They can also order the video images in the Portholes Viewer by the ones that have changed the most. This has the effect of drawing the user's attention to potential developments, such as people arriving or leaving, which can be useful in a number of contexts.

Lookback — Approximating Reciprocity

Portholes allows users to get feedback on which users have been accessing their images in the last 5 minutes. This feedback is controlled by the "lookback" option in their Preferences (see Figure 3) and the results are displayed in the Portholes Viewer (see "People currently looking at me (last 5 min.)" in Figure 1). "Lookback" approximates reciprocity[1] because it does not provide *immediate feedback* of when other users are "looking at the user" but which users "looked at the user in the last 5 minutes."

Ubiquitous Access

To support ubiquitous access to Portholes, we chose to implement our Portholes Viewer as a Web page (see Figure 1) allowing it to be accessed from any workstation computing platform (Macintosh, Unix, and Windows) that has access to TCP/IP. Cameras are attached to workstations. Image acquisition software, installed and running on each user's workstation, digitizes local video input and transmits the snapshot to an image server via TCP/IP. No additional cables (i.e., video cables) from each location need to be installed and no separate video network needs to be built. Supporting a new user at a site simply involves making sure that the user's workstation is part of a TCP/IP network, that the Portholes Web server is accessible to the workstation, and the camera and image acquisition software is installed on the workstation.

Remote Sites

Portholes supports the addition of new remote sites accessible via the Internet. By using the technologies of the World Wide Web to build Portholes, we are able to make use of an existing network for linking remote sites (i.e., Internet). However, firewalls and proxy servers prevent Porthole Grabbers at remote sites from depositing their images at the main site. Even without a firewall, the bandwidth and lag of a long-distance internet connection can make it inconvenient to connect to a remote Web server to receive Portholes images. Therefore, an independent Portholes setup exists at each site which bundles the images of the local users and their database files and deposits them at a central ftp server.

OUR METHODOLOGY

Through a process of user participation we evolved our initial prototype to create an acceptable, usable, useful and reliable system [7]. Our naturalistic approach of evolving Portholes varies from other similar approaches in several ways (e.g., [4, 15]). First, the system provides a focal point for discussing and experiencing the value of video-based, background awareness. Second, right from the beginning, we took guidance from prior work on video-awareness and media-space tools and theories of social and work relationships to develop the features in our initial prototype. Third, user feedback was obtained in several ways including: a) users emailing their comments directly from within the application (see Give Feedback and Report a Bug in Figure 1), b) polling users informally, and c) eliciting comments through regular meetings with the first two of our user groups in Table 1. With this informal approach, we have learned several important issues about the design of and the introduction of video-based, portholes-like, awareness tools as well as the implications for the redesign of such tools.

1. Reciprocity describes the situation where all communications are two way. If you are able to see or hear another, that person can, at the same time, see or hear you.

Groups	Size	Site(s)
Own group	9 of 12	500
Exploratory project	10 of 16	400, 500, NYC
Extended colleagues	6	NYC, Texas A&M, U of Colorado, UC Irvine
Development project	2 of 2	400, UC Irvine
Demo groups	~20	N/A

Table 1: Portholes' user group size and sites involved.

OUR USERS

We recruited user groups throughout the development of Portholes and after it was released. The makeup of these groups are quite broad by a number of measures. Table 1 and Table 2 provide a profile of the various Portholes user groups. The NYNEX individuals came from different groups at S&T and are based at one of three sites. Two of these sites are two buildings (400, 500) at our White Plains, NY location that are about a fifth of a mile apart; the third site is located in Manhattan (NYC) about 25 miles from White Plains. We added Texas A&M and University of California at Irvine in 1996 while the University of Colorado site was involved from the outset

Portholes users have differing backgrounds and job functions due to the heterogeneous makeup of the people working at other NYNEX sites and the mix of developers and applied researchers at S&T. Some groups like the second user group included people who were not acquainted with each other and had not worked together prior to the project. Other groups, like the first and fourth groups, worked together but had little or no social ties like the people in the two university sites that joined later in the Portholes project.

