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Toward a Digital Stage Architecture: A Long-Term Research Agenda in Digitally Enabled Theater

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Since 1991, the Gertrude Stein Repertory Theatre (GSRT) has been pursuing a unique research agenda, attempting to develop a theater style and theory based on digital technology. The approach has its aesthetic roots in Japanese Bunraku-style puppetry, Meyerhold's biomechanics movement training, and Bharatta Natyam and other forms of Indian dance and performing arts. These traditions offer guidance in creating stylized characters using dramatic effects external to the performer, as opposed to the more naturalistic Stanislavski and Actors Studio performance styles.

Although often considered a traditional art form based on traditional techniques, theater has always had a serious impulse toward new technologies. For example, the Greeks invented numerous ingenious stage machineries including the *deus ex machina*, a system for lowering actors; the *ekkyklema*, a wheeled cart for revealing static tableaux; and *periaktoi*, an early visual display system that used triangular set elements mounted on pivots and turned by ropes and gears for quick backdrop changes. Theaters still use motorized periaktoi today for signage and stage spectacles.

Once theater moved indoors, advances in lighting technology were quickly enhanced and adapted to the stage, resulting in a wide range of sophisticated lighting effects. One of the first performances at the Paris Opera to be illuminated by electric lights inspired Gertrude Stein's *Dr. Faustus Lights the Lights*.

Early in the PC revolution, writers such as Brenda Laurel (*Computers as Theater*, Addison-Wesley, 1991) noted the close relationship between the digital environment and the live, interactive, multimedia nature of theater. In fact, digital technologies promise to help us reinvent live theater in even more fundamental ways than previous technological advances. There are an enormous number of possible synergies between theater and networked media, which various artists are just now exploring.

Live digital theater might include performers and audiences interacting simultaneously in multiple locations around the world. Digitally enhanced production processes (rehearsal, training, and artistic collaboration) would make true global, multicultural performances possible. We can create sets and characters with computer-generated animation and modeling tools (see Figure 1). Audiences might participate via the Internet or advanced broadband networks or attend public performance in specially equipped spaces. We can completely wrap audience members in digital media, immerse them in the play's world, or integrate the media with physical set components in

Figure 1. A VRML model of Meyerhold's 1926 production of* Magnanimous Cuckold. *In the Constructivist style, it was meant to suggest a "machine for acting." Meyerhold and other Russian artists of the period were drawing inspiration from the latest advances in science and industry.

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complex and surprising ways. The experience might include a range of obvious or subtle interactions between audience members, actors, the narrative, and the environment.

Shared research agenda

GSRT has used the digital-theater concept as a research challenge to collaborate with computer scientists, engineers, and software developers as well as other artists and arts institutions. Partners have included digital technology companies (IBM, Lucent, NTT, Macromedia, and PictureTel) and academic research institutions (Yale University, Virginia Tech, and the University of Georgia) as well as US and international theaters. GSRT also has an affiliate for-profit organization (Learning Worlds), which develops software and networked multimedia platforms.

Considering that theater has been evolving for 2,500 years, the impact of digital media on theater will clearly take some time to mature. At the same time, digital technology is still evolving and, in some cases, isn't yet adequate or practical for some potential applications.

In the last few years, GSRT has focused on developing a long-term research agenda that addresses what it considers the key enabling technologies for live, multilocation digital theater. The strategy is to divide the agenda into phases or workshops and to share it with multiple partners based on interests and available resources. We'll eventually make the resulting tools and processes available to other performing artists and institutions.

A related research initiative, the Global Performing Arts Consortium, pursued in conjunction with Cornell University's Institute for Digital Collections, is developing metadata standards for digital archives in the performing arts. The goal is to develop a series of multimedia and multilanguage databases (including designs, production photos, sound and video, 3D models of sets and theaters, and so on) that can be searched cross-culturally based on a common data architecture.

Digital characters

Although artists and technologists ranging from George Coates to Robert Wilson have done much work on digital sets, GSRT has been concentrating on the problems related to creating digital characters. Ideally, these characters would merge physical and virtual elements. They should be created live, since prerecorded elements tend to distort a performance's time-flow. Also, they shouldn't be limited to flat screens or projection surfaces.

