

Live Media: Interactive Technology and Theatre

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In the past century, film, radio, and video technologies gave rise to new forms of dramatic expression and a global entertainment industry. In the past decade, interactive media technologies have been producing an artistic and cultural revolution of similar, if not greater, proportions. Interactive media are giving birth to new art forms, and the practice and history of theatre has a great deal to contribute to these new forms.¹ As I have argued elsewhere, the way that current digital artists valorize the concept of “interactivity” relates closely to the way theatre and performance artists have long valorized the concept of “liveness.” Digital artists strive to define interactive experiences in much the same way, and perhaps for many of the same reasons, as did creators of Happenings and environmental theatre in the 1960s (Saltz, “Interaction”).

The primary focus of this paper, however, is not the role of theatre in interactive media but the role of interactive media in theatre—“theatre” here referring to the old-fashioned, nonparticipatory Western performance genre in which a group of live performers gathers before a group of live spectators to enact a scripted play. My central concern is not with the interaction between spectators (the “end users”) and media but rather the interaction between performers and media. Theatrical productions can define this interaction in a wide range of radically different ways. To illustrate the range of options, I will draw on examples from productions that I have directed over the past three years under the auspices of the University of Georgia’s Interactive Performance Laboratory. In the end, I hope to show not only that incorporating interactive technology into theatre opens dynamic new possibilities for theatre artists, but more deeply that it compels us to reexamine some of our most basic assumptions about the nature of theatre and the meaning of liveness.

Defining Interactive Media

First I wish to establish just what interactive media technology means in this context. By interactive media, I refer to sounds and images stored, and in many cases created, on a computer, which the computer produces in response to a live performer’s actions. The tricky part is specifying exactly how such media are different, functionally, from older, purportedly noninteractive media,

which I call linear media. After all, on some level, even analog devices such as tape recorders, VCRs, and film projectors are interactive: an operator interacts with controls to call forth specific sounds and images.

Three crucial features distinguish interactive media from linear media:

1) *Random access*. Digital technologies (even simple ones such as audio CDs and DVDs) allow almost instantaneous movement between noncontiguous media segments. To this extent, virtually all musical instruments are interactive media devices. A pianist or guitarist, for example, can move very rapidly between arbitrary notes. By contrast, the operator of an audio or video tape deck must advance through information sequentially to get from one segment to another.

2) *An arbitrary link between trigger and output*. Since computers store and manipulate sounds, images, and everything else in the same form—as binary information—there is no innate, mechanical connection between the media content and the input that triggers it as there is in the case of both acoustic musical instruments and analog media devices such as tape decks. Fingers plucking strings directly produce a guitar's sounds, much as light shining through translucent film directly produces cinematic images. By contrast, a computer can use any kind of input (keyboard, mouse, tactile sensor, motion detector, or anything else that feeds data into it) to trigger any kind of output (sounds, images, lights, motor control). Furthermore, a single input can trigger any number of outputs, allowing for highly coordinated control of multiple media elements.

3) *Media manipulation*. The most powerful feature of interactive media stems from our ability to write programs that manipulate digital information based on input. Consequently, a trigger need not have an invariable, one-to-one relation to the media it produces. I can program a computer to project a different sound or image depending on how closely two performers move together, or how loudly they speak, or what notes they sing, and I can make the output change over time or react to past events. Not only can the computer select prerecorded media segments according to complex algorithms, it can generate its own media on the fly, creating entirely new sounds or images. One of the very earliest interactive installations, Myron Krueger's *METAPLAY* (1970), vividly illustrated this potential by empowering participants to "paint" virtual images on a wall-sized video display by moving their arms in space.²

Dangerous Liaisons: Media and Theatre

It is easy to imagine how interactive media might be useful in improvisatory, participatory, or nonnarrative genres of performance. For example, musicians can use interactive technologies to create amazing new instruments capable of generating a limitless variety of sounds in a limitless variety of ways, and so it is not surprising that, among artists, musicians were the first and continue to be

the most prolific in exploiting interactive media. Similarly, dancers have eagerly exploited the ability afforded by interactive technologies to control lights, images, and sounds directly through their movements.

But the relevance of interactive technology to scripted theatre is less obvious. After all, in a scripted and rehearsed performance, the sequence of events is predetermined. One might suppose that interactive media would be unnecessary, and even downright dangerous, adding a needless element of risk to the endeavor.

Notice, however, that if we take this reasoning to its extreme, we will soon find ourselves questioning the very institution of live theatre, including and most pressingly theatre's use of live actors. If perfect invariance between performances and the absence of risk were the ultimate ideals, then live theatre would have no reason to exist at all in the twenty-first century; the art form should have ceded to recorded media such as film and video long ago. The value of live theatre, especially in a mediatised age, lies precisely in its variability. Regardless of how rigorously scripts and the rehearsal process constrain performances, each performance within those constraints is a unique event. The rigorous structure of performance traditions such as Noh, which prescribes the actor's every gesture, serves merely to amplify the significance of the most minute variations. The thrill of the live is to see a performance event unfold, with all the risk that entails. Live performance is inherently interactive. The spontaneous give-and-take between performers and spectators, and among a group of sensitive performers, is integral to theatre's appeal as an art form, both in the most highly stylized genres of theatre and in "realistic" theatre.³

Now consider the impact of injecting linear media into a live theatrical performance. Imagine an extended scene between a live actor and a videotaped actor. Unlike a live partner, the videotape will be unforgiving of any errors the live actor might make (for example, missing a cue) and will never adapt to variations in the rhythms or dynamics of the actor's delivery. The medium forces the live actor to conform rigorously to it. Such a performance combines the worst of both theatre and media: it lends the live performance a canned quality without endowing it with any of film or video's advantages, such as the ability to select the best takes, edit out the mistakes, or apply camera movement or jump cuts to the live actor's performance. It is no wonder that extensive use of linear media has never become more than an occasional gimmick in the theatre.⁴

Interactive media do not sap the spontaneity or variability from a live performance, as linear media do, since they embody those qualities. Media are interactive to the extent that they adapt to the performer rather than making the performer adapt to them. By definition, the more interactive the media, the more responsive. Theatre that incorporates interactive media has the potential to combine the strengths of both live performance and media. Whether it realizes that potential in any particular case, of course, depends on the specific choices made in a production and the deftness with which those choices are carried out.