Our users' reception to new technology and in particular, Portholes is varied (i.e., from enthusiastic to reluctant, open-minded to skeptical and suspicious, willing early adopters of technology, etc.). Most individuals have only a superficial knowledge of how Portholes functions. Many people, in particular those in the exploratory project group and those we gave demos to, were not familiar with CSCW research and technologies. On seeing and hearing about Portholes, most of them were generally ambivalent. Tang and Rua [15] noted similar sorts of reactions when they described such media space tools to the people they interviewed prior to developing Montage. We believe that these reactions are typical of those that will be encountered if video-based awareness tools are made widely available. Thus, these reactions and our experiences with addressing them provide some valuable insights into the design of video-awareness tools and the introduction of this type of tool into the workplace. Addressing the initial perception of this technology is not only important for gaining acceptance of the technology but it is also important for allowing researchers and users to explore its value through the use of the tool.

Groups	Disciplines	Job Function
Own group	CS, Psychology	Researchers (8), student intern (1)
Exploratory project	Anthropology, CS, ME, GIS, Graphic Design, Product Development.	Managers (3), researchers (3), developers (3), student intern (1)
Extended colleagues	CS, EE, Telecom	Researchers (3), student intern (2), developers (2)
Development project	Writer, CS	Document writer(1), student intern (1)
Demo Groups	Varied	Researchers, developers, vendors, managers

Table 2: Disciplines and job functions of user groups.

The final user group includes NYNEX colleagues and visitors who saw demos of Portholes. While this group would perhaps not be considered by some as "users" at all, we include them for two reasons. First, they represent the diverse set of people that visit S&T for one reason or another (e.g., S&T as a showcase for R&D, for new telecommunications services and applications). Second, despite this diversity, there is a consistency in the initial reactions that they have to Portholes and our use of cameras and video images to support awareness. We have found that these reactions recur whenever we attempt to recruit new Portholes users. Understanding these reactions and finding ways to address them are important if we are to be able to truly explore where the value of video images lie in support of group and collaboration awareness.

USER REACTIONS

Five user reactions to Portholes consistently arise when we demo or recruit user groups. They include:

1. camera shyness,
2. threat of surveillance,
3. loss of control over privacy,
4. lack of feedback and control of video images, and
5. lack of support for awareness of audience

The ambivalence towards Portholes points to the need to understand the problems with and limitations existing in Portholes. With each reaction, we explore both the issues underlying it and the approaches and limitations to resolving it. Some issues and resolutions were proposed by the users, some emerged through participative design, some involved the introduction of technological enhancements and others became evident through mutual education and understanding of users and designers about the technology. In many cases, the issues and resolutions were rarely obvious. Having Portholes to show and use was useful for focussing discussions on what users were uncomfortable with.

Reaction: Camera Shyness

Some users are uncomfortable with having cameras aimed at them and seeing video images of themselves in Portholes or even in the monitor of their video phone. They feel that they are constantly in front of a mirror. They have a heightened sense of self-awareness, are more self-conscious about their appearance, and feel that the camera captures unflattering images of them. We have found that these people are also uncomfortable about having their photograph taken.

Reposition Camera

As part of several Portholes review sessions with our second group of users, we discussed ways in which Portholes could be changed or redesigned to address this concern. One user suggestion is to place the camera at a distance from the user. This has the effect of removing, in part, their discomfort with having the camera in close proximity. By being at a distance, the image of the user is smaller and facial details are less discernible. One of the users wanted to place the camera on the frame of his office door. This idea appealed to some users because it puts the camera in the familiar position of a co-worker who is looking into one's office.

No Image Mirror

Users who have the most discomfort with being in front of the camera attribute it, in part, to the monitor on their video phone camera or to their image in the Porthole Grabber window. They did not want their image conspicuously available to constantly draw their attention. We have replaced some of the video phone cameras with a different camera and added a user-selectable option to the Porthole Grabber software to suppress the display of the snapped image.