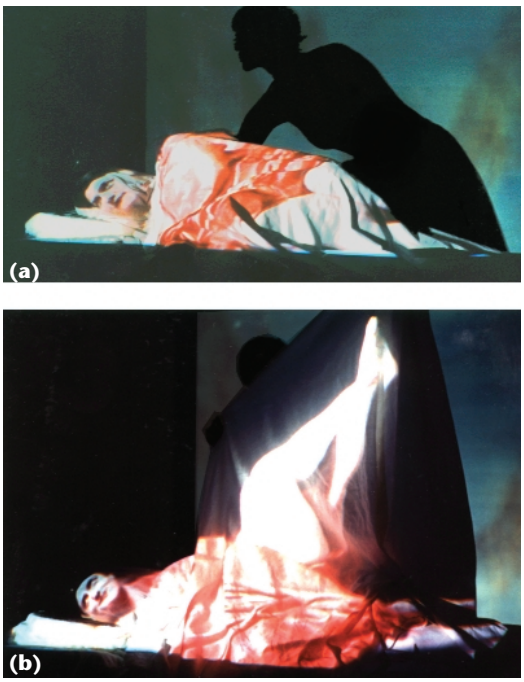

Figure 2. (a) Four performers create one character through digital videoconferencing and projection. (b) One local actor (dressed in white) is the receiver of the image, and another helps to manipulate the drapery that serves as a projection surface. One remote actor is the face and body, another the legs.

The critical research involves methods for projecting digital images onto live choreographed (moving) performers within a large theater space. In particular, we'll overlay images of remote actors (senders) on actors in the local space (receivers) as a first step in developing the capability of merging casts in different geographic locations into one live theatrical performance. Figures 2a and 2b give examples of this method.

The problems we need to solve include

- moving a projected digital video image across the stage in synchronization with a performer's choreographed movements,
- coordinating projected images and performers (senders and receivers) without interference,
- developing practical equipment and systems for digitizing and keying the sender's images, and
- synchronizing other digital media and stage components (virtual sets, animation, lighting, and so forth) with the senders' and receivers' performances.

The solutions to these problems will be cutting-edge innovations in several fields:

