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Tradition and Innovation

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Technology and Theatrical Innovation

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Clown Bill Irwin provides comic commentary on our fascination with technology as he finds his identity fragmented between his physical and technological selves, in *Largely New York*. Written and directed by Bill Irwin, St. James Theatre, New York.
© Joan Marcus

The human exchange between an actor and an audience is so central to the theatrical experience that we often think of the world of science and machines as antagonistic to live performance. Yet in every period of recorded theatre history, the world of the stage made use of available technology to heighten its expressive power. Every costume, mask, prop, set, and theatre structure requires technical skill and tools to create. Technology is a force in our lives, and theatrical forms use, reflect, and comment on its power.

The curtain rising, sets changing, and lights illuminating the stage were once novel inventions that we now take for granted. The front curtain goes back to ancient Rome; rapid set changes date from the Renaissance; the spotlight was introduced only in the nineteenth century. Electric stage lighting, now an essential design element complementing sets and costumes, was not in wide use until the twentieth century. Innovative artists and engineers brought these new technologies to the stage, inspired by their novelty or their aesthetic potential.

Theatre artists have always made use of available technologies to create stage effects, and often they prompt engineers, technicians, and craftspeople to develop new devices

Artists

IN PERSPECTIVE

JOSEF SVOBODA (1920–2002): VISIONARY ARTIST, TECHNOLOGICAL INNOVATOR

Czech designer Josef Svoboda redefined stage design in the twentieth century. In a career boasting over seven hundred productions at major theatres across the globe, Svoboda brought kinetic sets; expressive lighting; and slide, film, and video projections into an overall aesthetic in which new technologies supported dramatic action. He preferred the title "scenographer" to "designer," feeling that it better expressed his role as a vital participant in creating a comprehensive, active space for performance. For Svoboda "design" suggested beautiful stage pictures conceived in two-dimensional sketches or superficial decoration, whereas "scenography" applied to a conceptualization of space in three dimensions. Filling a stage with vapor or cutting it with strong beams of light was scenography.

Svoboda first gained international recognition in 1958 at the Brussels World's Fair, where he and director Alfred Radok presented two multimedia works, *Polyekran* and *Laterna Magika*. These performances combined multiple projections with sound design and live actors performing ballet and pantomime. The precise coordination of live and recorded elements and Svoboda's new multiscreen projection system made *Laterna Magika* the most popular exhibit at the fair and won it first prize. *Laterna Magika* later lent its name to the Laterna Magika theatre in Prague, which has continued to experiment in this mixed-media format. Svoboda became the principal designer for Laterna Magika in 1973, but the bulk of his innovative design work was accomplished at the National Theatre in Prague, where he served as principal designer

and technical director from 1948 to 1992, and where he would bring his new techniques to theatre and opera production.

Svoboda's training in architecture led him to see space as a primary organizing principle in life and on stage. Moving set pieces that could reconfigure the space during the course of a production were a central motif in his work. For Wagner's *Ring Cycle* at Covent Garden (1974–1976), the main set unit was a large central platform supported by telescopic columns that could tilt in numerous directions. The surface of the platform would transform into stairs at an angle proportional to the tilt whenever the platform tilted more than 15 degrees. The underside of the platform was covered with a mirrored surface, so Rhinemaidens in the trap area under the stage appeared to the audience as a mirrored reflection.

Sometimes Svoboda effected a change of space with projections, a trademark of his work, or with light, an element he crafted with precision. In his design for Chekhov's *The Three Sisters* at the National Theatre in London in 1967, stretched cords hung at the back of the stage were used as screens. With frontal projections, they became a wallpapered interior; with rear projections, a forest with beams of sunlight peeking through.

Svoboda found traditional design sketches and renderings inadequate for conveying his ideas and used kinetic, lit models instead. These models and the exhibits he created for world expositions were a source of the technical innovation he would bring to the stage. His background as a master carpenter and architect gave Svoboda the practical knowledge to turn his powerful artistic visions into theatrical reality. When the available technological instruments fell short of his needs, he invented his own, including the Svoboda light curtain, the Svoboda light ramp, and the Svoboda footlight, instruments he intro-

or techniques. At other times new tools themselves inspire theatrical innovations and lead artists in imaginative new directions. Technology helps stage all aspects of the human experience, from everyday domestic exchanges, to confrontations with natural disasters, fantastic journeys of the imagination, and spiritual encounters with the divine.

We have come to take technology for granted as today's advances are rapidly incorporated into our daily existence and change the way we live. Just think of how the home computer and the Internet have altered so much of our lives. In the theatre, just as in life, each advance opens a realm of expressive potential and spurs innovations that can alter theatrical forms. Today theatre has unprecedented technical means at its disposal.

Media such as film, television, video, and the Internet surround us; they entertain us, educate us, and move us emotionally, as at one time only theatre could do. Now these new media compete with the theatre, find their way into productions, and create the cultural background that frames our theatrical experiences. To understand theatre's relation to contemporary technology, we must appreciate the role technology has always played in both enhancing and transforming theatrical traditions.

duced to theatres around the world. His inventions enabled projections and controlled lighting to become functional elements of stage design. To eliminate light reflecting off the stage floor when projections were used, he tilted the floor backwards and covered it with a non-reflective surface. A specially designed screen gave clarity when projections were used alongside other theatrical lighting. His 1967 design for *Tristan and Isolde* at the Hesse State Theatre in Wiesbaden became famous for its pillar of light created with illuminations of a special aerosol mixture of water vapor and fog droplets holding an electrostatic charge. The light image disappeared when droplets with an opposite charge were released. In reorganizing and modernizing the technical procedures at the Czech National Theatre, Svoboda gave the company the latest equipment and a fully trained staff of over three hundred personnel, support that helped him realize his artistic goals.

Svoboda used the most modern materials and techniques, but saw them only as tools. Without a meaningful theatrical text, these sophisticated techniques to him were merely gadgets. He once claimed that he would design a set with cheese if it was appropriate for the play. Svoboda was also aware that his designs needed to speak to the cultural climate outside the theatre as well as to the play on stage. In a career that extended over some of his homeland's most turbulent sociopolitical times, his visionary theatrical spaces reflected change and the hope for the future his audiences needed in their own lives.

For the 1962 production of Milan Kundera's *Owners of the Keys,* a domestic drama that focuses on a young man's inner struggle with his duties under Nazi occupation, Josef Svoboda used lighting and kinetic sets to accommodate the play's fluid, back-and-forth movement between two realistic rooms and a series of visions that revealed the main character's inner world. The realistic locations, set on wagon stages, evaporated as the wagons were pulled behind a black curtain. The visions, like the one pictured here, were enacted in a space of physical and emotional emptiness, defined by a pyramid of light reflected from a mirror at the top. Directed by Otomar Kreja, Tyl Theatre, Prague.
© Dr. Jaromir Svoboda

What Is Technology?