Sharpen Image

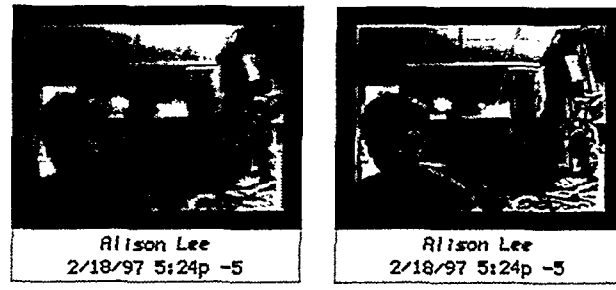
A third approach is to digitally improve the image grabbed from the camera (see Figure 4). We have found that we can compensate for many of the defects in the grabbed images by increasing the contrast and applying a sharpening filter. The resulting images are more aesthetically pleasing and appeal to some of our camera-shy users. This was serendipitously discovered during our efforts to provide more user control over privacy by decreasing the clarity of their image through image blur.

Snap New Image

Occasionally, embarrassing images are seen because they are often sharp and are captured at unexpected times. We assumed initially that if these images were captured, users would not mind because the images would be only briefly available and to Portholes users of a trusted group and other Portholes groups to whom the user have allowed access. However, one user angrily stopped using the system after it caught the person in an embarrassing pose. In response, we added a feature that allow users to snap a new image that replaces the current video image.

Reaction: Threat of Surveillance

Many people we have discussed Portholes with (including those who declined to participate) are simply unwilling to have the system capture their images while they work because they view it as a method of surveillance (one such person has referred to our system as "Peepholes"). They



normal image sharpened image

Figure 4: A Normal and a sharpened image.

worry that their superiors will use Portholes to see if they are working. Our colleagues who maintain the NYNEX Shuttle (a high quality video conferencing system) encountered extreme resistance to shuttle nodes in public places (e.g. cafeterias) for much the same reason. We checked several public shuttle nodes and found that all their cameras have lens caps in place.We approached this problem in two ways, with some success.

Technology Introduction and Walkthrough Approach

When potential users are solicited or they inquire about using our system, we have made it a practice to sit down and show them the system, explain our motives behind designing it, and discuss their concerns. We want to ensure that users understand the goals of Portholes, as well as how it functions, so that we gain their understanding and trust. In our discussions, the privacy-related issues of *capture, construction, accessibility* and *purposes,* as discussed in Bellotti and Sellen [1], are addressed. Specifically, we underscore that the purpose of Portholes is to provide awareness of one's virtual work group and of potential occasions for collaboration, not surveillance. We assure them that their images are only captured every 5 minutes and that their cameras are not attached to security style monitors. We explain how their images are processed in the construction of the Web page. We reassure them that their images are only accessible to Portholes users. This is effective with some of our users but others remain suspicious.

Reaction: Loss of Control over Privacy

We opted to continue to use video images in our Portholes system because of the rich awareness information available from the visual channel and the minimal effort required by the owner to disclose this information. However, the ease with which awareness information can be accessed causes some users to be concerned about loss of privacy. When this was first discussed, we suggested, based on other media-space experiences, that users should feel free to point the camera at a wall or out a window whenever they desire privacy. However, this suggestion was not adequate for all users. At issue is not only the need for privacy but also the need for a lightweight mechanism to control privacy. Ideally, this mechanism would allow users to increase or decrease privacy, to inform other users of their new privacy state and to provide immediate feedback of the change. Most Portholes systems are not designed in a way that facilitates the tight coupling between the means to change privacy and the means to obtain feedback that privacy is attained. In effect, without these two attributes, what typi-

cally happens is that people find the privacy features insufficient and turn their cameras off. This not only ensures privacy but also achieves it with minimal effort. Through discussions and user experimentation, three alternatives emerged which addressed the feedback and interaction issues.

Video Messages

Nearly all the users in the first group have video phones as their cameras. A feature of these video phones is the ability to freeze an image and transmit it as the video signal. Several users began experimenting with this feature, including one user who made up index cards containing text like "Out to Lunch", "Do Not Disturb", etc. It had the virtue of being simple, and the monitor on the video phone reminded people about the image being transmitted. With a touch of a button, the video phone exits out of the freeze mode to transmit a live signal.

