# The Social Computing Room: A Multi-Purpose Collaborative Visualization Environment


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Figure 1. The Social Computing Room.


## ABSTRACT

The Social Computing Room (SCR) is a novel collaborative visualization environment for viewing and interacting with large amounts of visual data. The SCR consists of a square room with 12 projectors (3 per wall) used to display a single 360-degree desktop environment that provides a large physical real estate for arranging visual information. The SCR was designed to be cost-effective, collaborative, configurable, widely applicable, and approachable for naïve users. Because the SCR displays a single desktop, a wide range of applications is easily supported, making it possible for a variety of disciplines to take advantage of the room. We provide a technical overview of the room and highlight its application to scientific visualization, arts and humanities projects, research group meetings, and virtual worlds, among other uses.



**Keywords:** Collaborative and distributed visualization, large and high-res displays, immersive and virtual environments


## 1. INTRODUCTION

As the amount and complexity of electronic data increase, more sophisticated technologies to enable understanding of and insight into these data become necessary. Scientific and information visualization techniques are especially well-suited for such a purpose, as the visual system has the highest throughput of the human senses,


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and is known to be an excellent pattern-recognition system.[1] To improve visualization capabilities, various display technologies offering greater visual complexity and richness than a standard computer monitor have been developed. Visualization environments such as display walls, CAVEs, and domes have all been built to enable greater understanding of and insight into data than is possible with a standard computer monitor, and all have their own strengths and weaknesses for various applications.

The Social Computing Room (SCR) is a novel collaborative visualization environment that borrows from previous visualization environments, but was developed with different goals in mind. The SCR was designed to be cost-effective, collaborative, configurable, widely applicable, and approachable for naïve users. The SCR consists of a square room with 12 projectors (3 per wall) used to display a single 360-degree desktop environment (Figure 1). Other features of the room include multi-sensor tracking technology, surround sound, and cameras providing a 360-degree view of the room.

The layout of the SCR enables users to view large amounts of data and provides a large physical space for arranging data around the room, taking advantage of human spatial awareness for organizing data.[1] Additionally, the SCR enables multiple users to visualize data collaboratively, potentially enabling more complex analyses and deeper insights than is possible with a single user. The SCR is used for data visualization in the sciences and humanities, and is also used as a space for explorations in new media.

One way to think of the SCR is as a hybrid between a CAVE and a display wall. Some differences from previous visualization environments include:

- Unlike a display wall, which takes the model of a standard flat-screen display and increases the physical size, often adding pixels for improved resolution, the SCR rearranges additional pixels to surround users, creating a qualitatively different experience than that of a display wall.
- Unlike a CAVE or dome, the SCR is not designed exclusively for 3D virtual environments. The SCR has proven very useful for displaying and arranging large amounts of 2D data, as well as 3D data.
- Because the SCR displays a single desktop, a wide variety and combination of applications can be run without any code modification or the use of external packages such as Chromium[2] or SAGE.[3]
- The SCR was designed to be configurable, enabling a wide range of projects and peripheral devices to support them.

This paper is organized as follows: Section 2 provides a summary of previous work in visualization environments. Section 3 provides a technical description of the SCR. Section 4 describes some of the software infrastructure developed to take advantage of the room. Section 5 gives examples of a variety of uses of the room. Section 6 concludes and presents future work.

## 2. PREVIOUS WORK

Various types of environments have been developed to enhance visualization display. Among others, these environments include display walls, CAVEs, domes, and environments designed specifically for collaboration.

### 2.1 Display Walls

Display walls typically use multiple display devices, such as projectors or flat panels, to create large area, high resolution displays, and can be driven by single computers or multiple-computer clusters.[4] Display walls are useful for individuals and groups who wish to view large amounts of data. They are typically easier to use than CAVEs and dome displays, as no specialized rendering typically needs to be performed by the application developer, and a standard windowing system is typically presented to the user. Systems such as Chromium[2] and SAGE[3] can be used to handle the distributed rendering needed for complex display walls.