The word *technology* comes from the Greek *techne*, meaning "skill," "art," or "craft." While *technology* suggests sophisticated, scientific means, it refers more broadly to any technique we use to shape our physical environment and facilitate our cultural practices. Technology sets human beings apart from other animals because it takes us beyond mere biological instinct. Carving stone tools, making fire, weaving cloth, and forging metals are some of the earliest technologies of humankind. Writing is a technology that not only helps us keep track of objects and ideas, but also makes possible new modes of expression. The production of artifacts through technological means is so bound up with our cultural practices that it is impossible to imagine or describe human beings without it. It is equally impossible to describe the world of theatre in the absence of technology. A theatre without technology would consist of a naked actor performing outside without props, sets, or musical instruments, in front of a group of naked spectators seated on the ground.

Even so, some technical devices stand out because they are novelties, create amazing special effects, or require specially trained technicians. They may even threaten to displace the actor as the center of the theatrical event, especially when they incorporate cutting-edge scientific achievements that impress us in their own right, beyond what they contribute to the art.

We can draw a distinction between *low-tech* and *high-tech* devices. These fall along a continuum, and the high-tech devices of one generation may end up being the low-tech devices of the next. The difference between them generally reflects the degree to which they replace human power with nonhuman power. The more high-tech a technology is, the less physical human effort it requires to make it work. Sometimes these devices replace or supplant the human presence on stage, and because theatre essentially features humanity at its center, the introduction of new high-tech elements inevitably raises questions about their influence on theatre as we know it.

The Impact of Technology

When new technologies enter the theatre, we are not always clear how best to exploit their theatrical potential. Artists and technicians may play with them in rehearsal and performance, discover their possibilities, and develop ways to make them work on stage, often through trial and error. Over time, as they prove their worth, the theatre adopts them as general practice. Once the technology is mastered, new personnel train in the field and continue to discover novel ways of bringing out the technology's full theatrical potential.

Audiences also adapt to new technologies. A quick set change captivated Renaissance audiences, but has less impact today. Color washes over the stage permitted by the introduction of electricity to stage lighting astounded early-twentieth-century spectators, but today we expect this effect. New technologies can disrupt the audience's focus on acting and text, but as familiarity grows, they can heighten the effect of both.

Whereas some uses of technology *enhance* production, others *transform* the theatrical form. Technology enhances a production when it works in conjunction with other artistic elements to illuminate meaning. When technology supplants the acting and text, it may transform the theatrical event into something different.

Deciding whether a particular technological element is enhancing or transforming is a subjective matter. It can depend on our general attitude toward technology, our ex-

pectations concerning the theatrical event, and ultimately how we understand the nature of theatre itself. Some theatre practitioners are resistant to new technology because of its potential to eclipse the live performer, while others embrace new possibilities to enhance their productions. In either case, it is impossible simply to ignore the technological changes that continue to reshape our daily lives and their potential influence on how we experience the theatre.

Technology and Culture

Technological devices shape our interaction with the world around us, but they also reveal how we see ourselves within that world. Some theatrical traditions use very few devices and rely on the actor or dramatic language to carry meaning. Others exploit a variety of means to create a theatre of spectacle and illusion. In every historical period, the use of artificial devices on stage has exhibited not just technical accomplishments, but cultural values.

Ancient Greece

The ancient Greeks did not make extensive use of technical devices in their theatrical productions, but the few they did use clearly reflected their cultural attitudes and their aesthetic sensibility. The **mēchanē** was a large hand-powered crane that hoisted actors
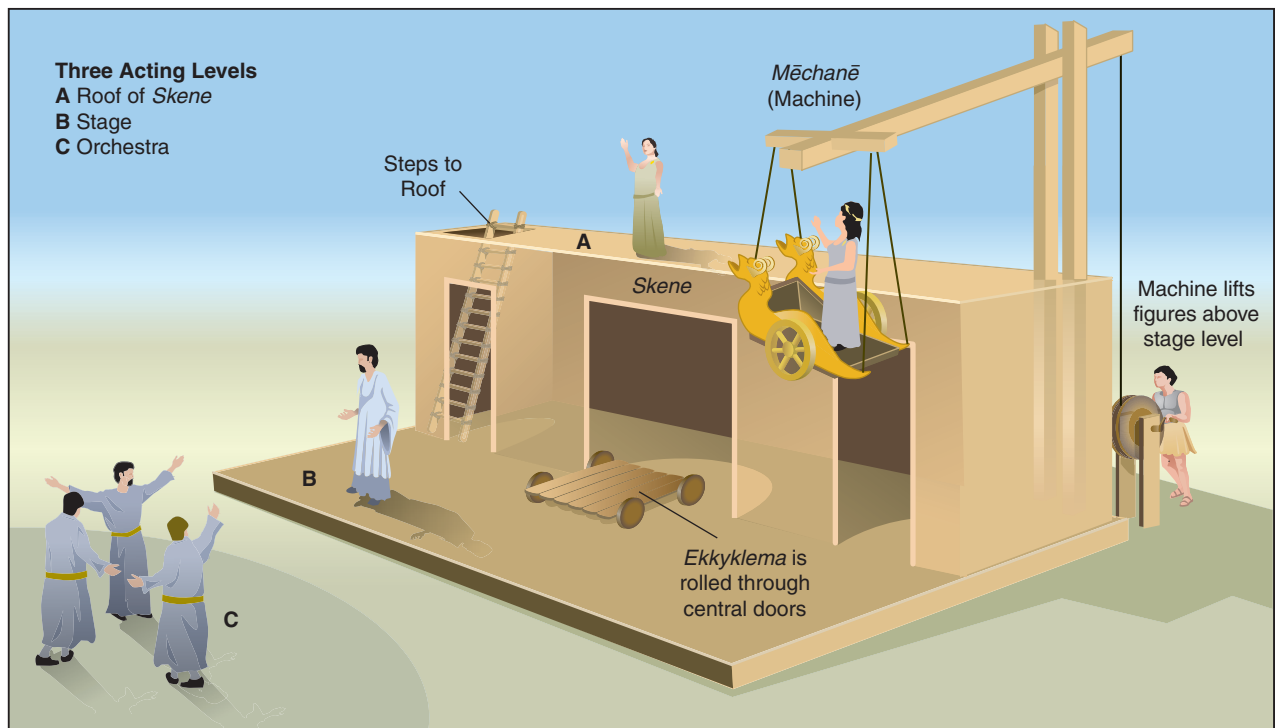

Three Acting Levels
A Roof of *Skene*
B Stage
C Orchestra

Steps to Roof

A

Skene

B

C

Mēchanē (Machine)

Machine lifts figures above stage level

Ekkyklema is rolled through central doors

Figure 14.1 Stage Devices of the Ancient Greek Theatre. The *mēchanē* on the right was a crane used to lift actors playing gods above the *skene.* The *ekkyklema,* a platform on wheels, could be rolled out of the central doors to display a tableau, a visual scene depicting the aftermath of an off-stage event.

above the *skene*, or back wall, of the performance area. The flying actor usually portrayed a god, so the *mēchanē* suggested the gulf between human and divine power (see Photo 3.2). It captured the philosophical issues at the heart of Greek tragedy in a visual theatrical metaphor.