Image Blur

In an effort to address some users' concerns about the amount of detail revealed in the video images and their ability to retain control over image capture, we introduced a number of gradations for image clarity that users can select from (see Figure 5). We initially found that only two users regularly changed their image clarity, although a third person permanently switched his image to "foggy." The others simply left their images in the default normal, non-blurred state. We have found that our users prefer to disable their cameras when privacy is desired and use the sharp, clear image when it is not. It is possible that this is because we have not made changing the blur setting accessible with one quick action (as in the image freeze solution). It may also be that users who desire privacy do not trust the process in which the blurred image is constructed. Alan Borning, who developed Polyscope, suggests another possible explanation; it is sometimes important to provide options not only because they add functionality but because they provide a sense of reassurance that users' concerns have been recognized and addressed.

Door Cam

Some users from our second group suggested that a "door-cam" solution could be adapted to facilitate privacy. Specifically, the camera is mounted on the door so that closing the door causes its frame to block the camera or change its view to the hallway. This both ensures privacy as well as provides an ideal user interface; closing the door is often the physical means by which one indicates that privacy is desired and by which one attains privacy in offices. This proposal is similar to the active sensing door-state capability experimented with in the University of Toronto Telepresence Project. In our opinion, it is the most effective solution because it addresses both the interaction design issue as well as the feedback issue that the users have concerning the control of privacy. Furthermore, unlike the "pointing the camera at the wall or out the window" alternative, people do not have to remember to restore the camera setup when they no longer desire privacy. Finally, the different views provided by the camera conveys the feedback of privacy states to other portholes users.

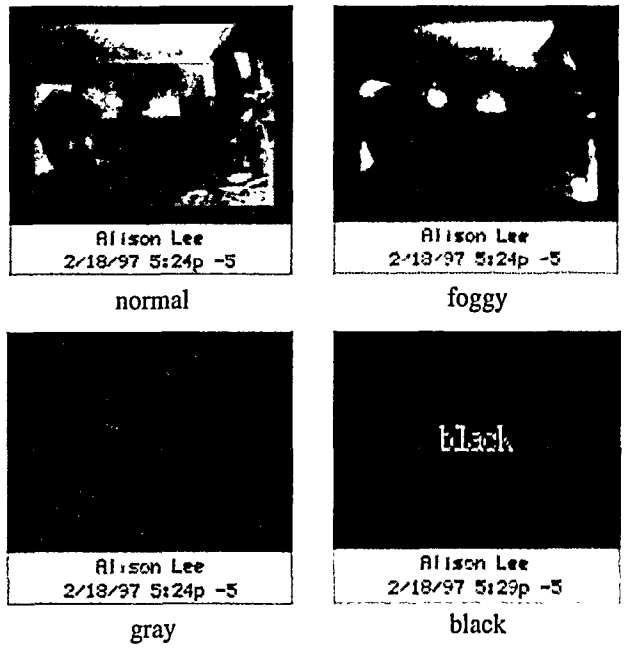


Figure 5: Successive image blurs from "normal."

Reaction: Lack of Feedback and Control of Images

Portholes captures a frame from a user's camera once every 5 minutes. Some users in the second group objected to the lack of control over their images. They perceived this automated feature as someone else "controlling" their camera. A basic characteristic of portholes-like awareness tool is this automatic image capture and the passive update of the video images matrix. We needed to find ways to give users more feedback and control without handicapping the nature of this interaction model. Aside from the image blur capability mentioned in the previous section, we identified four additional capabilities.

Activity Sensing

We interviewed users who blocked or turned off their cameras as well as several people who refused to use our system. A common suggestion was that we permit a "motion only" Portholes which only gives information about the presence or absence of a person but no visual information about the person's activities. In response, we implemented the activity sensing capability which measures the amount of change between two successive images [10]. Users may opt to disclose the value of the activity measure along with a blurred or grayed video image (see Figure 6). We have had positive reactions from our second group of users when we started experimenting with this feature and have had one person who previously refused to use Portholes reconsider.

Increased Feedback

Users demanded more feedback about when an image is grabbed and what the captured image looks like. First, we added a user-selectable option in the Porthole Grabber to play a sound before grabbing an image. We then gave the user the additional option to specify a lag between the sound and the image grab. Next, we added a user-selectable option in the Porthole Grabber to display the most recently captured image (i.e., similar to the one in video phones). We

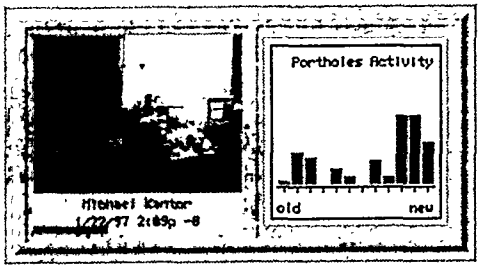


Figure 6: Activity as red bar and for the last hour.

have found that several of our users elect to have their image displayed and one user claims to comb his hair more and be more conscious of his posture because of the visible image.