Display walls created from multiple flat-panel displays suffer the problem of physical bevels between the displays interrupting an otherwise contiguous display. Projector-based displays introduce issues with projector alignment, luminance mapping, and color-correction to produce a seamless display. Methods for producing seamless projection from multiple projectors onto a planar surface have been described,[5,6] and extended for projection onto arbitrary surfaces.[7] The SCR currently uses no such automatic calibration techniques, instead relying on occasional manual calibration and alignment. This approach has worked well for many users, although automatic calibration techniques could be pursued in the future for certain applications. Other visualization environments include CAVEs and domes, which can immerse the user in 3D virtual environments.

### 2.2 CAVEs

A CAVE (Cave Automatic Virtual Environment) is an immersive virtual-reality environment in which 3-6 walls of a room-sized cube are projected onto by multiple projectors using some combination of front and rear projection.[8] Tracking of a single user's head position, typically using electromagnetic sensors, combined with shutter glasses, enables real-time stereoscopic display within the CAVE, giving the impression that the user is surrounded by a 3D virtual world.

The terms "immersive" and "presence" are often used in the virtual-reality literature.[9] The degree of immersion is a measure of the physical characteristics of the system, including field of view, field of regard, stereoscopy, and frame rate, among others. Presence is the user's subjective feeling of being in the virtual world. The SCR is less immersive than a typical CAVE, due to factors such as a lack of stereoscopy and a smaller vertical field of view. However, the SCR is more immersive than a flat-screen display due to the 360-degree display of projected surfaces. The degree of immersion in the SCR lends itself well to the types of activities the room was designed for, which are more focused on creating a collaborative space where users are surrounded by imagery than on creating a fully-immersive experience to increase the feeling of presence in a virtual world for a single user.

While a very compelling experience for a single user, CAVEs suffer the drawback that the perspective rendered is constantly update for the user whose location is being tracked. Therefore other users inside the CAVE can easily become disoriented. In addition, CAVEs require specialized software to run correctly, are designed specifically for displaying 3D virtual worlds, and construction can be quite costly in comparison to the SCR.

### 2.3 Domes

Domes and other curved-surface displays offer wider fields of view than flat-screen displays.[10] As with CAVEs, domes are effective in providing an enhanced immersive experience for users in virtual environments. Both single- and multiple-projector domes exist, and domes can display tracked or non-tracked stereoscopic 3D. Like a CAVE, domes only appear perspectively correct for a single user. However for large enough domes, multiple users can obtain views from near the center of projection that are close to correct. Domes are also similar to CAVEs in that they typically require custom software solutions to display correctly. Typically, multiple views of the scene must be rendered and then warped and blended together, either in software or hardware, to obtain a seamless image that is corrected for display on a curved surface. Domes are also typically most useful for applications involving 3D virtual worlds.

### 2.4 Collaborative Environments

The SCR is a unique environment that does not fit neatly into any of the previous categories. Subjectively, the 360-degree display is something more than a display wall, yet it is not designed specifically for displaying virtual worlds in the fashion of a CAVE or dome. It is important to note that the display is a primary feature of the room, but the real focus is on the collaborative group operating in the space. Additionally, an emerging mission of the SCR is to provide a collaborative visualization space for groups interacting with large amounts of data in cooperation with remote participants. There have been several efforts in industry and in academia that address aspects of the SCR mission.

Smart office and ambient computing efforts such as IBM's BlueSpace project have a focus on easy access to information through shared visual displays and responsive environments. A particularly instructive idea in the BlueSpace project is the "Everywhere Display," in which a steerable projector can turn any surface in a room or office into an interactive display, providing a more natural interaction with data.[11–13] Whereas a steerable mirror assembly allows the Everywhere Display to provide ambient information in a collaborative space, the SCR provides projection on the entire surface of the room.

The SCR also shares some common themes with the Interactive Mural project at Stanford University.[14] The Interactive Mural project uses large visual displays to support work methods in common use by design studios during brainstorming, in which sketches and media are displayed on every available surface in a work room to support collaborative activity. The Interactive Mural attempts to mimic the paper and "Post-it" note collaboration style through a large visualization display and a pen interface. The SCR addresses this model through the Collage and CollageWPF applications described in Section 4. The unique 360-degree display of the SCR may enable a more effective model of the brainstorming environment described in the Interactive Mural project, which could be an interesting area of research.

## 3. TECHNICAL DESCRIPTION

This section provides a technical description of the SCR, including the room construction, display configuration, and hardware devices in the room.