Testing the Possibilities: The UGA Interactive Performance Laboratory

Over the past decade, a small but growing number of theatre companies have begun to explore ways to integrate interactive media into theatre. Among the most innovative have been the George Coates Performance Works, the Gertrude Stein Repertory Theatre, and the Institute for the Exploration in Virtual Realities (i.e.VR) at the University of Kansas. Four years ago, I founded the Interactive Performance Laboratory (IPL) at the University of Georgia specifically to investigate the relationship between live performance and interactive media.⁵ The IPL is a physical facility—a combined production studio and classroom space—as well as a program of research and instruction. The lab features a wide assortment of sensors that detect movement, proximity, touch, and light. It also contains hardware and software necessary to use that sensor information to cue (directly or indirectly) sounds, projected images, video and three-dimensional computer animations, stage lighting, motors, and any other electrical device. The most sophisticated of these technologies is a six-degree-of-freedom motion capture system, which I describe in greater detail below.

The interactive technologies used in the lab are giving rise to new art forms that defy traditional disciplinary boundaries. One of the goals of the IPL is to allow students to investigate the dramatic potential of such art forms. In many of the works produced in the lab, spectators interact with virtual or robotic characters; some pieces operate on a less literal level to invoke only the suggestion of character or the hint of dramatic action. These interactive sculptures and installations are designed not for theatres but galleries and site-specific settings. A second goal of the IPL is to explore ways of using interactive technology to stage dramatic texts in traditional theatre settings. While I regard both aspects of the IPL's work to be equally important, the remainder of this essay will focus exclusively on the latter avenue of research.

The IPL has two primary objectives for its theatre experiments: 1) to incorporate digital media into theatre without compromising the spontaneity of live performance and 2) to make the media dramaturgically meaningful—in other words, to use the media only insofar as they enhance the meaning of dramatic texts. Key to this second objective is selecting texts for which the technology is integral to a compelling directorial interpretation rather than using the production as a pretext for showing off the technology.

To date, I have directed three productions in conjunction with the IPL.⁶ Each production explored a different set of relationships between the performance and the media, with the media becoming increasingly pervasive and interactive.

Mediated Interactions: *Hair*

In 1968, the rock musical *Hair* was remarkable for its timeliness, both in form and content, especially in comparison with previous mainstream Broadway musicals. It addressed urgent social issues such as the Vietnam War, the hippie movement, recreational drug use, and race relations, and it embraced contemporary musical idioms such as rock and the experimental performance techniques of groups such as the Living Theatre and Open Theatre. But by the time the IPL produced *Hair* in the Fall of 1997, the play had become a period piece. One of my greatest challenges as a director was to find ways to make the play vital, fresh, and relevant to an audience consisting mostly of students not even alive when *Hair* was written. The IPL's use of interactive technology was, in part, a response to this challenge. The production used computer-generated animations and digital video compositing to bring the audience into the minds of the characters, in particular by externalizing the sensations and images of drug-induced hallucinations.⁷

The production included two sequences incorporating digital media. The first occurred during an original ten-minute prologue set in 1997.⁸ This prologue frames the musical as an extended flashback to Berger's past life. Berger, former leader of the tribe of young hippies and now close to fifty years old, has come to UGA to lecture about the values and lifestyle he has long since renounced and to promote his new book, *Get a Haircut: The Myth of '68*. What appeared to be a slide of Berger's youthful hippie self was projected behind Berger as he talked. At one point the slide suddenly came to life and announced that the drugs that Berger took in his youth "never get out of your system." After bursting into a psychedelic flow of colors and images, the slide reverted to its initial frozen pose. It came to life twice more to respond to the actors and ultimately helped to convince Berger to embrace his past and rejoin his old tribe. This scene playfully violated the audience's assumptions about the ontological status of the projected image. The jolt the audience experienced did not result merely from the unexpected motion within the ostensibly static image but more profoundly from the ability of this image from the past to interact with the present.

The most extensive use of media in the production spanned an eighteen-minute sequence of short scenes and songs in the second act. This sequence depicted the tribe's collective drug trip the night before Claude goes to Vietnam. The actors and band performed all the songs live during this sequence, which began with a large rear-projection screen filled with stars and planets. Images of six actors drifted weightlessly in and out of the frame along with objects such as a shimmering peace symbol and LBJ's head (figs. 1 and 2). In front of the screen, the same six actors sang that their bodies were "floating in space." In this scene, the world of the performers and the screen existed on parallel planes without interacting. In the scenes that followed, the boundaries between performer and screen blurred. For example, at one point the live Claude leapt behind the screen,



FIG. 1. Zachary Taylor, Star Scott, and Jocelyn Walters in media still from the University of Georgia production of *Hair*. Composite image: Scott Stevens.