Delete Video Images

Users in our second group pointed out that merely having the feature of snapping a new image to supplant the last image is insufficient. In their view, the embarrassing image is still around for an entire hour, instead of just a few minutes as in other Portholes systems. This is a consequence of the our Portholes' feature that keeps the last 12 images for the time-lapse animation. In response to this concern, users can select the video images in the image set and replace them with a red frame containing the word "censored". Some users pointed out that the red color and the word "censored" drew too much attention. We have since replaced both of these elements by a NYNEX blue color and the word "removed" (Kevin Schlueter's image in Figure 1). These changes, along with the other improvements, seem to have addressed concerns about embarrassing images as we have had no further objections.

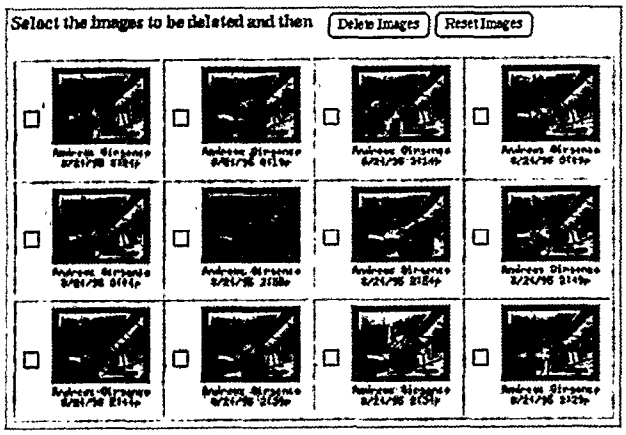


Figure 7: Deleting inappropriate images.

User Customization

As some of our users became more accustomed to the system, they began to want more control over their images than simply the ability to eliminate embarrassing ones. Two of our users would point their cameras out their office windows, and one user pointed the camera at the crest of a favored NHL team. Another user, who had a video phone, would use the camera to show the book cover, conference schedule, etc. These users were freely customizing their Portholes image to show something of their own choosing, particularly when they were away from their office or desired privacy. When we met with our users, they often requested the ability to set their Portholes image to an arbitrary image file. We have responded to this by providing an extended analogue to the video-phone free-frame option in the PC/Windows version of the Portholes Grabber. Users may cut and paste images to substitute for the video images for and/or take their video image and modify it in a paint program before it is displayed.

Reaction: Lack of Support for Awareness of Audience

Often, when we show Portholes (i.e., Portholes Viewer) to visitors and potential new users, they comment about the uneasy feeling of having unseen eyes looking at them. Similarly, their discomfort with cameras and video images are in part attributed to the fact that they do not know where the images are being projected to and who sees their images. In subsequent discussions, it became apparent that image matrix presentation emphasizes group awareness to the total exclusion of support for awareness or active feedback related to who the audience is and what the size and makeup of the audience is. The lack of this kind of awareness support contributes to the uneasiness that new users or visitors have with a portholes-like system.

At the root of this issue is the fact that portholes-like systems as well as media spaces in general, fail to provide cues to users about being in public [8] and contextual cues to allow users to frame their interactive behaviors [9]. Bellotti and Sellen [1] describe the former deficiency as "*disembodiment from the context into and from which one projects information.*" The latter deficiency is the "*dissociation of actions from the actions' results.*"

Based on the feedback from and the discussions with our users, there are two kinds of awareness information about one's audience that are lacking in portholes-like systems. They are two different aspects of "reciprocity."