The ancient Greeks also made use of an ***ekkyklema***, a platform on wheels that rolled on stage displaying actors prearranged in a tableau—a staged picture. The Greeks did not like to depict violence on stage, but the *ekkyklema* allowed them to show the aftermath of violent action without showing the graphic brutality that caused it. Aeschylus probably used the *ekkyklema* in *Agamemnon* to reveal the dead bodies of King Agamemnon and Cassandra after they had been caught in a net and stabbed to death by Queen Clytemnestra, although the murders took place off stage. The *ekkyklema* allowed the Greeks to contemplate tragedy as an idea, rather than just a sensational, often bloody, spectacle.

It is impossible to know whether the Greeks first brought these devices into the theatre to accommodate plays already written as we know them, or whether playwrights introduced ascending gods and offstage action in their works because they knew the *mēchanē* and *ekkyklema* were available. What we do know is that both devices were part of Greek theatrical convention and today inform our understanding of that tradition.

Ancient Rome

More so than the Greeks, the ancient Romans were brilliant engineers and tended to be more interested in concrete practical realities than abstract philosophical reflection. Consequently, theatre in Rome was never a forum for social debate, as it was in Greece. During the period of the Roman Empire (27 B.C.E.–476 C.E.), when Rome had an extremely large, diverse population and performances catered to the tastes of the masses, Romans used their engineering skills to create spectacular events. They flooded arenas for theatrical naval displays called **naumachiae** (see Photo 14.1), in which sea vessels did battle on water before spectators, often resulting in real casualties. The Romans also invented the front curtain, back curtain, and sliding scenery. They even developed new ways to accommodate the audience such as retractable awnings at outdoor amphitheaters that protected spectators from rain and sun. The Romans made technology a focus in a theatre of spectacle.

Photo 14.1
This eighteenth-century engraving of a *naumachia* offers one visual interpretation of these ancient Roman spectacles in which flooded arenas were the site of nautical battles. Engraving by Johann Bernhard Fischer von Erlach, part of *Entwurf einer Historischen Architektur,* circa 1721.
© *Historical Picture Archive/ CORBIS*

The Middle Ages

During the Middle Ages, when liturgical dramas took place inside churches and cathedrals, young celebrants costumed as angels adorned with wings and halos were hoisted on ropes and pulleys to the highest rafters to portray God's heaven on Earth. Occasional accidents only reaffirmed the importance of faith in the afterlife. When religious dramas moved outdoors, local guilds constructed pageant wagons that traveled through the town to carry the settings for cycle plays that depicted Christian history from Creation to Judgment Day. Each guild designed and constructed the set for one biblical story, so these productions gave artisans a chance to display their skills to the community. In England the shipwrights' guild staged the story of Noah with a swaying ark. Other effects included fountains springing from the ground, trees withering, and miraculous transformations such as Moses' staff turning into a snake. The Hellmouth, the mouth of a beast representing the entryway to hell, spat out real fire. These Christian religious plays used machinery and special effects to bring God's miracles to life for their audiences.

The Renaissance

The Italian Renaissance prompted new explorations in science and art, and both found their way onto the stage in the form of elaborate, illusionistic perspective sets. Later, between 1641 and 1645, Giacomo Torelli (1608–1678) perfected a system for transforming all the elements of a stage set at once. The **chariot-and-pole system** consisted of a series of ropes and pulleys attached to a succession of painted flat wings set in grooved tracks on the stage and then hitched to a pulley system located beneath the stage. When the gears moved, it pulled the ropes, moving all the flats simultaneously to reveal a new scene instantaneously. This device startled and amazed audiences at the time, both for the magical transformation it effected on stage and for the ingenuity that accomplished it. Torelli's fame led to a royal summons to the court of France, where he introduced his scenic practices.

Figure 14.2 A device to create a Paradise effect for the Feast of the Annunciation, developed by Filippo Brunelleschi (1377–1446) in Florence, c. 1426. A wood structure holding three rings of lanterns representing stars and twelve choir boys dressed as angels, held by iron belts, was hoisted through a pulley system high up into the rafters of cathedrals, and suspended from the church roof. Below this device, eight more angels and the angel of the Annunciation hung from the pictured copper *mandorla,* or almond-shaped structure, also studded with star lanterns, which could be lowered toward the actor playing the Virgin in the church when the annunciation arrives.

The chariot-and-pole system was a perfect addition to lavish court productions that already had glorious sets and costumes created by professional artists and featured music and dance rather than dramatic text. It put new developments in art and science to use for the theatre and seemed to confirm the divine right of the princes who commissioned these entertainments by manifesting heavenly magic in the form of grand theatrical illusion.
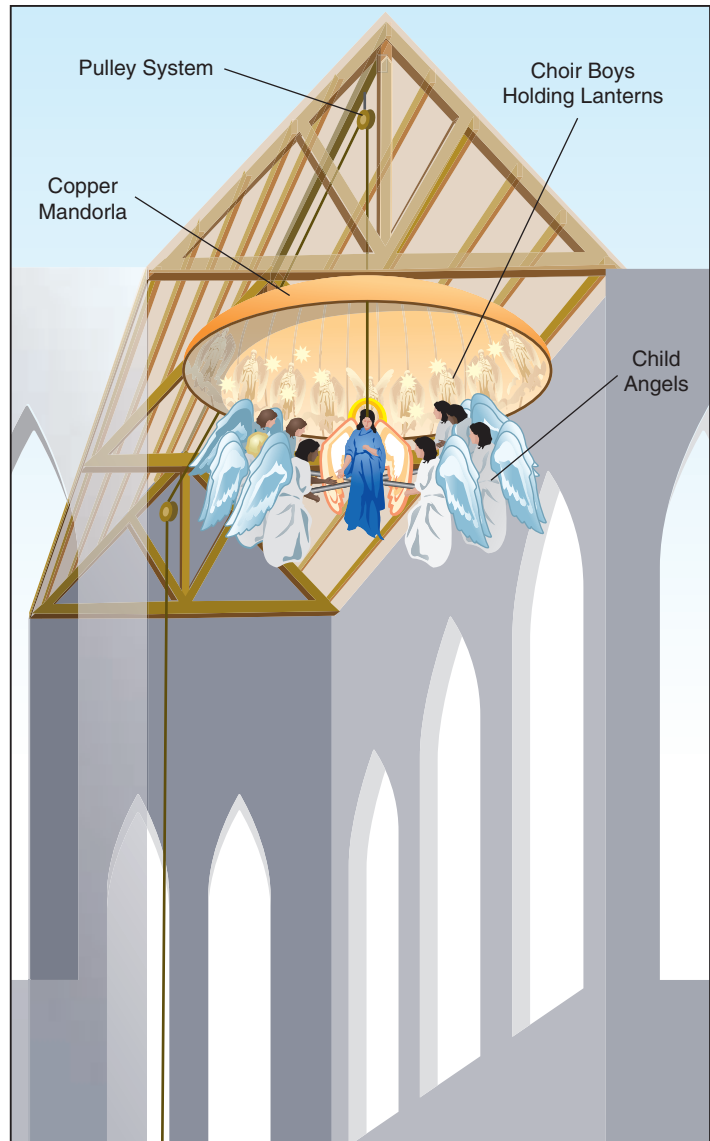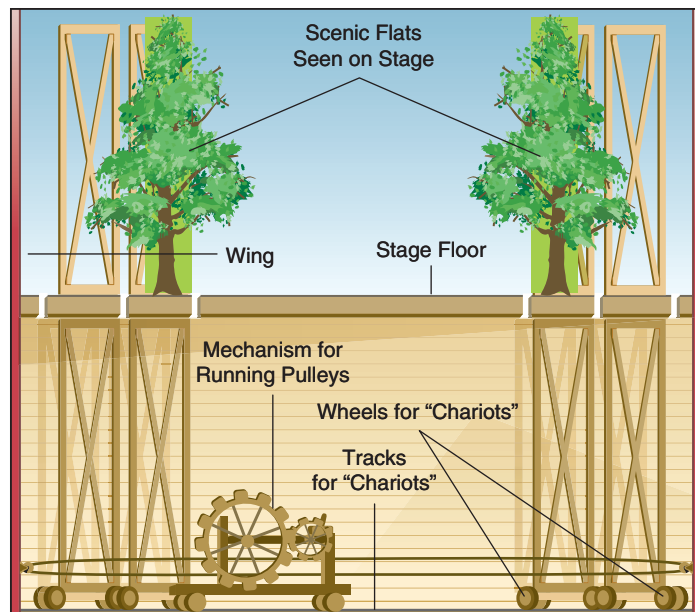
Figure 14.3 The Operation of Giacomo Torelli's Pole-and-Chariot System for Simultaneous Scene Changes.   The scene is actually created by a series of flats along the side of the stage painted to create a receding perspective. The scenic flats are placed in grooves on the stage and can be moved into the wings along these tracks by a system of interconnected ropes and pulleys below the stage. When the mechanism for running the pulleys is turned, one set of flats slides out and another set with a different scenic design rolls in simultaneously, creating rapid scenic changes that dazzled seventeenth-century audiences. Photo 14.2 below shows a Torelli set created through a series of painted flats manipulated in this manner.