FIG. 2. Jocelyn Walters and Star Scott in media still from the University of Georgia production of *Hair*. Composite image: Scott Stevens.

and instantly his image appeared onscreen spiraling downward into a swirling vortex, as if Claude had magically crossed the threshold from stage to screen (fig. 3). At another point, an animation of Abraham Lincoln moved off the screen, and a twelve-foot wooden puppet identical in design appeared onstage, creating the illusion that the figure crossed from the two-dimensional world of the screen into the three-dimensional world of the stage. An image of John Wilkes Booth then appeared on the screen and fired his gun at the puppet, which fell to the stage with a loud thud. In this case, an animated action seemed to produce an effect in the real world. Other scenes reversed that dynamic, as when live actors playing stereotypical American Indians shot imaginary arrows at animated soldiers on the screen, exploding the soldiers into red, white, and blue streamers.

The most significant technical and creative challenge was to maintain the spirit of immediacy and improvisation vital to the play. Rather than forcing the live performers to conform to a linear video sequence, the projected animations had to adapt to the timing of each individual performance. We achieved a tight integration between media and performers by dividing the media into several hundred still images and short digital video clips and “playing” the images with a MIDI keyboard offstage. In some cases a single video was as long as a couple of minutes, but most of the media cues came at a fast and furious pace. The



FIG. 3. Ed Hohlbein (Claude) in media still from the University of Georgia production of *Hair*. Composite image: Scott Stevens.

offstage keyboard player fulfilled much the same function as the i.e.VR's "Virtual Environment Driver" (VED). "By monitoring the live actors," Lance Gharavi explains, "the VED [in the i.e.VR production of *The Adding Machine*] was able to freely interact with them, adjusting for their movements and fluidly and expressively manipulating the world around them" (257). Both the i.e.VR's VED and *Hair*'s keyboard player mediated the interaction between the live performers and the projected media, rather than allowing for a direct interaction. Nonetheless, using this technique, one can make the media highly responsive to the live events. For example, during one section of *Hair*, as singers rapidly sang out names of colors, the appropriate colors splashed on the screen in rhythm to the music; during another, animated mouths opened and closed in synch with the speech of the live performers.

If These Walls Could Talk: *Kaspar*

The IPL presented Peter Handke's *Kaspar* (1968) as its second full-scale production in the Spring of 1999. Handke's text draws its inspiration from the true story of Kaspar Hauser, a teenage boy who mysteriously appeared on the streets of Nuremberg in 1828 after having spent his entire life confined in a small cellar without any human contact. He had to learn everything from scratch: how to talk, use silverware, wear clothes. Handke's play depicts the indoctrination of an unsocialized adult into society. The play radically abstracts the narrative, stripping Kaspar's story of all historical specificity. Indeed, the play is devoid of all realistic context; it transpires entirely in the theatrical present, with no hint of a past or a future. As Handke observes in the play's introduction, "The play *Kaspar* does not show how it REALLY IS or REALLY WAS with Kaspar Hauser. It shows what IS POSSIBLE with someone" (59).

Technology is integral to Handke's play. For the first half of the play, the actor playing Kaspar is alone onstage as a group of "prompters" monitors everything Kaspar does. These prompters, who reveal nothing about themselves, bombard Kaspar with assertions, syllogisms, clichés, and questions that model various kinds of speech acts without having any real content. They do not function as individual dramatic characters. Handke does not even divide the prompters' text among different voices; he delegates that task to the director. Neither Kaspar nor the audience ever sees the prompters. They exist only as disembodied voices emanating from speakers. For Kaspar himself, who has never seen another human, it must seem as if the room itself were speaking, as if the space had agency.

The IPL production expanded on the notion of technologized space implicit in Handke's text. A pair of Macintosh computers generated sounds and projected images, controlled LED lights planted in the actors' costumes, and tracked sensors built into the furniture.⁹ This use of technology was integral to the production's interpretation of Handke's play. The technologically rich, intelligent environment of the stage manifested the prompters' all-encompassing, anonymous, inhuman

control over Kaspar. The production portrayed the dystopic potential of the very technologies it employed, in effect using the technology against itself.

Throughout most of the play, the image of an eyeball filled a lens-shaped projection screen at the back of the stage. This eyeball, controlled by an offstage computer operator, followed Kaspar wherever he went, suggesting the prompters' inescapable surveillance (fig. 4). Periodically the eye closed and the screen displayed words and images for Kaspar's benefit. For example, at one point in the play the prompters deliver model sentences for Kaspar to emulate. In the IPL production, a projected image of Kaspar's face mouthed these sentences, moving its lips to the prompters' (male and female) voices (fig. 5). At another point, as the prompters encouraged Kaspar to arrange the haphazardly scattered pieces of furniture into a conventional domestic configuration, a schematic image of each set piece appeared on the screen in its proper position and flashed until Kaspar repositioned the designated object correctly.

In the examples of media in *Kaspar* I have discussed so far, the interactions between the live performer and media were mediated by a computer operator, much as they had been in *Hair*. Elsewhere in the production, however, we used sensors to produce unmediated interactions between the live performer and the media.

The sensors came into play most extensively during an early scene in which Kaspar first investigates each piece of furniture onstage, one at a time, with no preconceptions about these objects' conventional purpose. My desire to direct the play grew out of my ideas for this scene, which was at the heart of my concept for the production as a whole. The text is very specific about how the actor is to interact with each set piece: Kaspar slides a drawer in and out, pushes a chair around the room, rocks a rocking chair, unscrews the legs of a three-legged table, etc. Kaspar learns to individuate the objects by developing relationships with them, interacting with them as characters, learning from them. The play provides the prompters with language to accompany Kaspar's interactions with each set piece. The printed text adopts an unusual convention, printing the stage directions for Kaspar in a left-hand column and the corresponding lines for the prompters to the right. The prompters' language intervenes to define Kaspar's relationship with the physical objects. In effect, the prompters lend their voices to the objects, transforming the objects into extensions of themselves. The entire room becomes a cyborg presence.