Who is in the Audience

From the outset of our Portholes development, we considered reciprocity to be an essential element because previous CSCW work has suggested that users can monitor and control the self-presentation and behavior [4, 11, 14, 15]. When properly implemented, reciprocity is also a form of feedback [1]. In Portholes we initially implemented reciprocity by providing users with two lists. The first is list of people who select their image in their Viewer and when they last accessed it — "Who is Looking at Me." The second is the complete list of people who can view the user's images (see "People/Places in My Portholes Viewer" in Figure 3). Our initial group of users was satisfied by this. As we began to show Portholes to more people, we were repeatedly told that they wanted to know "who can view their images". While the information they desired is accessible via an explicit request, our users really wanted it in the main display. In effect, the overview display in portholes-like system is asymmetric in the display of awareness information — it displays who the user can see but not who can see the user. In the next section on Lessons Learned and Redesign Implications, we propose a redesign of the Portholes Viewer that incorporates both information along with the group overview information.

Lookback

As we gradually expanded our user base, we also heard objections along the lines of "I want to know who is looking at me." We initially misunderstood these comments and thought that our users simply did not know about the existing features such as the "Who is Looking at Me" list. In actual fact, the users wanted to know more than who had them in their viewers — they wanted to know who was presently looking at them. One exasperated user, after being told about the existing reciprocity features summed this up well when he said, "but I want to know who is looking at me NOW!" Some users pointed out that the lack of this feature made Portholes significantly less desirable than having someone look in through their door. That is, Portholes is being used to accomplish a task normally accomplished via physical presence (i.e., peer through a door) but has lost one of its important but subtle reciprocity aspects (i.e., knowing who is looking in). Our users want an immediate indication that they are being looked at. They also want an image of the person looking in and that the image should conspicuously "pop up" on the display to attract their attention.

This capability requires the addition of functionality in our grabbers and an overhaul of our Portholes architecture. In the interim, we developed the "lookback" capability which displays small images of those who have accessed one's Portholes image in the previous 5 minutes (see the bottom of Figure 1). Our users are more satisfied with this than we expected and have commented that they like the persistence of the small images. As a result of this "lookback" feature, we have relabelled the original "Who is Looking at Me" button to "Who has Included Me" (see Figure 1).

LESSONS LEARNED AND REDESIGN IMPLICATIONS

One significant contribution of our study of Portholes is the user concerns raised within the context of deploying the tool within a workplace consisting of a larger and more heterogeneous mix of people. Our experiences have provided insights into how it will be received by a broad base of users and what the tool should include to overcome the initial reactions to a portholes-like awareness tool. More importantly, we have gained a better understanding of the reactions and the issues underlying them. This understanding can be put to use in improving the design of Portholes. Consequently, in this section, we take one step back and review both our approach and the critical components of a portholes tool for group and collaboration awareness.

Social Contract Among Users

Our involvement both as researchers and developers in the Portholes project was necessary because of the investigative aspects of the work. However, in practice, it would be rare for both users and developers to be in close proximity of each other so that developers can shepherd the introduction of such technologies. Furthermore, in our project, we set a small number of ground rules about being a user of Portholes (e.g., users could not subscribe to use Portholes if they were unwilling to publish their own images). In practice, such ground rules should not come from the developers and they should not be enforced by the developers. Instead, both the ground rules and its enforcement should be negotiated, agreed upon, and enforced by the users themselves.

Consequently, the deployment of a production version of Portholes should support capabilities that allow users in the Portholes groups to develop and enforce a social contract among each other for the acceptable use of Portholes. Part of this contract relates to not only what information the users agree upon but also how the disclosure mechanisms work for people within the same group and for outsiders to the group. This is a proposal for future work. It is evident that the issue of disclosure remains one that developers cannot determine. However, as researchers, it is important that we identify, as we have here, what sorts of information users might want to disclose. Appropriate processes or mechanisms — social or technological — should be available to facilitate the development and compliance of user contracts.