Scenic Flats Seen on Stage

Wing

Stage Floor

Mechanism for Running Pulleys

Wheels for "Chariots"

Tracks for "Chariots"

Torelli's position in France was later usurped by Gaspare Vigarani (1586–1663), who created the Salle des Machines. This hall of machines was the largest theatre in Europe, and its curious dimensions led to both its success and failure. Only 52 feet wide by 232 feet long with a stage depth of 140 feet, spectacular effects of perspective were possible through the 32-foot-wide proscenium arch. Unfortunately, technological feats were put before practical needs, resulting in the acoustics being so poor that the theatre was seldom used.

The Nineteenth Century

The nineteenth century saw an increased interest in the application of science to all aspects of life, including the arts. Even popular journals such as the *Scientific American* ran articles on the application of new technologies to the theatre, and one of its editors,

Photo 14.2

Engraving by Pierre Aveline of the forest landscape designed by Giacomo Torelli for the third act of the opera *Venere Gelosa* (Jealous Venus), first performed in Venice in 1643.

Photo from Sveriges Teatermuseum

Albert A. Hopkins, wrote "Magic: Stage Illusions and Scientific Diversions" (1897) to describe scientific applications in performance.

Nineteenth-century American melodrama, with its emphasis on sensationalism as mass entertainment, was quick to draw on the new technologies. Producers kept devising ever more startling stage effects to compete for audiences. *The Mansaniello; or, The Dumb Girl of Portici* advertised its explosion of Mount Vesuvius with burning lava and fireworks as a featured attraction, and *Timour the Tartar* had the hero rescue an unfortunate from the surges of a simulated waterfall.

During the early part of the century, technology itself was often the theatrical event. Audiences would come to see panoramas that encircled them in round buildings. Later, continuous scenes painted on lengths of cloth were wound on spools and unfurled as moving scenes rolling across the stage behind stationary objects such as ships or carriages that appeared to be changing location. This technique can be seen in many films. Louis-Jacques Daguerre (1751–1851) pioneered the use of painted transparent cloth bathed in changing light manipulated through overhead shuttered windows to give the impression of movement through time and space. His famous double effect dioramas were painted on both sides. Through the regulation of light, one or the other side, or both, could be made visible. His diorama, "Midnight Mass at St. Étienne-du-Mont" showed an empty church gradually filling with people for midnight Mass and then emptying again. Daguerre's work with light led him to make pioneering discoveries in the field of photography.

Rejecting Technology

The absence or willful omission of elaborate technological stage effects can also make a theatrical statement. As we have already seen, in Asian traditions such as Chinese opera, *noh*, and *kathakali*, forms more concerned with the art of acting than with stage realism, the actor defines the environment and creates theatrical effects through subtle gestures and suggestive movements; stage elements are few and preserve the actor-centered aesthetic. In Chinese opera a billowing blue cloth held at either end by a stagehand is sufficient to indicate ocean swells.

During the Vietnam War, Western theatre artists created actor-centered productions that deliberately avoided high-tech stage effects and devices. This movement was

> **Challenges and Choices**
>
> If the central element of theatre is the actor, is theatre that relies on technology to make an impact inferior theatre?

Photo 14.3
Nineteenth-century audiences enjoyed events in which technological innovation was the primary spectacle. Here, moving scenes of a Daguerre diorama provide entertainment. The scene is of interest itself, but the main attraction was watching it transform into another, effected by the turning of the scrolled canvas behind the screen.
© *Bettmann/CORBIS*

Performance

IN PERSPECTIVE

FROM PUPPETS TO PERFORMING OBJECTS

Puppetry, one of the earliest forms of performance, is becoming a central player in today's world of media entertainment. The term *performing object* is replacing the term *puppet* to describe a wide range of inanimate objects found in theatrical performance and on film, all manipulated either directly by a performer or through a variety of technological means.

Puppeteer Stephen Kaplin[1] describes how performing objects range along a continuum that begins with the actor in costume and moves to the most technologically sophisticated computerized creatures. When actors put on wigs and costumes, they are using inanimate materials to help them project character. When they wear masks, the separation of the performer and the performing object is more distinct. Actors manipulate masks by moving their heads and, in so doing, bring the mask, and the character, to life. A puppet is an object fully removed from the actor. The farther the object is from the performer, the more technology the performer requires to manipulate it.

Sometimes the technology is simple—a wooden stick for a rod puppet or a set of strings for a marionette. At a greater distance the technology can become more complex, such as radio signals or computers to control animatronic or mechanized puppets. Even computer-animated

figures can be considered performing objects. They are manipulated by someone projecting character through advanced computer technology. In the first *Star Wars* film in which the character Yoda appeared, he was primarily operated from underneath, like a hand puppet, by Henson puppeteer Frank Oz. The size of the figure was partially determined by the length of Oz's arm. In his second movie appearance, Yoda was primarily an animatronic or mechanically operated puppet, controlled by a puppeteer working the controls from off the set. In his final appearance, the animatronic Yoda was assisted for two scenes by a computer-animated counterpart, whose every move was crafted in cyberspace.

The transformation of puppets into performing objects links puppetry with computer animation, one of the most innovative and popular forms of entertainment of our times. It draws connections between the ancient skills of puppeteers and the new skills required for technological media. It also reflects the aesthetic approach of many contemporary stage artists who combine a range of performance techniques on stage.