As a director, I was fascinated by the three-way interaction among Kaspar, the set pieces, and the prompters' language. To sharpen this interaction, I wanted to find a way to allow the voices to respond automatically to Kaspar's actions. We selected specific sensors that could detect when each set piece was handled in precisely the way Handke's stage directions specify. For example, we used an accelerometer to sense the movements of the rocking chair, and pressure-sensitive resistors to detect when Kaspar pressed on the cushions of the sofa. These sensors fed directly into a computer that played the appropriate audio sequences

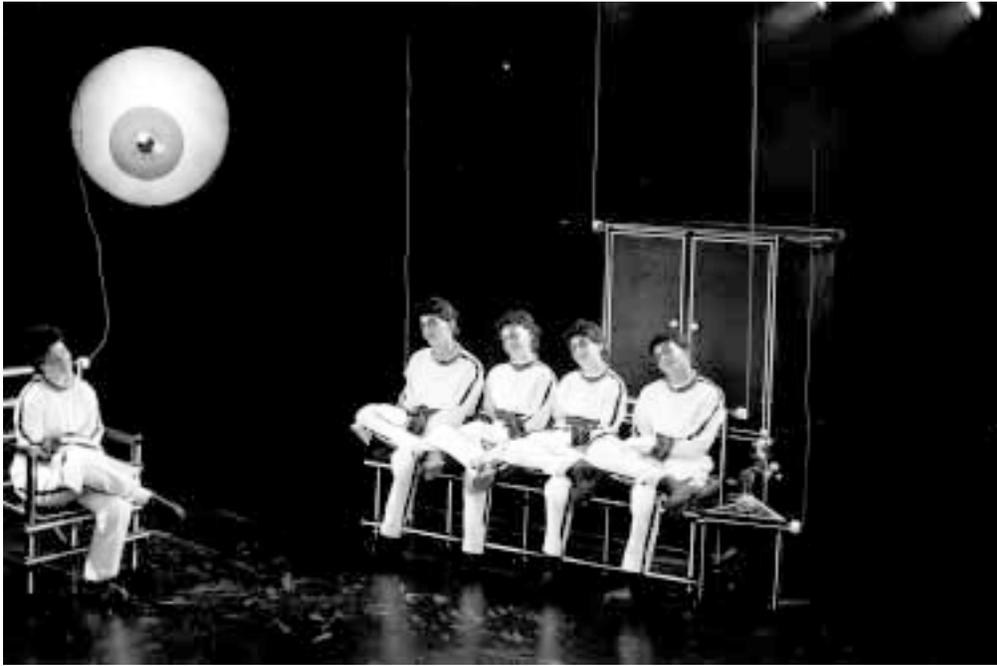


FIG. 4. Lisa Cesnik, Jeff Borck, Emily James, Sarah Schindler, and Erik Landgren in the University of Georgia production of *Kaspar*. Photo: Bradley Hellwig.



FIG. 5. Adam Voss (Kaspar) in the University of Georgia production of *Kaspar*. Photo: Bradley Hellwig.

when, and only when, Kaspar was interacting “appropriately.” For example, the instant Kaspar rocked the rocking chair, the audience heard the corresponding text through the speakers; the instant he stopped, the words stopped. In this way, the interactive technology transformed the set into a large Skinner box that conditioned Kaspar by automatically reinforcing all and only correct behavior.¹⁰

Similarly, during the scene in which the prompters first train Kaspar to speak, we used Kaspar’s own voice to trigger the media. Kaspar gradually discovered that he could turn the prompters’ voices off simply by speaking and that the voices would resume as soon as he silenced himself.¹¹ This mechanism provided what behavioral psychologists call “negative reinforcement”: the desired behavior (Kaspar’s speech) halted a negative stimulus (the prompters’ relentless torrent of language). As soon as Kaspar gained confidence in this convention and began to enjoy control over his environment, the prompters reversed the rules and used Kaspar’s voice as an on switch instead: the prompters’ voices began when Kaspar started talking and stopped when he stopped. By linking the prompters’ speech to the technology in this way, the production intensified what Handke calls the prompters’ “speech torture,” the process through which the prompters break Kaspar down in order to build him up in their own image (59).

It would have been pointless to incorporate functional sensors into the set if the audience did not recognize that the set was wired and that the environment was responding directly to Kaspar’s actions. Bright red cables connecting the set pieces to the computers became a prominent feature of the set design, designed by MFA student Jason Lake. In the beginning of the play, cables extended from each set piece to the lighting grid in crisscrossing diagonal paths, like strings in a Richard Foreman production. Eventually, after Kaspar arranged the furniture in accordance with the prompters’ specifications, each cable extended straight upward, producing a strictly ordered pattern of parallel lines. The cables, then, functioned both semiotically and practically, with the semiotic function highlighting the practical one.

The image of the cables, however, could not in themselves convey the real interactivity of the environment to the audience. The audience had to see Kaspar himself discover that interactivity as he tentatively explored, and then eventually mastered, the artificial world around him. In other words, for extended portions of the play, the technologized objects functioned as the live actor’s acting partners. Consequently, the interactive technology was not something that we could add, along with the stage lighting, during final technical rehearsals. The actor simply could not rehearse long stretches of the play before the technology was, at least roughly, in place. He began to work with prototypes of the set pieces, the sensors, and the media they triggered from the very first rehearsals. This production reinforced a general principle about the use of interactive technology in performance that I call “the paradox of the interactor”: the more rigorously the performer has rehearsed with the technology, the more clearly the audience

will recognize the ability of the environment to respond dynamically and spontaneously to the performer's actions. The performer must teach the audience to understand the conventions that define the interactions by starting slowly with the simplest interactions (e.g., "the sound plays only while I am rocking this chair") before moving on to more complex interactions.