### 3.1 Room Construction

The SCR is a 22'-2"×22'-2" square room with an 11'-6" ceiling. A 6"-wide soffit offset 3'-4" from the walls descends 4'-6" from the ceiling. With 3/4" plywood installed behind the sheet rock for strength, the projectors and mirror assemblies described in Section 3.2.1 are mounted to the outside of the soffit between it and the outer wall. The central area of the ceiling interior to the soffit is 10'-6" high, and is equipped with a Unistrut metal framing system[15] and dozens of Cat6 lines run to an equipment closet adjacent to the SCR. The Unistrut system provides extensiblity for additional devices in the room, such as those described in Section 5.2.1. The Cat6 lines support installation of non-networking devices for project-specific customization since many device signals can be converted to run over Cat6. Diagrams of the SCR are provided in Figure 2.

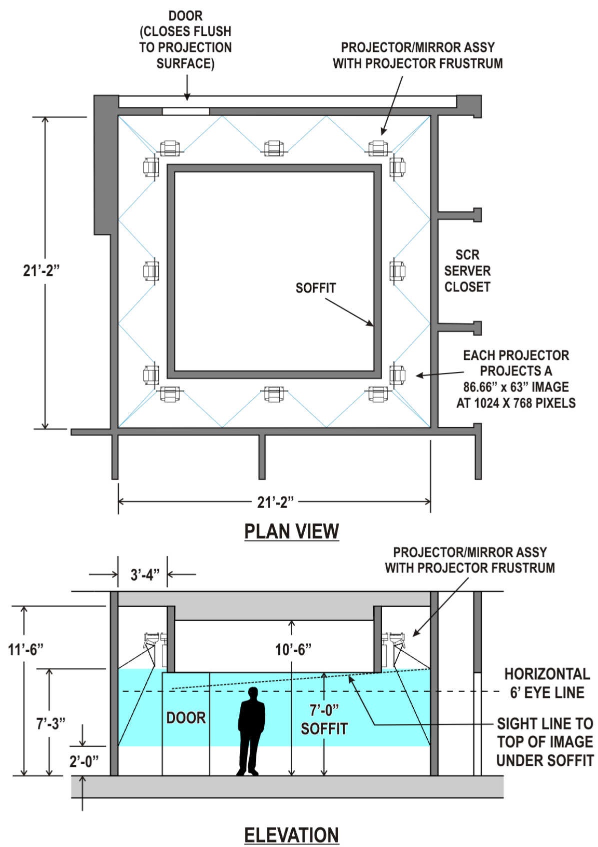


Figure 2. Floor plan and elevation diagrams of the SCR.

### 3.2 Display Configuration

The SCR display consists of 12 projectors (3 per wall) attached to the soffit between it and the outer wall. Custom-built mirror assemblies enable the projectors to fill each wall 3'-4" away from the display surface.

#### 3.2.1 Projectors and Mirror Assemblies

The SCR is outfitted with NEC WT-610 projectors, each with a resolution of 1024×768. These projectors are built with a mirroring system that achieves very short throws (e.g. a diagonal image of 60" at a distance of 10.4"). The projectors are oriented abutted adjacent one-to-another horizontally, and currently no edge-blending is utilized. In order to fill each of the 4 walls with 3 projector images, each projector must project an image with a width equaling 1/3 of the wall's 254" width, or 84.66". Using 3D modeling to simulate the projected frustrums from each projector, it was determined that producing this size image from each of the projectors would create interferences between the projectors in the corners of the room. To shorten the space that each projector requires, front-surface mirrors are used. The final distance of the soffit to the wall was determined by the positions of the mirrors, projectors and structural framing required to support the assemblies.

The final height of the projector/mirror assemblies and soffit were driven by several factors, including: (1) Image Height: Determining an appropriate height of the image on the wall for seated and standing users of different heights was necessary. With a fixed image height of 63" (as determined by the 1/3 wall width as described above), the bottom edge of the image was set 2'-0" off the floor, placing the top of the image 7'-3" off the floor. This final placement was determined through some experimentation before the room was built. (2) Soffit Height: In addition to supporting the projector/mirror assemblies, the soffit is intended to hide the majority of this equipment to minimize distraction. However, the lower the soffit, the greater chance the view of the entire image by someone standing might be blocked. Using a sight line in the elevation drawing, we can see that a soffit starting 7'-0" off the floor does not block the view of a 6-foot tall individual.