Director-designer Julie Taymor freely mixes masks with *bunraku*-style puppets, shadow puppets, and other manipulated objects of her own invention in a single production. To call her work "puppetry" underestimates the variety of stage images she employs. Performing artists Janie Geiser and Kazuko Hohki combine performing objects with film and video, a match that often works more fluidly than live performers working in concert with video and film.

The performing object is a meeting point for theatre and technology. Any performing object can threaten to

1. Stephen Kaplin, "A Puppet Tree: A Model for the Field of Puppet Theatre," The Drama Review 43, 3 (Fall 1999): 28–35.

to some extent a theatrical response to the military-industrial complex that supported the war. Its aesthetic affirmed the ability of ordinary people to take control of society, politics, and culture through human strength, ingenuity, and grassroots initiatives. Some groups, such as the San Francisco Mime Troupe and Bread and Puppet Theatre, delighted in a low-tech aesthetic, using basic portable stages, masks, and papier-mâché puppets. These simple techniques empowered participants to take control of the theatrical means of production. Other groups, such as the Living Theatre, the Open Theatre, and the Performance Group, did away with even these low-tech elements and focused on the physical and emotional transformations of unadorned actors on a mostly bare stage.

During the 1960s, many avant-garde groups around the world focused on the emotional power of the actor. Most notable was Jerzy Grotowski's Polish Laboratory Theatre. Believing that the essence of theatre was the actor and the audience, Grotowski rejected technology and replaced it with a "poor theatre" that relied on the actor's phys-

Challenges and Choices

Is a theatre that rejects technological effects necessarily more humanistic?

displace the actor's central position on stage, especially when it is operated electronically. However, some of the most technologically advanced performing objects have a performer, or several, behind them who give life to what is otherwise inanimate matter. In the case of computer animation, in which a tangible object doesn't even exist, the actor who performs the voice of a character may be its primary life source. Actors are recorded first, and the animation must complement their vocal renditions. Ani-

mated figures are even made to look like the actors doing their voices. The Henson Digital Performance Studio allows a puppeteer to operate a computer-animated figure in real time, bringing it closer to live puppetry.

In the past puppeteers were often masked or hidden on stage. Today they are often visible, drawing focus to their skills in performance. By featuring object manipulators in this way, the theatre continues to emphasize the central role of live performers. Are new technologies such as computer animation replacing live performance, or are they allowing us to better appreciate live puppetry as a valued contemporary art form?

Audrey II, a plant that needs human blood to grow, is the true star of the Broadway revival of *Little Shop of Horrors*. Pictured here, with Hunter Foster as Seymour, Audrey's mix of low- and high-tech components includes foam, universal joints, and a lighting system that allows her veins to glow. Throughout the show, as Audrey II grows bigger and more ominous, the series of Audrey II puppets designed by The Jim Henson Company and Martin P. Robinson increase in size and complexity. The final Audrey II is twenty-three feet high and can stretch into the audience to look for tasty morsels. Michael Leon-Wooley gives Audrey II her voice while several different puppeteers, led by *Sesame Street* veteran Martin P. Robinson, manipulate the puppets. Directed by Jerry Zaks. Virginia Theatre, New York.
© Paul Kolnik

ical presence. Using little scenery, no recorded sound, simple costumes, and interesting spatial arrangements, he led a group of exquisitely trained actors toward a potent theatricality.

Competition with Other Media

Since the invention of film in the early twentieth century, new media technologies have given theatre stiff competition and usurped its central position in the world of entertainment. Early film and television often imitated theatre, defining themselves as a recorded form of theatrical performance before developing their own specific techniques. Vaudeville houses showed short films along with their live acts. Live performance drew in crowds, and movies were used as "chasers" to chase the audience out of the theatre at the

Challenges and Choices

At what point does an object cease to be a puppet embodying human qualities and become merely a machine? What are the essential qualities a machine must have to be considered a puppet or a performing object?

end of the show. But film quickly expanded into an art form of its own, taking audiences away from live theatre with cheap ticket prices and easy access. Television dealt an even greater blow to the theatre than film did, largely because of its convenience. Early television producers actively competed with the theatre by broadcasting television dramas based on stage plays or written by known playwrights and advertising television as "theatre in your living room," without the hassle of going out for the evening.

Today additional media such as video and the Internet provide an endless assortment of mass-marketed entertainments at the average person's disposal any time of the day or night. They are ubiquitous, easy to access, and have saturated our cultural environment with characters, storytelling techniques, and thrilling special effects, elements that had long been the sole possession of live theatre. Theatre practitioners have to compete with these new technologies and often do so by asking, "What can the theatre do that these other media entertainments can't?" Answers usually address the live human presence in theatre and its ability to incorporate audience interaction in the artistic moment itself.

Today our vast exposure to other forms of media entertainment shapes the way we approach and understand theatre itself. Large corporations that sponsor and control the aesthetic and expressive dimensions of television and film now shape theatre, too. We might worry that rather than providing its own unique forms of expression, theatre will come to look more and more like the entertainments we see elsewhere. The Disney corporation is responsible for the renovation of the Times Square theatre district in New York, where it now produces its own shows based on Disney movies. Disney's stage version of *Beauty and the Beast*, for example, is an attempt to replicate the popular animated film. While in the past a good play might serve as the basis for a movie, today movies are being turned into Broadway shows such as *The Lion King, Hairspray!, Enchanted April, Forty Second Street, The Producers*, and *The Graduate*. The types of stories and scenarios produced in other media now guide the creation and appreciation of much theatrical fare.

New Technologies in the Theatre Today

Today's new technologies are entering every aspect of theatrical production, from how artists think and plan a show, to the very nature of the theatrical event audiences see and experience. Each new invention offers new ways to conceive and carry out theatrical work and forces us once again to ask the question, "What is theatre?"

Technology Behind the Scenes

Audiences are usually unaware of the many ways sophisticated technology contributes to the theatrical event. From conception to execution, theatre professionals now make use of the latest technical resources to produce a play. Designers rely on computers to plan and execute designs; directors use computers to envision the space; scene shops use computers to interpret those designs during construction; and the backstage staff relies on computers for the efficient running of a show.

Computers in Design

Computers offer artists new ways to visualize their work in three dimensions before setting foot in an actual theatre. Set and costume designers use **CAD**, or computer-assisted drafting, programs such as Autocad or Vectorworks to help them draft precise and uni-

form drawings. Computer sketches allow them to visualize and modify colors, textures, and forms as they contemplate different design options. Use of a scanner or design programs such as Photoshop and Illustrator can be helpful tools in creating backdrop images, designs for props, wallpaper, and signs on stage. Lighting designers use these programs to test lighting effects on virtual sets and costumes. Computer models are used to solve technical problems and make aesthetic choices before carpenters and costumers begin building actual sets and costumes.

Designers and directors also explore virtual reality equipment to experience a stage space in three dimensions before it is built. Using systems developed by NASA to simulate environments for astronaut training, theatre artists can create an imaginary fully equipped performance space and tour it to see how staging ideas will work and how set designs feel from the inside.