Real Time Motion Capture: *The Tempest*

What initially drew me to *The Tempest*, which I directed in the Spring of 2000, was the challenge of depicting the play's magic, and in particular, Ariel, its ultimate embodiment. Many interpretations stress the juxtaposition of Ariel and Caliban, construing those figures as antithetical and complementary. That emphasis is legitimate but ignores the fact that Ariel exists on a different plane of reality than the other characters, including Caliban. Ariel is not a flesh and blood being; he is an insubstantial "airy spirit" with no fixed form, invisible to everyone except Prospero, the only character aware of his existence. He has the ability to appear and disappear in a flash and transform himself into any form he desires. How can a human actor represent the ethereal nature of this character? Technology has always been a key element of this play: stage directions in the 1623 Folio call for various "quaint devices" to accomplish Ariel's feats. The quaint devices of present-day interactive technology are uniquely suited to meeting the play's challenges.

The use of digital media in the IPL production was not merely a technical device for creating stage spectacle. More importantly, it helped demonstrate my view that Prospero's particular brand of magic is rooted in mind control: Prospero, through Ariel, manipulates the other characters' perception of reality. The magic in the play offers a metaphor keenly relevant to our postmodern world, where reality is constantly being remade and "spun" by a vast media machine. Digital media, in particular, are becoming increasingly potent and pernicious tools, lending an uncanny aura of authenticity to images altered or manufactured out of whole cloth.

An enormous rear projection screen, 32' wide by 18' high, dominated the set of the IPL production designed by Allen Partridge. Two large rocks flanked the screen. In the shadow of one rock, Prospero secretly surveyed the island through a large periscope-like device. Atop the other rock was a small cage holding Ariel, serving as a constant reminder of Ariel's involuntary servitude to Prospero. The large center area in front of the stage, which we called the "sound stage," was empty except for two small rocks. The majority of the play's scenes, and in particular all the scenes featuring the island's shipwrecked visitors, took place in this space (fig. 6).

In my interpretation, virtually everything that the characters saw while on the island was a fiction carefully crafted by Prospero. The island environment was an illusion created by digital video images that filled the large projection screen.



FIG. 6. Scene design rendering by Allen Partridge for the University of Georgia production of *The Tempest*.

These virtual settings were not static but contained subtle movements: waves slowly rolled in and out, trees and grass swayed gently in the wind, and butterflies fluttered past to punctuate romantic moments.¹² As the characters moved throughout the island (or at least thought they were moving throughout the island), the landscape reflected changes in location as well as in weather and time. These virtual scene changes and the movements within them were triggered using an offstage MIDI keyboard, precisely as in *Hair*. We used this same technique for special effects throughout the production. For example, a food-filled banquet table appeared to tantalize the nobles in Act Three, fantastic animated creatures performed a wedding ceremony during the masque in Act Four, and a video image of Miranda and Ferdinand playing chess appeared inside an oversized moon in Act Five.

By far the most interactive aspect of this production, however, was its use of real time motion capture technology, to the best of my knowledge the first

use of this kind of technology in a live dramatic production. We enlisted motion capture technology to solve the problem of representing Ariel's incorporeal nature and her magical abilities. Motion capture technology allowed us to cast Ariel both as a computer animation and a live actress simultaneously (we cast a woman in the role). It put the live actress in direct control of the animation's speech and movements, preserving Ariel's ability to respond dynamically to the events onstage.¹³

The live actress performed in full view of the audience with sensors strapped to her head, wrist, elbows, hands, waist, knees, and ankles. These sensors transmitted detailed information about the actress's movements to a computer that produced the three-dimensional animations of Ariel. These real time animations were projected onto either the large screen behind the sound stage or onto a smaller screen (4' wide by 5' high) inside Prospero's cell (fig. 7). Voice recognition software matched the actress's phonemes in real time, allowing the animation's lips to move automatically in sync with the actress's voice. The only aspect of the animated Ariel's performance not directly under the live actress's control was its facial expression, which an offstage operator controlled.

The other live actors never acknowledged the live Ariel in her motion capture suit. When they interacted with Ariel, it was always with the projected animations she guided. The only exception came at the end of the play, when Prospero finally sets Ariel free: Prospero liberated Ariel by opening her cage and removing



Fig. 7. Marshall Marden (Prospero) in rehearsal for the University of Georgia production of *The Tempest*. Photo: Peter Frey.

the sensors from her body, at which point the actress ran through the audience and out of the theatre, leaving Prospero alone in an empty, media-free world, his “magic” gone.

The most extensive interactions were between Ariel and Prospero. To rehearse these crucial scenes, I adopted a very different strategy from the one used for *Kaspar*. While in *Kaspar* I used the interactive technology in rehearsals from the beginning of the process, in *The Tempest* I deliberately put off lengthy rehearsals with the technology until very late in the rehearsal process. The reason for this difference was that in *Kaspar* the primary interaction was between the actor and technology, while in *The Tempest* the primary interaction was between the two live actors. Jennifer Snow, who played Ariel, worked with the motion capture system in the lab for a few hours early in the rehearsal process to get a feel for the physical constraints the sensors imposed on her movements (fig. 8). Even more importantly, she explored the way her movements looked when mapped onto the three-dimensional animation’s body and developed a vocabulary of movements that comfortably fit her virtual body and expressed her character’s intentions, attitudes, and emotions. She returned to the lab periodically after those early sessions to continue practicing with the sensors (figs. 9 and 10).