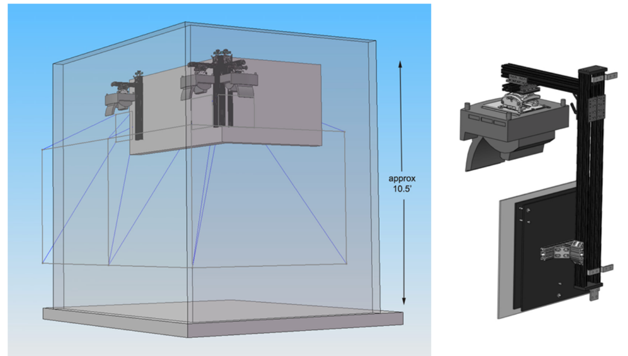

Figure 3. Diagram of the projector and mirror assemblies used to create short-throw front projection in the SCR.

The custom mirror assemblies were created using 80/20 modular aluminum framing.[16] With the mirror assemblies, the system is able to produce an image of 84.6"×63" (approximately 105.5" diagonal) within the 3'-4" space. With the projector's resolution of 1024×768, this yields a projected resolution on the walls of approximately 12 pixels per inch. The mirror assemblies and USB cables discussed in Section 3.2.2 are the only custom-built parts used in the SCR. All other parts are commodity, resulting in increased cost-effectiveness.

Benefits of the projector setup include: (1) Front projection maximizes the space used for the room when compared to rear projection. With front projection we are also able to project onto a variety of surfaces, including the sheetrock used to construct the room. For both of these reasons, front projection results in a more cost-effective solution than would have been possible with rear projection. (2) Mounting the projectors between the soffit and the outer wall hides them from view and does not obstruct the image being projected from any point within the room. (3) Projecting from above with a steep angle enables users to get very close to the wall before casting any shadow. The elevation view in Figure 2 shows the frustrum projected from the mirrors and how close a user can stand without casting a shadow. A diagram of the projectors and mirror assemblies can be found in Figure 3.

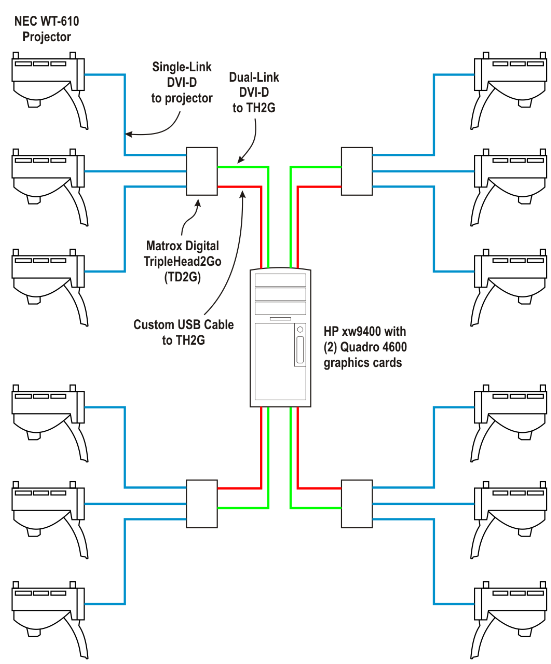

Figure 4. Diagram of the display setup enabling a single machine to display a single desktop environment driven by 12 projectors.

### 3.2.2 Video Configuration

The projectors are driven by a single workstation. Currently a Hewlett Packard xw9400 workstation running 32-bit Windows XP is used, however computers running both Windows Vista and Mac OS X have been tested in the room. Two NVIDIA Quadro FX 4600 graphics cards drive the 12 projectors. Each graphics card has 2 DVI outputs, for a total of 4 outputs. Each DVI output is connected to a Matrox TripleHead2Go device, which can split a single video output into 3 outputs. Custom USB cables are used to connect the TripleHead2Go units to the computer, as the maximum length specification for USB cables is 15', and the cables must run up to 30'. The cables are made from Cat6 using 2 of the twisted pairs, one for power and one for data. Each

TripleHead2Go is then connected to 3 projectors. Therefore, each of the four DVI outputs from the graphics cards displays on a single wall, and each wall (3 projectors) appears to the operating system as a single 3072×768 display. The four displays laid out horizontally result in a single 12,288×768 desktop. A diagram of the display configuration can be found in Figure 4.