Some artists are now experimenting with creating scenery by projecting virtual computer models on stage. In the work of San Francisco director George Coates, actors move through projected environments that continually change around them, transforming their world at a moment's notice. In his 1996 piece *Wings*, head-mounted displays allowed audience members to watch actors and 3-D virtual stereoscopic scenery at the same time.

Computers help artists communicate at a distance. Theatres send designers blueprints of the theatre space by e-mail, and designers send computerized images of their ideas for sets and costumes to directors for review, and then to the shops for construction. It is now possible for designers to work at theatres all over the country without being on site.

Computer-generated designs can also be converted into software that programs the power tools used in the construction of scenery. Computerized routers can cut wood and metal to the exact specifications of a design blueprint without the human labor of interpreting and measuring; this ensures accuracy and saves time and money.

Many designers, however, refuse to design with the aid of a computer. Some older designers were simply not trained in this way, and others claim that the computer hampers their creativity and removes them from the physical connection they have to the materials of their craft and the artistic work of designing. Although computers can be efficient for many tasks, some feel that they jeopardize the artistic integrity of theatrical design.

Running the Show

Today computers help the back-stage staff run the show. They facilitate the execution of traditional theatre tasks through automation. Computerized light and sound boards are now standard equipment, even in small community theatres and school playhouses. They can store and run a large number of complicated light and sound cues. Large theatres use computerized motion-controlled systems to effect and regulate set changes. Producers like using computers because they are more predictable than equipment that requires manual labor and thus more cost-efficient for large productions. They are also able to produce more sensational and cinematic effects. Computers give directors greater control of their work by bringing reliability and precision to lighting cues and set placement, but they may take away some of the spontaneity and excitement of live theatre.

When a show relies heavily on technological elements for its success, a breakdown in performance can lead to disaster. Early versions of Disney's *Aida* experimented with a robotic pyramid that changed shape for different scenes. Frequent problems caused the device to be cut from the show before it moved to Broadway. A rare computer failure at *The Producers* in the summer of 2003 prevented curtains from rising and scenery from moving, temporarily stopping the show. Breakdowns during performances are rare, but they can create havoc. On the other hand, they may also create opportunities for actors

Photo 14.4
Hudson Scenic Studios, a full service production and scenic fabrication company located in Yonkers, New York, regularly sends an entire bank of hi-tech equipment such as computers, monitors, and operating boards to theatres to operate and monitor the technological design elements constructed in their shops. This entire group at the loading dock is waiting to be shipped to a Broadway theatre to operate a single production.

and crew to save the day by improvising on the spot, returning the theatre to its fundamental nature as a live and ephemeral art.

Technology Center Stage

Some of the more interesting uses of new technology appear center stage, alongside actors, as an integral part of the production concept. Since the early twentieth century, directors have used projections to create scenery and provide visual and factual support or counterpoint to stage action. Erwin Piscator first used projections and film sequences in his political theatre in the 1920s to draw connections between recent historical events and the dramatic action, and to distance the audience emotionally from the play. Creating a workable interplay between live action and recorded action is a challenge, because film and video images often upstage actors. A slick media projection inevitably grabs the audience's attention. In 2003, *Ubung*, a production from the Netherlands, contrasted videos showing adults involved in decadent behavior—drinking, smoking, wife-swapping—with the same actions played live on stage by children. In this case, the live action commented on the video, giving each equal focus. The audience's attention was first drawn to the projected film because of its scale; it took a while for the audience to adjust its focus to include both the projected and live action and to grasp the thematic interplay between the two.

In contrast to film and video, recent computer technologies have the advantage of being interactive. They can play along with the live, changeable, spontaneous nature of the theatre and live within the show like the performers themselves. At the University of Kansas, Mark Reany has created interactive virtual scenery for a number of productions in which stage images change in response to the actors' movements. Dancer Bill T. Jones has performed with a computer-generated virtual dance partner (see photo 14.5), and Claudio Pinhanez used computer characters in his 1997 piece, *It/I*, developed at MIT. In David Saltz's production of *The Tempest* at the University of Georgia, the sprite Ariel was a 3-D computer animation performed by an actor in real time, using motion-capture technology. Backstage, wearing a suit wired to a computer, the actor manipulated Ariel's computer image with her own movements.

The intent of these experiments has not been to replace live actors, but to allow performers to engage with computerized characters in real time, offering novel performative and visual stage elements. Because of the expensive equipment and new research involved, many of these experiments are done in collaborations among artists, universities, and computer companies. New York's Brooklyn Academy of Music and Lucent Technologies are initiating a joint project to explore artistic possibilities and support the creation of new media performance projects that bring artists and Bell Lab scientists together. In these shared ventures, artists challenge their creativity, while media companies cultivate new applications for their equipment.

Although some new technologies live and interact on stage, others take the breath of life from the stage, replacing or mediating the live performance. Sometimes this intervention occurs without audience awareness. Most actors today in large theatres use stage microphones, small devices attached to their clothes or worn around the ear that are almost invisible to the audience (see Photo 13.10). What spectators hear is a digitized voice reproduced by a speaker rather than the actual human voice of the performer they see live on stage. These voices can seem eerily disembodied. Musical productions in particular rely on microphones, even in small houses, because their clear digitized sound reproduces vocal qualities we have become accustomed to from CDs and music videos.

The unmediated human voice often has trouble competing for our attention next to amplified sounds, but it can express a direct connection to the heart, mind, soul, and spirit that may be lost when digitized. Legend tells of the ancient Greek poet Sophocles giving up performing his own works because of his weak voice. The ability to project has separated stage acting from film acting. In film, microphones capture every vocal inflection, and voices are redubbed if they are unclear. Using microphones on stage helps film actors who may not have the same voice projection skills as stage actors. In the future, even stage actors may no longer train as they did in the past, giving special attention to vocal projection as a way of reaching out to the audience.

As artists rely increasingly on the microphone, the audience is forgetting how to listen to the text of a play and the subtle interplay between melody and words in musical theatre. In 2004, as a reminder of the emotional intimacy lost through the miking of the human voice, the show *Broadway Unplugged* featured twenty star performers singing show tunes without the aid of electronic amplification. The performance demonstrated that the emotional immediacy of direct contact may be the price of technological progress.

In 2003, a musician's strike on Broadway closed shows for several days and brought to the fore new concerns about sound technology replacing live music on stage. Theatre producers wanted to reduce the minimum number of live musicians required by the union's contract for Broadway musicals. They claimed that fewer musicians would help reduce Broadway ticket prices and allow artists

Photo 14.5
Dancer-choreographer Bill T. Jones dances with a computer-generated virtual dance partner to the music of Bach in a piece that reflects on solo performance. *Chaconne,* video work by Paul Kaiser and Shelley Eshkar, Wolfsburg, Germany. *Courtesy of the Bill T. Jones/Arnie Zane Dance Company; photo by Thomas Ammespohl*

Artists

IN PERSPECTIVE

In Their Own Words

CLAUDIO PINHANEZ

Claudio Pinhanez is a computer scientist and media artist. Since 1999, he has been a research scientist at IBM T. J. Watson, where he designs and develops interactive spaces and investigates physical interfaces to information. Pinhanez got his Ph.D. from the MIT Media Laboratory in 1999, working on the design and construction of physically interactive environments and in computer theatre. Pinhanez has also been a visiting researcher at ATR-MIC laboratory (Kyoto, Japan) and Sony Computer Science Laboratory (Tokyo), where he designed, produced, and performed interactive artworks.