The vast majority of her rehearsal work, however, was in a technology-free space, where she worked with the actor playing Prospero. In these rehearsals, she stood in the position the animated projection would eventually occupy rather



Fig. 8. Vincent Argentina (Motion Capture programmer) and Jennifer Snow (Ariel) in rehearsal for the University of Georgia production of *The Tempest*. Photo: Peter Frey.



FIG. 9. Marshall Marden (Prospero) and Jennifer Snow (Ariel) in rehearsal for the University of Georgia production of *The Tempest*. Photo: Peter Frey.



FIG. 10. Jennifer Snow (Ariel) in rehearsal for the University of Georgia production of *The Tempest*. Photo: Allen Partridge.

than the position on the opposite side of the stage, in Ariel's cage, that she herself would occupy during the performances. In the actual performances, Snow would not be able to look in Prospero's direction; since she would be controlling the animation's every movement and gesture, she would have to assume the poses appropriate for the animation projected across the stage. Consequently, she would need a clear image of each moment of each scene from the animation's perspective. For example, when Prospero was stage left and slightly downstage of the projected animation, Snow herself was far stage left and slightly upstage of Prospero: if she really looked at Prospero, the animation would appear to look away. Moreover, she needed to be keenly sensitive to the actor playing Prospero so that she could adapt her performance spontaneously to the subtle variations in his performance each night, relying almost entirely on his voice to cue her responses. Our rehearsal strategy required a great leap of faith on the part of both the actress and myself. Happily, the strategy proved more successful than I had dared hope. Snow effectively internalized the long hours of face-to-face rehearsals and adapted with remarkable ease to her station across the stage from Prospero.

In the scenes between Ariel and Prospero, the live actress's movements mapped literally onto the animation's movements. In other words, when the actress raised her left arm, the animation's left arm went up. In some of the other scenes, however, we processed the sensor input less literally. For example, during the wedding masque in Act Four, Ariel, in the form of the goddess Ceres, danced with Miranda and Ferdinand. The Ceres animation divided into two and was later joined by two images of the goddess Juno so that ultimately four animations danced together on screen, all controlled in real time by Snow. When Ariel assumed the form of the monstrous harpy, whose beaked face filled the entire projection screen, the actress's side-to-side and up-and-down head movements transferred directly to the animation. The forward-and-back motion of the head, on the other hand, was linked to the actress's voice: the head automatically moved closer as the voice grew louder.

Similarly, when Ariel sang, she often assumed the form of an undulating bubble that the actress moved around the screen with her hand. We used the voice recognition software in this case to change the shape of the bubble, with each phoneme creating a different shape and the volume of the voice modifying the size. The most unusual application of the motion capture technology occurred at the very top of the play when Ariel creates the tempest. The scene takes place on the deck of the ship; the projection screen at the back of the stage showed the stormy sea behind the characters. Snow held her arms in a crucifix pose, creating a line parallel to the horizon. Her arms represented the surface of the ocean, and as she swayed side to side and pitched forward and back, the sea moved with her. In this way, the actress "played" the sea, which became not merely an inanimate setting but an active agent.

The Relationship between Performer and Media: A Taxonomy

This last example, in conflating the roles of scene and agent, serves as an apt metaphor for the changing relationship between media and live performance in the theatre today. Up until now, media in the theatre (digital or otherwise) have most often been construed as a design element, a cross between lighting and scenery. In the work of pioneers such as Josef Svoboda, and more recently in Mark Reaney's virtual reality scene designs at the University of Kansas, the media function primarily as virtual scenery to define the environment within which a live performance takes place.

This way of conceiving the relationship between live performance and media, while entirely valid, is severely limited. As I experiment with interactive media in my own productions as well as in the classroom, I have become increasingly impressed with the variety of roles they can play within a performance event. In my own productions, I have distinguished between at least twelve ways of defining the relationship between performance and media. Note that I define these relationships in terms of media in general, not merely interactive media. Any of these performer/media relationships can be enhanced through the use of interactivity, but none of them requires it. I offer this list as the beginning of a general taxonomy, neither exhaustive nor mutually exclusive.

Virtual Scenery. The media provide a backdrop depicting the environment within which the staged action takes place. This virtual scenery can either be static or animated. The projected island landscapes in *The Tempest* exemplify this use of media in performance.

Interactive Costumes. Interactive costumes invert the relationship established by virtual scenery: while virtual scenery provides a backdrop against which the live actors perform, interactive costumes use the body of the live performer as a canvas for the media. For example, the choreographer Alwin Nikolais painted his dancers with changing patterns of light, and the Gertrude Stein Repertory Company is currently experimenting with the projection of video images on masks. During the final scene of *Kaspar*, nine Kaspar Doubles came onstage and ritualistically donned black muzzles; a row of LED lights was sewn into each muzzle, and they all blinked in the same changing pattern in sync with a computer-generated musical score that grew to a crescendo until the final moment of the play.

Alternate Perspective. The media depict the events enacted onstage from another visual perspective. During a scene in *Hair*, as actors jumped out of an imaginary helicopter into the wings, on the screen the audience saw silhouetted images of men in parachutes falling out of a helicopter to show the events from another perspective.

Subjective Perspective. The media depict the thoughts, fantasies, dreams, or sensations of some or all of the characters onstage. The image of Claude

falling into the vortex clearly exemplified this use of media, as did an extended nightmare sequence in which Claude imagined a series of pop culture icons (including the Beatles, Bugs Bunny, Superman, and Mighty Mouse) annihilating one another.