This arrangement provides the following benefits: (1) Presenting a single desktop to the user significantly decreases the barrier to entry in the room. Any application that runs on Windows XP can run in the SCR, so users can begin using the room immediately with whatever tools they commonly use. (2) The size of the room enables groups of up to 15 people to comfortably view a large amount of data. (3) Presenting the desktop as a 360-degree wraparound environment enables the engagement of human spatial awareness for organizing data, such as having different walls for different categories of data. (4) The spatial layout of the room enables each individual to piece together information spread around the room without being constrained by a linear presentation model.

One issue with the display configuration that should be noted is that many graphics cards, including the NVIDIA Quadro FX 4600, only support buffer dimensions of up to 8192 pixels. Therefore, attempting to open a single OpenGL window that wraps around the entire room will not work. A solution to this problem, described in Section 4.1.1, involves using a single OpenGL context bound to multiple device contexts.

Although the 360 degree wraparound desktop is the signature feature of the SCR, other hardware devices are also incorporated into the room.

### 3.3 Hardware Devices

**Seating**: A typical setup for the SCR includes 6 chairs with rotating arm-rests suitable for note-taking. Chairs can be removed or added as needed depending on the group and application. **Interaction**: A wireless keyboard and mouse are used to control the SCR. The keyboard and mouse can be passed passed between users to exchange control. **Tracking**: A Ubisense tracking system is installed.[17] This system uses radio-frequency identification to track tags in the room, with a spatial resolution of approximately 6". In this manner, location information of tagged objects or people in the room is available. This system was used for the Spectacular Justice multimedia art installation described in Section 5.2.1, and has also been experimented with for other multimedia applications. **Cameras**: Four standard-definition cameras, and one high-definition camera are mounted to the interior of the soffit. These cameras can provide a 360-degree view of the room and its occupants to remote collaborators. **Speakers**: A 5.1 surround-sound speaker setup is installed. Other speaker setups are also possible, including the setup described in Section 5.2.1. **Microphones and Echo-canceller**: Four lavaliere wireless microphones and one ceiling-mounted room microphone are connected into an echo-cancelling audio system for teleconferencing and mixed-media telepresence activities.

## 4. SOFTWARE INFRASTRUCTURE

Although any Windows XP application can be run in the SCR, we have developed applications designed to take advantage of the spatial layout of the SCR more effectively. We describe two such applications, Collage and CollageWPF.

### 4.1 Collage

Collage is an image and video viewing application developed after observing a number of groups using the room. A common task observed was viewing a large number of images spread around the room. Doing so typically required opening a large number of instances of an image viewing application and spreading the separate windows around the room. Collage was developed to make this task easier and add enhanced functionality. Figures 5 and 8 show Collage in use.

### 4.1.1 Implementation

Collage is built using wxWidgets, an open-source cross-platform GUI toolkit.[18] Orthographic rendering of images and video is performed using OpenGL, with video playback enabled via DirectShow. Because the graphics cards used only supports buffer dimensions of up to 8192 pixels and the width of the SCR display is 12,288 pixels, Collage uses a single OpenGL context that is alternately bound to left and right 6144 pixel-wide device contexts when rendering each frame. By setting the orthographic projection such that the correct view is rendered to each half, a seamless image is achieved.

### 4.1.2 Features

Collage enables opening of multiple image and video files. Most standard formats are supported. Upon opening the images, Collage spreads the images around the room. The user can click on any image to select and drag it around the room, and the mouse wheel is used to scale selected images. Additional features of Collage include multiple layout strategies, multi-image selection and manipulation, and automatic sizing of images to fit the display vertically.

One issue with using multiple instances of an image viewer program is that in one corner of the room, the left and right edges of the desktop meet. In this corner, the mouse does not wrap around the display to move from the left edge to the right edge, or vice versa. To move from one edge to the other, the user must typically move the mouse all the way around the room. Because Collage is a single application that wraps around the entire room, we can programatically control the mouse pointer to warp from one edge of the desktop to the other, enabling a more intuitive and productive experience. Similarly, images can be rendered such that they display correctly in this corner by rendering multiple copies in the correct location. Although a relatively simple program, Collage has proven quite useful for visualizing large amounts of data in the SCR.