Alternatives to Video Images

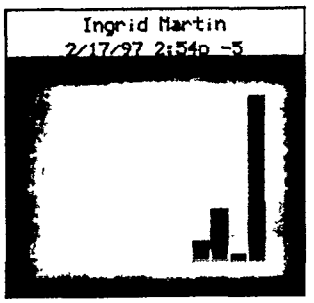
Recently, researchers have pointed out the need to design these systems in a flexible manner so that "*users may actively participate, adapt and appropriate the technology*" in order to truly facilitate the emergence of new and distributed forms of social organizations [1, 2, 9]. Much of this discussion has been presented within the general context of the design of media spaces. However, our work on Portholes both adds additional voice to this requirement as well as translating this requirement concretely and specifically (e.g., image blur, activity sensing) for Portholes. In the latter case, our findings provide new insights into a number of crucial properties of portholes-like tools for group and collaboration awareness. These properties extend beyond the ones (e.g., image matrix, video snapshots) that were characterized by the Polyscope and Xerox Portholes work [3, 5].

In particular, we propose that Portholes should have a property of using alternatives to video images for facilitating awareness. The user reactions concerning self-presentation, surveillance, and privacy are linked strongly to the exclusive use of video snapshots. In attempting to resolve these concerns, different controls such as image blur, image sharpening, and activity sensing were acknowledged as being helpful. However, these capabilities should not be supported strictly as control mechanisms on video images. Some users would prefer them as alternative options for video images in the image matrix.

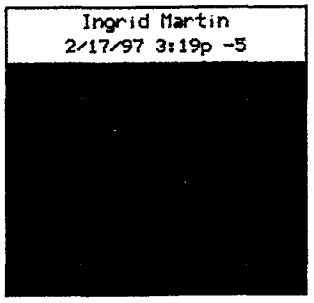
We propose that Portholes should allow the user to choose one or more of image blur, image sharpening, activity chart, video message, photograph, etc. Multiple selections would be composited by means of overlay or by adjacent positioning. Figure 8 illustrates how the options and compositions can represent alternatives to video images.

New Portholes Viewer Design

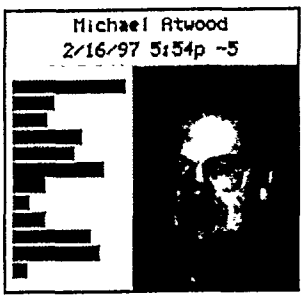
We designed a new version of the Portholes Viewer to address some of the user reactions concerning surveillance, reciprocity, and awareness of audience (see Figure 9). Several users expressed unease about the current design because the image matrix reminded them of a security-monitor setup [12]. Furthermore, in the physical world, when we enter the presence of others, we have access to many cues and information that remind us that we are in public [8]. Accordingly, we present ourselves and behave in such a way that befits our public persona.



foggy image overlaid with last hour's activity



gray image overlaid with video message of calendar



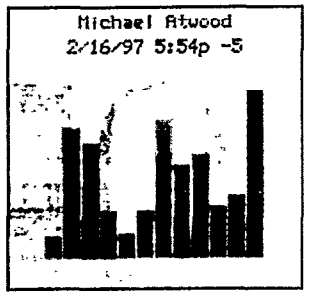


photo plus last hour's activity: adjacent & overlaid

Figure 8: Some alternatives to video images.

Consequently, we propose reciprocity and awareness of audience are important properties of Portholes just as the property of awareness of group and collaboration opportunities. The new design uses a 3D view of images in a room similar to a theater to incorporate all three pieces of information. Each user's Porthole Viewer has the user on stage and looking out to an audience encompassing all the Portholes users that can view the user's image. The theater metaphor serves to reinforce to users that they are both in public and are presenting themselves to others. As we mentioned earlier, part of the uneasiness that people had with the old matrix presentation was not really knowing if they were in public and how public was the distribution of their images (i.e., size of their audience).

The arrangement of the images into the front, back, and side rows reflects different awareness information. The images in the front few rows contain the images of people that are in the user's work group (i.e., images previously appearing in the image matrix that the user has explicitly selected). Images move to the front rows if the user includes them in the user's virtual group. These front-row images provide users with group awareness and collaboration awareness. They are positioned into the front rows, potentially, by the amount of activity change and recency of the images.

The images in the back rows are for individuals whose images are accessible to the user and for which the user's own images are accessible to them. However, they are in the back rows because the user has not included these people in the user's virtual group. These images are partially covered and scaled down so that more images can be presented to retain the perspective view. More importantly, they are available to complete the presentation with the front rows for awareness of the user's audience (i.e., both how big the audience is and who is in the audience). Note that the labels for the images are at the top so that this information is visible should the user be interested in a particular image.