Illustration. The media illustrate the performer's words. A common impulse, this use of media can in certain instances be effective. Too often, however, it is merely redundant. I discourage students from using media this way in their projects and usually eschew such use in my own productions. Nonetheless, I have at times resorted to illustrative media, as in *Hair* when actors sang "my body is floating in space" while the audience watched images of their bodies doing just that. This use of media, however, had a dual function, serving not only as a literal illustration of the lyrics but also as an expressionistic doorway into the characters' hallucinations.

Commentary. The media have a dialectical relationship with the stage action or serve as epic commentary on it. Erwin Piscator's use of slides and documentary film clips as a stage director in the 1920s provides the model for this use of media, which the Federal Theatre Project's "Living Newspapers" of the 1930s famously emulated.¹⁴ *Hair* provided a straightforward example of media as commentary when, as two live actors sang "What a Piece of Work Is Man," video clips and still photographs depicting the brutalities of the Vietnam War appeared on the screen, highlighting the lyric's irony.

Diegetic Media. Diegetic media exist as media within the world of the narrative—when, for example, a character onstage turns on a radio or television set. Kaspar did not perceive the images of furniture on the screen as real furniture in the room but as representations created by the prompters for his instruction. In *The Tempest*, Prospero's private cell contained two small video monitors that replicated whatever was being projected on the large screen. The purpose of these monitors was to make clear to the audience that the island landscapes, which all the characters but Prospero and Ariel accepted as real, were actually images manufactured by Prospero. Hence, not only were the images on the monitors themselves examples of diegetic media, but more importantly, the monitors served to alienate the audience from the images projected on the large screen, transforming those images from virtual scenery into diegetic media.

Affective Media. The media produce an emotional effect on an audience. Affective media are nondiegetic; they do not exist within the character's world. The most familiar form is the background music that gave melodrama its name, now ubiquitous in film. While affective media is most often auditory, visual media can also be used for this purpose. In *The Tempest*, Prospero used his magic staff to give Caliban cramps. As Caliban writhed in pain, a deep red glow pulsated over the virtual landscape.

Synesthesia. Synesthetic media are similar to affective media, but do not serve so much to tell the audience how to feel about the events onstage as to

mirror the performance in a different sense modality. Synesthesia is a neurological condition in which stimulating one sense organ triggers the experience of another sense; for example, a person might “hear” colors or “see” temperature. The undulating bubble in *The Tempest*, which automatically changed size and shape in response to Ariel’s voice, was a classic example of synesthetic media. The animation functioned here as a picture of the sound, translating the music’s rhythms, tone, and intensity into images.

Instrumental Media. Interactive technology is used to create new kinds of instruments. For example, one could cover the stage floor with pressure-sensitive tiles and program each tile to produce a different sound or different image when a performer steps on it. This use of media is similar to synesthesia in that it can track the performer’s actions very closely. However, in semiotic terms, synesthesia is iconic, while a virtual instrument is symbolic: the relationship between action and effect can be entirely arbitrary, as long as it is predictable. In effect, each sensor-enhanced set piece in *Kaspar* was a different instrument; once Kaspar learned how it worked, he had complete control over when the audio played. These instruments, of course, were very crude, allowing Kaspar only to turn the sound on or off.

Virtual Puppetry. The media create a performer’s double. For example, the animations of Ariel in *The Tempest* were virtual puppets that the live actress controlled with the motion capture system. Just as synesthesia blurs into instrumental media, instrumental media blur into virtual puppetry. The difference is that while an instrument is an extension of the performer, a kind of expressive prosthesis, a virtual puppet functions as the performer’s double. In other words, instruments are something performers use to express themselves (or the characters they play); a puppet is a virtual performer in its own right. This difference is clearest when one considers how the performer’s own voice functions in the two cases. When a performer sings while playing an instrument, the audience does not associate the voice with the instrument but with the singer. The instrument “accompanies” the singer. By contrast, one would not say that a puppet “accompanies” a puppeteer. Rather, a puppeteer, such as the actress playing Ariel, gives her voice to the puppet.

Dramatic Media. This type of media representation functions dramatically by interacting with the performers as a character in the narrative.¹⁵ *Hair* provided a number of simple examples, such as when the live Indians shot arrows at animated soldiers and when the animated Booth fired his gun at the live Lincoln. *The Tempest* took the dramatic use of media much further. While the relationship between the computer animation and the actress playing Ariel was one of virtual puppetry, the relationship between the same animation and the other characters in the play was dramatic. The animated Ariel was a full-fledged character in the world of the play.

Live Media

The IPL productions offer examples of all twelve media/performer relationships that I have outlined. The primary focus of the IPL's theatrical experiments, however, has been on the last type of relationship. The holy grail for me as a director is to produce a dramatic relationship between performer and media, to grant media real agency, casting them in a role on par with the live performers. Interactive media technologies put this objective within reach for the first time.

When live performers and media interact dramatically, a fascinating ontological question arises: is interactive media itself "live" or not? Consider the case of the Ariel animation in *The Tempest*. This image is surely not live in the sense of being a flesh and blood human. In fact, it is not a physical object at all; it is a purely virtual artifact. The animated image of Ariel is not even live in the sense that a television broadcast can be; it is not a photographic or televisual index of an absent human being but the creation of a digital artist. At the same time, though Ariel's physical presence is not live, its actions are by virtue of not being prerecorded. The animated Ariel has the same capacity to react, improvise, and make mistakes that a live performer does.