## 4.2 CollageWPF

The Collage prototype was provided to several groups using the SCR. The anecdotal reports of the users were positive, and given the response, it became clear that the Collage functionality should be enhanced in several ways: (1) Extend capability to new types of media, such as 2D and 3D graphics, charts and graphs, web browsers, and spreadsheet data. (2) Enhance the ability to interact with data to multiple users via hand-held game controllers or multi-touch technology. (3) Enable users to preserve layouts and save annotations to data. (4) Enable “wall-to-wall” collaborations between the SCR and remote users using heterogeneous display technology.

The InfoMesa technology demonstrator from Microsoft Life Sciences[19] proved to be an interesting model for Collage extensions, for the underlying technology, and for application functionality that matched the comments and suggestions of the Collage prototype users. InfoMesa provides a rich user interface, including a scrollable “whiteboard” containing various media widgets, along with an emerging model for annotation, search, and persistence.

InfoMesa is built on the .Net stack, using the C# language. Windows Presentation Foundation (WPF), built on top of DirectX, is used for graphical display. Early tests with InfoMesa and WPF showed that the technology could provide a 12,288×768 application window on a single Windows XP or Vista machine without a need to manipulate OpenGL contexts. In addition, the C#/WPF combination provides a higher-level coding environment within which enhancements can be created.

Enhancements continue on a WPF port of Collage, called CollageWPF. This port incorporates ideas from InfoMesa and Collage, tailoring the functionality to the SCR environment: (1) New widgets have been added to display time-series graphics, and to ingest PowerPoint presentations. (2) New layout managers have been created to assist in arranging graphics. (3) Parts of the SCR display can be designated as magnification areas, so that any content moved to that region will automatically resize to the maximum display resolution. (4) A meta-data system is being developed to capture whiteboard layouts, as well as the location of underlying assets, such that a whiteboard may be preserved and shared. (5) Features are being developed for textual, digital ink, and video annotation, based on InfoMesa implementations. (6) Asset “drivers” are being created to enable the whiteboard to search, retrieve, and store assets in arbitrary data stores, such as the iRods data grid.[20]

# 5. APPLICATIONS

## 5.1 Visualization

In general, the SCR is useful for viewing large amounts of data. One visualization strategy that is especially well-suited to the SCR is that of small multiples.[21] Small multiples are series of small similar pictures that convey information through repetition. Time series data, simulation runs with different parameters, the results of different segmentation algorithms, and multi-variable GIS data are all examples of data that have been viewed as small multiples arranged around the SCR and analyzed by collaborators. Specific images of interest can be identified and scaled up, and images can be collected from around the room for closer comparison.

The SCR is also useful for integrating large amounts of heterogenous data. For command-and-control scenarios, different walls can display different types of data, such as simulation data, web pages, or live video feeds, taking advantage of human spatial awareness to organize the data (Figure 1).

### 5.1.1 In-Class Scientific Visualization Critiques

A specific example of a successful use of the SCR for scientific visualization is as a space for comparative visualization critiques. Russ Taylor's Visualization in the Sciences graduate-level course at UNC-Chapel Hill has been using the SCR to perform in-class critiques of visualization homework assignments (Figure 5). Certain homework assignments in the course involve the visualization of a particular data set. Students are required to design and implement a visualization of the data set given specific questions about the data, and submit a single image displaying their visualization. The SCR enables the class of 12 students and 2 instructors to arrange the various visualizations around the room and comparatively evaluate how well each answers the supplied questions about the data. In the words of the instructor:

Figure 5. A scientific visualization class using the Social Computing Room for visualization critiques.

> The Social Computing Room is an ideal location to perform the design reviews and voting for the visualization homeworks in the Visualization in the Sciences class. We can project the entries from each student on the walls all at the same time, along with a text description of what questions they were supposed to answer, and then all sit and talk about the comparative strengths and weaknesses of each approach. The ability to walk right up to the images lets us both see them at high detail and vote (by dropping pennies) for our favorite visualizations. The central seating area makes the room comfortable for hour-long sessions and extended discussions. The USB input lets us bring our own content to be displayed. The auto-layout software combined with the ability to move images around manually enables us to rapidly set up a session.