■ **Why do you chose to create theatre using computers as characters?**

I think the use of computers in theatre has been too limited to backdrops and stage effects. If we look into today's movie-making, we see an impressive number of computer graphics characters with striking levels of expression, from the animated creatures born at Pixar studios to the intricacies of Gollum's acting in the Lord of the Rings trilogy. So there is an enormous wealth of techniques that can be used to populate the stage with admirable new characters and worlds. So, the first answer to this question is one of opportunity. At the same time, I think computer characters simply follow the traditions of puppetry. I have always admired the cleanliness of puppet acting, where the limitations on articulation and expression force the puppeteers to deeply explore body movements to convey emotions and ideas. When I was working with computer characters in theatre, I always had in mind the *bunraku* puppet plays I watched in

Japan, which always fascinated me more than their non-puppetry equivalent versions in *noh* and *kabuki* plays.

■ **What do computers offer the art that human actors don't?**

Like puppets, computer characters can have nonhuman bodies and physical abilities. In particular, I am interested in computer characters having "bodies" encompassing multiple media, including computer graphics, video, sound, and lighting. For example, the computer character in the play *It/I* that I wrote and directed in 1997 has a "body" composed of multiple computer graphics objects that appear on stage screens; It "talks" through video segments and expresses rage through stage lighting. The mix of these elements creates a very special character on the stage that would be impossible to recreate in a human form and body. At the same time, It has a very minimal body, like a puppet, allowing an exploration of its expressiveness in depth.

■ **Do you consider yourself a theatre artist or a media artist?**

I consider theatre as my means of expression. Although I love contemporary performance and installation art, I found myself much more comfortable creating for a theatrical audience than in an art gallery or a performance space. My work does not seek to break the stage–audience connection characteristic of theatre, but instead, looks for expanding the range of stage possibilities much the way computer graphics is enabling new kinds of characters and dramatic situations in movies.

■ **Is it really possible for a computer to be spontaneous and "in the moment" the way an actor can if it is drawing from a limited range of preprogrammed responses?**

I do not think today's technology enables us to create an improvisational computer actor on stage. But for the

Challenges and Choices

When technology replaces human skills, such as when computers are used to draft sets or microphones are used to project the voice, do we risk losing these skills forever? Is that important?

more creative freedom in determining the musical accompaniment of a show. Of course, such a move also guarantees a loss of jobs for musicians and the replacement of much of the theatre's live music with electronically produced sound. Music is an interactive element that must live and breathe with the performers. Musical directors adjust the orchestra's timing to the rhythms of the actor's nightly performance and to audience response. They also cover up for missed cues and other unexpected occurrences. Recorded music is frozen; its tempo, unchangeable. Faced with the specter of performing to canned music, actors joined the musicians' picket lines, and Broadway musicals were shut down for the duration of the strike. The union eventually accepted a

more traditional theatre, based on action–reaction dynamics within the context of a "preprogrammed" story line, it is possible to build computer actors quite able to occupy the stage. However, I believe to keep computer characters alive on stage, they have to be responsive to the actions of the human actors. A computer character should never be constructed to trigger reactions based on elapsed time. Human actors are trained to be responsive and have a hard time adjusting themselves to fixed time reactions. In other words, it is essential to keep the stage action as a "dialogue" of actions and reactions from the characters. Providing the computer character with some variability of reactions, even if randomly chosen, helps keep the human actors on stage "listening" to the character and reacting/acting according to what actually happened.

■ **How do you envision this kind of work evolving in the future? What is the next step? Does the answer depend on the creation of new technologies?**

We have to continue to explore and understand the possibilities of computer characters in theatre. The real problem may be getting theatre people and audiences acquainted and comfortable with this new means of theatrical expression. While in dance there is already a community working with technology for quite a long time, in theatre we are still restricted to a few companies, even in active experimentation areas such as New York.

In *It/I*, actor Joshua Pritchard, playing the character "I," shares the stage with an autonomous computer-actor system playing the character "It." The computer-actor controls the imagery on the screens, the stage lights, and sound effects responding to the human actor's actions detected by a computer vision system. The performance was written and directed by Claudio Pinhanez with art direction of Raquel Coelho, performed at Massachusetts Institute of Technology.
Copyright Claudio Pinhanez, 1997

Source: Used with permission from Claudio Pinhanez.

compromise that diminished orchestra size, though not as drastically as first proposed. The eventual eradication of live music in the theatre was never before such an imminent threat.

Performing in Cyberspace

In the early 1990s, avant-garde artists began exploring the possibilities of cyberspace performance bringing together actors and audience members at different locations through the use of high-speed Internet. So called *telematic* performance has expanded

Artists

IN PERSPECTIVE

In Their Own Words

ELIZABETH LECOMPTE

Elizabeth LeCompte is best known for her work with the New York–based experimental theatre company, the Wooster Group, of which she is a founding member and director. For thirty years, the Group, under LeCompte's direction, has played a pivotal role in bringing evocative and technologically sophisticated uses of sound, lights, and video to the stage. Since 1975, LeCompte has constructed (choreographed, designed, and directed) numerous dance, film, and video pieces as well as seventeen multimedia theatre pieces with the Group.

■ **Why is technology such an important part of your directorial concept? Are you more drawn to its stage effect or to the commentary it makes on human existence in the twenty-first century?**

I don't know. I just like having all kinds of technology in the room when I work. For fun. It's fun to play with and it stimulates a more free-wheeling work environment. I like to put the real thing next to its copy and have them play off each other. It gives the actors power by amplifying and doubling them, and I can imagine worlds that couldn't be in the theater thirty years ago, and ideas that inform old texts in new ways.

■ **How does your use of technology in a production evolve during rehearsals?**

It's different for every piece, and it depends on what people are bringing into the space new, and what we worked with in the last piece. We discover how to use the technology over time and in relation to the text. It happens naturally, so that in the end there is no separation between form and content.

■ **Do your actors require any particular skills in order to perform with the technological elements you use in production?**

No. Only that they like the ideas we are working with. If they come with an opinion already formed that technology is bad, then it inhibits their ability to play.

■ **What is the effect on actors when they are competing with technology for attention on stage?**

They aren't competing with the technology. It's a tool for them to be creative.

■ **Does the fragmentation of the human form that you often achieve undercut the actor as the central element of the theater?**

No. No more than the fragmentation of time and space in the theater undercuts a performance. For me, the performers are the reason for the theater. The "text" (which includes the words and the technology) is there for them. No one would write a play if there were no performers to perform it.

■ **Does the fragmentation of the text undercut the playwright, and can you discuss some of the reactions of playwrights to your work?**

Texts for the theater have always been edited and shaped for the company and/or for the time. I think that's what I do too. It's a tradition from Shakespeare. To say we "fragment" the text is more radical than what we actually do. Sometimes we only do a piece of a play (a play within a

Challenges and Choices

Does theatre require that all the actors and all the audience be present in the same space? Does cyberspace take everyone into the same virtual world?

ever since, inspiring much original work and theoretical writing about its implications for the theatre.