Reciprocity information is presented by images at the sides turned 45 degrees. This provides users with an awareness of who is looking at them. We have received very positive comments from current and prospective users after showing them the mock-up of the new design. We plan to implement this using a combination of a Java applet and VRML.

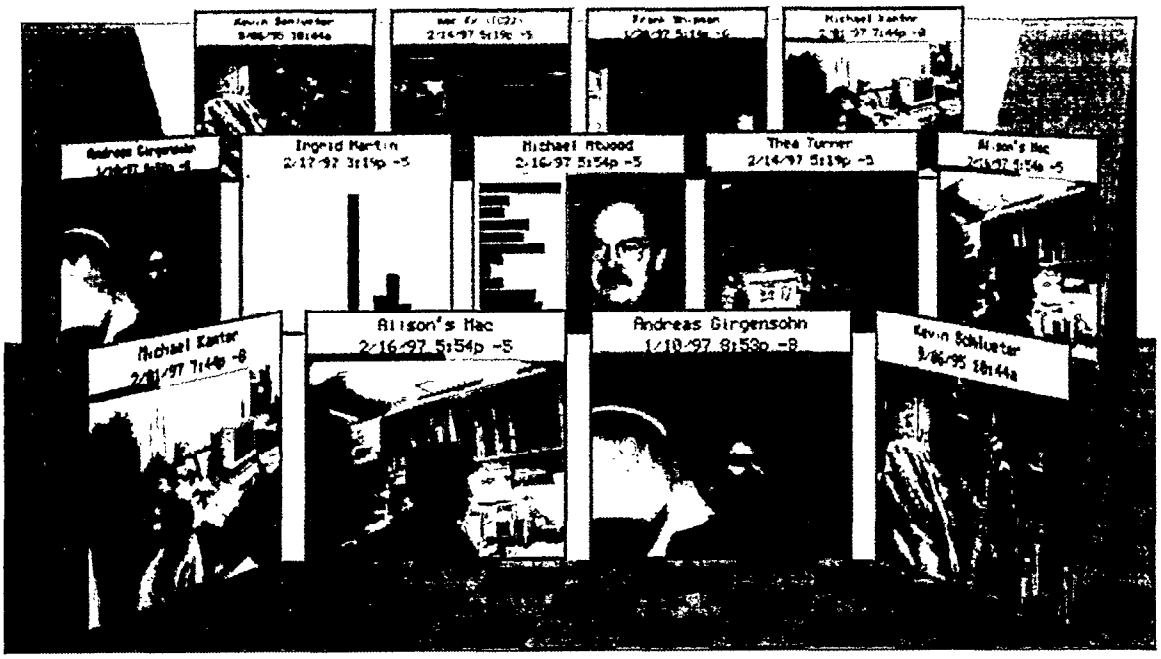


Figure 9: Mock-up of a redesigned Portholes Viewer.

CONCLUSION

The initial reactions to NYNEX Portholes have been enlightening as well as valuable in helping us think about the crucial properties of portholes-based video awareness tools. First, the overview model needs to be supplemented to accommodate reciprocity and awareness of audience. Second, it is not only important to support privacy but it must be designed in such a way that it is easy to achieve and that immediate feedback of the change is provided. Third, it is important to design feedback and control capabilities within the system so that users retain control over their video images while still permitting the system to perform periodic, automatic, and passive capture, distribution and update of video images. Fourth, in addition to group and collaboration awareness, Portholes needs to support activity awareness [10]. Fifth, it should be a property of Portholes to allow users to choose alternatives to video images.

Our experiences highlight the critical role that people's initial perceptions and reactions of the technology play in its acceptance. The knowledge we have gained from deploying Portholes to a broader base of users adds to the current small body of literature on experiences with introducing media space technologies. The factors that underlie these concerns are complex, difficult to pinpoint and only being gradually teased apart and understood [1, 9, 12]. Hence, the need to experiment with a mix of diverse resolution approaches is important. Furthermore, without more comprehensive knowledge of the critical properties of the design of media spaces like video-based, background awareness tools, there is a greater need to design these systems in a flexible manner for users to adapt and alter them in order to for such technologies to support group work.

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