- digital encoding and conferencing,

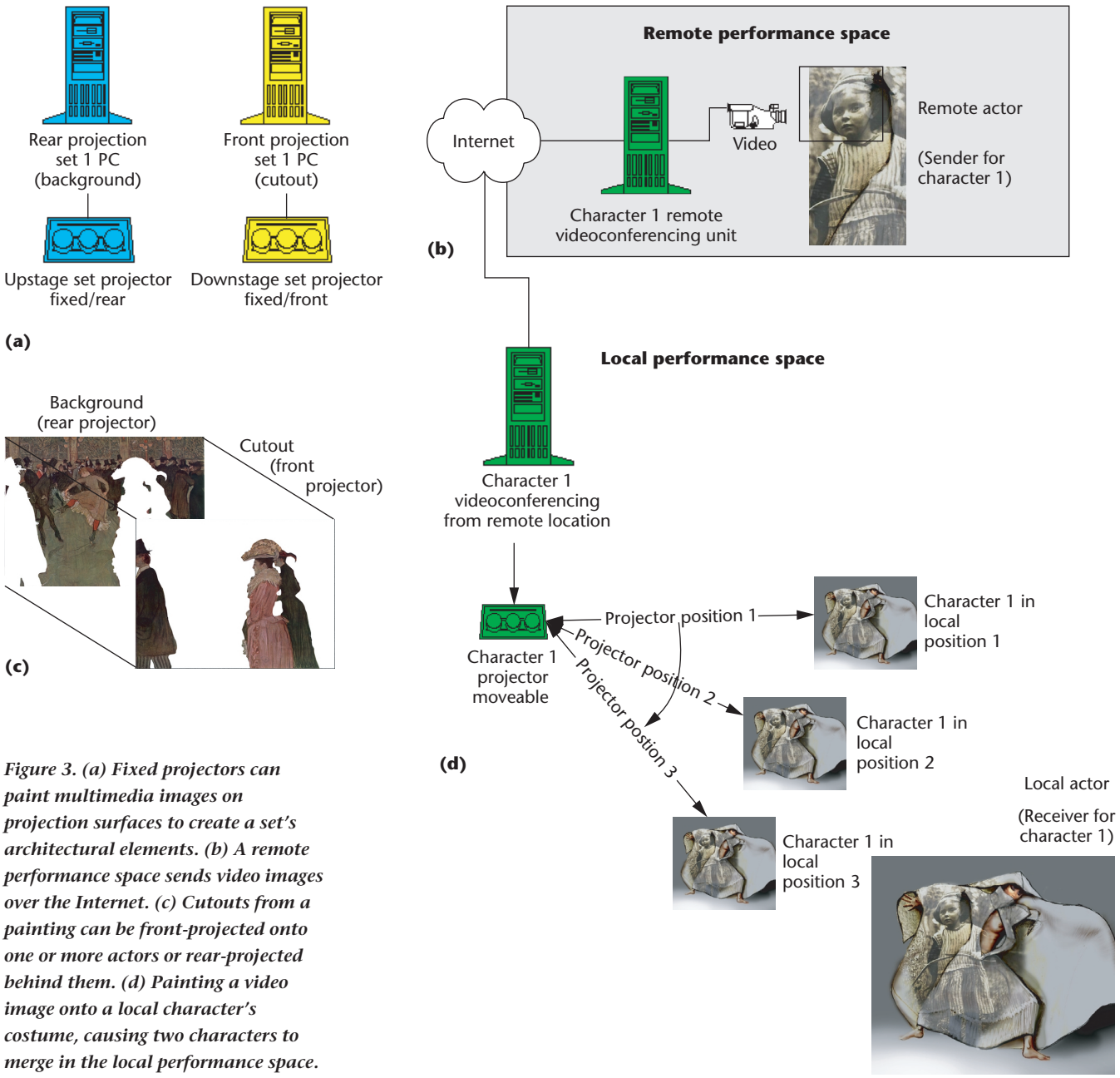

Figure 3. (a) Fixed projectors can paint multimedia images on projection surfaces to create a set's architectural elements. (b) A remote performance space sends video images over the Internet. (c) Cutouts from a painting can be front-projected onto one or more actors or rear-projected behind them. (d) Painting a video image onto a local character's costume, causing two characters to merge in the local performance space.

- digital display technology,
- computerized show control, and
- IP-based network synchronization and messaging.

Figure 3 shows the technical complexity of and artistic opportunities available with multilocation performances. In the scenario in Figure 3, we use a combination of fixed, moveable, local, and remote projectors to create digitally enhanced characters. With fixed projectors, we can create a set's architectural elements by painting multimedia images on front- or rear-projection surfaces. We can also use animation (2D or 3D) to generate virtual movements and seamlessly blend project images into the lighting design.

In addition, we can synchronize set changes and multimedia sequences between locations over the Internet. Cameras and videoconferencing equipment at remote locations can pick up the video images of senders (see Figure 3b). The moving images are carried over the Internet and pro-

jected in the receivers in the local performance space (theater). For example, Figure 3c shows cutouts from a painting. We can front-project the cutouts onto one or more actors and rear-project the painting's remaining elements behind the actors. A moveable projector (mounted in a motorized lighting yoke, for example) can track the receiver, or local actor, across the local performance space. Figure 3d shows how we paint the sender's video image onto the costume, which results in a merging of the two characters.

Research process

GSRT has developed a rigorous process for aesthetic and technological experimentation that involves formulating a list of *scenelets* or aesthetic hypotheses, testing each one methodically and recording the results (including the required technological components). In a series of experimental workshops, we test successive generations of the digital tools and equipment. Each workshop reveals further problems and challenges, as GSRT works toward a desired artistic end while simultaneously modifying the tools. The tools shape the product, just as the product shapes the tools.

As GSRT's artistic director, I collaborate with a digital production team. The team consists of artists from traditional theater, film and television, and digital media, including a stage manager, programmer, costume designer, director of photography, projection designer, actors, and lighting designer.

Previous workshops have concentrated on various pieces of the puzzle. A workshop at the University of Georgia focused on the influence of various video frame rates and compression algorithms (used in different videoconferencing applications) on acting styles. Another at the Here Arts Center in New York City explored the aesthetic and dramatic relationship between actors physically on stage and live remote actors being projected larger than life.

Implementing the research

After two years of concept and design work, the GSRT staff and I are working to refine the digital mobile projection system and apply it to a live production of Gertrude Stein's *The Silent Scream of Martha Hersland*, which is being adapted for the virtual stage from the novelist's *Making of Americans*. An upcoming workshop at the University of Iowa will experiment with projectors in motorized, digitally controlled yokes, in tandem with special costumes designed to provide larger display surfaces for projection, making it easier to integrate projected images with the choreography (see Figure 4). GSRT hopes to present a full production of the 80-minute multimedia play live and over the Internet in 2003.

Figure 4. A recent design workshop for Making of Americans *resulted in a series of drawings and 3D models inspired by the fashion designer Issey Miyake. The costumes provide various geometric surfaces that let performers in motion (senders) more easily "catch" the images of remote performers.*

It's too early to tell whether digital technology will become an indispensable part of live theater performance in the near future. It may become a separate medium, or remain a curiosity in the repertoire of individual artists. The arts are at the same time more fickle and more glacial than the sciences. One digital music composer claims that it required 70 years after the piano was invented before any music was composed that remains in the historical canon.

GSRT has adopted a long-term perspective, in keeping with theater's pedigree. We want to experiment with the latest technology as soon as it becomes available. But how it's reflected in the final work of art and how history will judge that work is impossible to predict. All research is a statement of belief in the possible, a leap into the dark. **MM**

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