## 5.2 Arts and Humanities

The SCR is also used for applications in the arts and humanities. For digital arts, the SCR enages artists by presenting them with a new type of display to use as a "digital canvas." In the humanities, the SCR offers much of the same benefits as for scientific visualization by enabling comparitive visualization of large amounts of data. This section provides an example use of the room in both the arts and in the humanities.

#### 5.2.1 Spectacular Justice

Spectacular Justice was a multimedia art installation that used the SCR as a tool to confront visitors with the issue of the death penalty (Figures 6 and 7). It was created as part of the Carolina Performing Arts *Criminal/Justice: The Death Penalty Examined* project, a season-long campus- and community-wide exploration of death penalty issues. Joyce Rudinsky, Associate Professor of Communications Studies at UNC-Chapel Hill created a multimedia installation surrounding visitors with images, video, and audio.

Visitors wore Ubisense tags to track their locations, and the media in the room responded based on how people were grouped. The installation also took advantage of the extensibility of the room, adding various peripherals to enhance the experience. Two 54”×41” HoloPro HX Amiran anti-reflective glass rear-projection screens from Brookview Technologies,[22] along with projectors to project onto them, were hung from the Unistrut ceiling to break up the space of the room and add additional layering of the visuals. American Technology Corporation HyperSonic Sound H450-B directional speakers[23] pointing at the ground were hung in the corners of the room, with the purpose of encouraging individuals to group together for a more communal experience. A fifth directional speaker was attached to an AMX AXB-PT10 PosiTrack Camera Controller hung from the ceiling. This speaker could select a single person to track and deliver focused audio to. The following quote explains how the artist was able to take advantage of the spatial layout of the SCR:

> Spectacular Justice was installed in the Social Computing Room at RENCI’s Carolina engagement site. The SCR offered an incredible opportunity for an art installation due to its immersive characteristics. Viewers were surrounded with eye-level video creating an experience of existing in the same space as the video. The installation’s collected images shifted across walls and holographic panels to create a sense of a contemporary, information-based experience. The sense of architectural space was subsumed to an information space defined by layers of electronic information.

Figure 6. Two patrons of the Spectacular Justice multimedia art installation.

Figure 7. An image of the Spectacular Justice multimedia art installation, including a HoloPro projection surface hung from the ceiling on the right.

#### 5.2.2 Archimedes Palimpsest

The SCR is also used for visualization of data from the Humanties. One such example is visualization of the Archimedes Palimpsest,[24,25] an ancient manuscript containing erased texts that include two treatises by Archimedes found nowhere else. To view the erased texts, high-resolution multi-spectral image-capture techniques have been applied to each page.

Two aspects of the Palimpsest project are well-suited for visualization in the SCR. First, the sophisticated image-capture process produces multiple views of each page of the document. This aspect fits neatly into the small multiples visualization practice supported by the SCR (Figure 8). Many images of the same section of the Palimpsest can be compared in the SCR, and working with the images in the Palimpsest suggests many

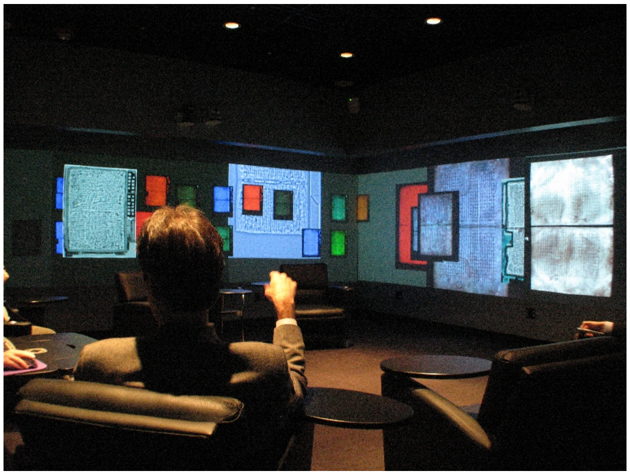

Figure 8. Viewing multi-spectral images of pages from the Archimedes Palimpsest.

Figure 9. A 360-degree SecondLife client, enabling interaction with life-sized avatars.

tools to support visualization activities using the Collage and CollageWPF applications described in section 4. Second, the Palimpsest imagery is of extremely high resolution (a typical example image is 10,880×8,160 pixels). The 12,288 horizontal resolution of the SCR therefore enables researchers to view entire lines of text at full-resolution. The Archimedes Palimpsest data illustrates how the SCR can be used for a variety of applications involving imagery from the humanities, including facilitating comparison, search, and annotation.