Granted, Ariel's liveness derives from the liveness of the flesh-and-blood performer who controls it. How would Ariel be affected if it did not rely on a human controller? What if Ariel were an autonomous software program, a "bot" with artificial intelligence, capable of generating performances on its own? As long as the programming were sophisticated enough to adapt in new and meaningful ways to unanticipated variations in the live actors' performances, such an Ariel would be live in precisely the same way as the motion-capture controlled Ariel is. Allucquère Stone provides a compelling description of interactivity as "two agencies in conversation, playfully and spontaneously developing a mutual discourse" (11). As media becomes truly interactive in that sense (with or without the help of motion capture), it no longer stands in opposition to live performance. On the contrary, it becomes a species of live performance. For better or for worse, the age of frozen media is coming to an end. An age of interactive, live media is upon us.

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Notes

1. Brenda Laurel, in her 1991 book *Computers as Theatre*, was one of the first to draw attention to the close connection between interactive digital technology and theatre. As Matthew Causey and Charles Lyons trenchantly observed in an address to the Fourth International Conference on Cyberspace at Banff in 1994, Laurel's book uncritically adopts a set of reductive neo-Aristotelian assumptions about theatre and drama, which limits

the book's usefulness to performance scholars and practitioners. It is important to bear in mind, however, that Laurel's book does not purport to make a theoretical or practical contribution to theatre. The goal of the book is to offer computer programmers a new paradigm for thinking about user interfaces, and the book has had enormous impact in that arena.

2. In *METAPLAY*, the participants' interactions with the media were mediated rather than direct: Krueger, hidden in another room, watched the participants on a video monitor and drew lines that mimicked the participants' gestures using a stylus on a graphic tablet. By the mid-1970s, Krueger had developed the sensor technology necessary to allow participants to manipulate the video images directly through their own movements, without a hidden facilitator's mediation (Rheingold 119-22).

3. Cultural theorists such as Walter Benjamin and much more recently Philip Auslander regard the cult of the live as an ideological tool of capitalism, and both argue that the aura of liveness is fading in an age of media (which for Benjamin means photography and film, and for Auslander means primarily television). The general tone of my discussion casts liveness in a far less sinister light. But a defense of liveness falls beyond the scope of this paper, and in fact my fundamental position here is neutral with regard to such critiques. In any case, I would argue that interactive technology is reviving the cult of the live in a way that demands close critical scrutiny.

4. I do not mean to suggest that it is impossible to integrate video into live performance successfully. On the contrary, some productions have developed ingenious strategies for using video; the Wooster Group, for example, often exploits the dissonance between the live performance and prerecorded video to great effect (in addition to making brilliant use of closed-circuit video, which does not pose the same problems).

5. The IPL began unofficially in 1997 when I offered a new course called Interactive Multimedia and Performance and incorporated interactive media into the production of *Hair*. A Curriculum Development Grant from UGA officially established the IPL the following year. The lab serves both undergraduate and graduate students, with the most advanced work being conducted by students in the Drama Department's MFA program in Dramatic Media.

6. In 1996, prior to coming to UGA, I directed an environmental production of nine Beckett plays at SUNY Stony Brook that used some of the interactive technologies I discuss here to very different ends. See my "Cyborgs."

7. Scott Stevens and John Davis, then graduate students in Dramatic Media, created the animated sequences following a detailed scenario I provided. The animations, along with digitized video images of actors shot against blue screen, were composited in Adobe After Effects. The production incorporated approximately twenty minutes of digital media, which took over two hundred work hours to produce. During the performance itself, a MIDI keyboard triggered each short segment of animation in real time. The keyboard was connected to a Power Macintosh running Arkaos X<>Pose "Visual Sampler" software.

8. This prologue was written by MFA playwriting student Josh Krach.

9. MFA student Vincent Argentina created the animations for *Kaspar*. Macromedia Director ran on one Power Macintosh for the operator-controlled media sequences, and Cycling74 Max/MSP software ran on a second Macintosh for the sensor-driven sequences and to synchronize the flashing LEDs built into costumes with computer-synthesized music. An Infusion Systems i-Cube was used to interface the sensors and LEDs to the Macintosh.

10. A Skinner box is a device invented by the behavioral psychologist B.F. Skinner that automatically trains animals to perform complex tasks by reinforcing particular behaviors.

11. We accomplished this effect by concealing a mechanical switch in the arm of a chair. The actor simply squeezed this switch whenever he was speaking. Ideally, we would have used the actor's voice itself as a switch. However, though it would be easy for the computer to monitor the sound level onstage with a microphone, this microphone would also pick up the sound of the prompters, and so the prompters' own voices would switch themselves off. The switch built into the chair turned out to be a very effective solution, and the actor quickly learned to press the switch whenever he spoke without thinking about it.

12. UGA faculty members Michael Hussey and Allen Partridge created the animated backdrops.

13. We used a Polhemus magnetic motion capture system with eleven sensors. MFA student Jason Quinlan created the three-dimensional models of Ariel using Lightwave, and Vincent Argentina used Kaydara Filmbox software, running on Windows NT, to link the 3-D animations to the motion capture data and to render the animations in real time. We triggered the video loops of landscapes and pre-rendered special effects using X<>Pose software running on a Macintosh and used a video mixer to composite the motion-capture animations from Filmbox into the prerendered video.

14. The originators of the Living Newspapers, most notably Arthur Arent and, to a lesser degree, Hallie Flanagan, denied Piscator's influence. Nonetheless, there is no question that Flanagan at least was very familiar with Piscator's work (McDermott 28-41).

15. Phaedra Bell calls this way of using media in the context of live performance "dialogic media." The defining attribute of dialogic media is "inter-media exchange," which she describes as "the mutual acknowledgement of images produced by separate media and their accompanying interchange of dialogue, glance, attribute, equipment or other currency such that the images cohere and appear to coincide in the same time and space" (44).

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