## 5.3 Research Group Meetings

The SCR has proven useful for a number of research groups holding meetings. Typically, the users will load whatever data they wish to present, either via accessing it over the web or via a USB flash drive. A single "maestro" will then open data, arrange it around the room, and manipulate it. The "maestro" is easily interchangeable by passing the wireless mouse and keyboard around. A specific example of a research group using the SCR for their group meetings is discussed below.

### 5.3.1 Melanoma Image Analysis

One of the groups using the SCR performs image analysis of digitized melanoma biopsy slides. This is a very image-intensive group, as they are interested in tasks such as comparing different segmentation algorithms on various slides, comparing scatter plots of features detected from slides, and visually inspecting and comparing slides to gain an understanding of the differences between healthy areas and areas exhibiting melanoma.

Using the SCR has proven very valuable to this group for visualizing a large amount of data simultaneously. A typical usage scenario involves designating a single wall as the main wall of interest, dragging relevant images to that wall for discussion, and moving images not being discussed onto side walls. The ability to move images to side walls instead of removing them from view is quite useful, as individuals are still able to view all of the data and draw insights in parallel to the main discussion thread.

Another use of the SCR for this group is collaborative grant writing. In a method similar to that for viewing image data, a single wall is used to display the document being edited. Supplemental documents can be spread around the room, and the group can suggest text and images from these documents to incorporate into the main document.

## 5.4 Virtual Worlds

Preliminary work has also been completed for using the SCR as an interface to virtual worlds such as SecondLife or Croquet/Cobalt.[26–28] While the SCR was not designed as a fully-immersive 3D virtual environment such as a CAVE, it does offer interesting possibilities for investigating combined real-world/virtual-world applications taking advantage of the physical real estate of the SCR.

A 360-degree adaptation of the SecondLife client has been developed that renders to 4 viewports, each with a 90-degree field of view (Figure 9). This client has been used for a virtual mock trial project with the UNC School of Law, in which virtual jurors attended the mock trial via SecondLife, viewing avatars of the litigants, witnesses, and judge, along with video and audio feeds from the room, displayed in the same virtual courtroom as that seen by the live participants on the walls of the SCR. More information about this project can be found at `http://www.renci.org/news/features/mock-trial-virtual-world-real-learning`, and we are interested in pursuing other real world/virtual world applications within the SCR.

### 5.5 Other Applications

The SCR is used for a wide range of applications in addition to those highlighted above. Some of these applications include: Code reviews; Viewing large spreadsheet data; Viewing building plans; Interactive poster sessions; A media classroom for student video projects; Creating interactive music using Wii Remotes and Ubisense tags; Interactive dance experiments using HD video conferencing linking the SCR to another institution; A showcase for multimedia class projects in Romance Languages; Software user-group sessions; Multimedia promotional presentations; Media-rich classroom experiences.

## 6. CONCLUSIONS AND FUTURE WORK

We have presented the Social Computing Room (SCR), a novel collaborative visualization environment for viewing and interacting with large amounts of visual data. The SCR consists of a square room with 12 projectors (3 per wall) used to display a single desktop environment, creating a 360-degree immersive experience for users that provides a large physical real estate for arranging visual information. The SCR was designed to be cost-effective, collaborative, configurable, widely applicable, and approachable for naïve users. We have demonstrated a number of applications of the SCR, including applications in scientific visualization, arts and humanities projects, research group meetings, and virtual worlds.

There are plans to continue to expand the Collage programs based on user input. Technology demonstrated by InfoMesa will continue to develop, such as persistence and sophisticated annotation, while also experimenting with multi-user input.

The 360-degree display, video and audio coverage, and extensibility of the room create a fertile environment for investigating the boundaries between physical and virtual worlds in a manner similar to that of the virtual mock trial described in Section 5.4.

Exploration will continue in the area of new media as well. Experiments have been conducted in the SCR by several researchers using Wii Remotes and UbiSense tags to enable interactive musical experiments, which could be combined with interactive graphics and video provided by the SCR display.

So far, we have a large amount of anecdotal evidence regarding the utility of the SCR. Future work will involve user studies to measure changes in performance when using the SCR for specific tasks.

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