In 2001, Rensselaer Polytechnic Institute and New York University teamed up for the forty-minute opera, *The Technophobe and the Madman*. Audience members at both locations, 160 miles apart, watched half the cast performing live and the other half on the Internet via large screens. Two musicians on each end accompanied the singers, and computers assisted in blending the music. In 2003, the Gertrude Stein Repertory experimented with "distance puppetry" in a production based on Stein's novel, *The Making of Americans* (1925), using simultaneous performance venues in Iowa and New York con-

play). The text isn't fragmented, we just use a fragment of the text. This use bothered Arthur Miller—who said he was afraid people wouldn't know that there was more of it. Playwrights I have spoken to are inspired by our work (Tony Kushner, Paul Auster, Romulus Linney).

■ **Could you ever see yourself returning to a "poor theatre"?**

I couldn't return to something that I never did. Technology is integral on every level—spiritual, social, aesthetic—of my way of making work. It would be the singer without the song.

■ **Of all your productions, where did technology serve your concept best, and why?**

Each one, like children, is different and unique. I wouldn't think that way about my work. I don't have a concept to begin with. I have a text, performers, and my space. The concept is the final piece, and the final piece *is* the concept.

Irina (Beatrice Roth) expresses frustration about her life in the Russian provinces to sister Olga (Peyton Smith) and Dr. Chebutykin (Roy Faudree), who appear on video monitors, in The Wooster Group's production of *Brace Up!*, translated by Paul Schmidt from Chekhov's *Three Sisters*. Directed by Elizabeth LeCompte; video work, Christopher Kondek; scenic design, Jim Clayburgh; lighting, Jennifer Tipton. The Performing Garage, New York.
© Paula Court

Source: Used with permission of Elizabeth LeCompte, Director, The Wooster Group, Creating with Technology.

nected by videoconferencing. The company projected the faces and bodies of actors at one location as masks and costumes on actors at the other venue, so the characters became a amalgamation of physical form and virtual image. By creating new characters in this way, the production hoped to mimic Stein's method of dissection and collage in creating literary characters. In other instances actors, each in a different location, performed for viewers watching from their own computers at home. In each of these examples the traditional notion of a theatrical event as a gathering of performers and spectators is being challenged and transformed. The Internet allows people at great distances to come together, disrupting the traditional connection between actors and audiences.

Techno-Theatre Aesthetic

Some theatre companies and independent artists envision their work through the active integration of film, video, computers, high-tech sound, and other digital media with theatre's live action, creating a new mixed-media techno-theatrical aesthetic. Film, video, and digital sound can barrage the audience's senses to create a montage effect. These media allow for greater and quicker shifts in location and can change a production's pace and sense of movement. In counterpoint to live action, they can break up linear stage narratives and provide spectators with links to outside or distant events as well as glimpses into a character's inner life. Daily, technology helps us move at a fast pace around our cities and the world via telephone and the Internet, facilitating and interrupting the flow of our lives. A techno-theatrical aesthetic reflects the way technology has already infiltrated our everyday existence, transforming how we think about time and space and how we connect to each other.

New York's Wooster Group works as an ensemble under the direction of Elizabeth LeCompte. Their theatrical work juxtaposes film, video, and multitrack scoring with dance, movement, and dialogue to reinterpret both new and classic works. In *Brace Up!*, based on Chekhov's *The Three Sisters*, live performers off stage appear on stage on video monitors alongside live stage action (see photo on page 381). Actors alternately speak on stage or from microphones visibly located behind the main playing area. The interaction between television and live action turns the plight of the three sisters into a staged reality TV show. Additional video clips break up and comment on the story line. Video segments included the grandmother of an actor trying out the lines of the play's elderly nanny, silverware being dropped again and again, film clips from Kenneth Branagh's *Henry V*, and an image of Godzilla accompanied by a loud sound appearing each time the character Solyony is about to speak. Actors were meant to use their video images both as masks and mirrors. *Poor Theatre* (2004) used technology to comment on Grotowski's theatre of minimal technology. Similar integration of technology is seen in much of the Wooster Group's work. The effect is that of a fragmented reality, a collage of real and electronically amplified images and sounds.

Robert Lepage brings a combination of film and theatrical sensibilities to stageworks such as the *Seven Streams of the River Ota* created in 1996 with his theatre company, Ex Machina. This seven-hour piece combines film, music, dialogue, and puppetry to show a global view of twentieth-century world tragedies from the atomic bomb to the Holocaust to AIDS, told through interconnected individual lives. The production used rear film projections and live video links to tell this epic tale. In *Elsinore* (1996), a retelling of *Hamlet,* Lepage plays all the roles, talking to his own real-time video images and distorting his voice through pitch-shifters to create an array of characters. The production disorients the viewer with a set of three moveable panels that rotate to reveal new scenes and videos depicting overhead or rear projections that shift the spectator's point of view. Infrared and thermal cameras and sonar slides allow spectators to peek behind castle walls. The final duel is projected from a video camera atop the poisoned sword.

The Builders Association makes technology's infiltration and transformation of everyday life the theme of their techno-theatrical pieces. *Alladeen*, their 2003 stage production directed by Marianne Weems, was linked to a web project and music video directed by Ali Zaidi (see photo on page 266). It explored the philosophical concerns emerging from today's global technology. The piece presents Indian men and women as they train to become phone operators at an international call center in Bangalore serving American companies and their clients. They learn American pronunciation and culture so they can pretend to be based in the United States. Video projections create a counterpoint to the stage images. The workers watch episodes of *Friends* as part of

their training, and their faces morph into those of the American *Friends* characters through video projections. Video fantasy sequences based on Bollywood-style films describe the workers' hopes for the future. The Builders Association collaborated with playwright Jessica Chalmers at the University of Notre Dame for a multimedia performance, *Avanti: A Postindustrial Ghost Story*. Staged in an abandoned Studebaker factory in South Bend, Indiana, this site-specific piece projected images and videos onto moving screens that functioned like Renaissance flats to tell the apocryphal story of job loss and industrial failure when Studebaker went under (see Photo 14.6). Groups like the Builders Association are experimenting, not just with technology, but with artistic perspectives that combine traditional theatrical elements and contemporary technologies to make theatre that comments on technology itself and speaks to our current experiences and concerns.

Concerns about Theatre and Technology

Along with these exciting experiments come concerns about the introduction of technology in production and how it may be changing the very nature of theatre. New media with more interactive capabilities can upstage actors or even replace them altogether. Contact through a computer projection, however interactive, can never fully replace the energy shared between people in the same space. In the last hundred years we have been both fascinated with and frightened by new innovations and technological forces. Their promise of improving our lives is enticing. Yet, as we have witnessed, these transformations are not always for the better, nor are they entirely within our control. Fear and skepticism about new technologies of all kinds, and the worry that they undermine our basic humanity, remain part of our general cultural dialogue as we continue to debate the value of every scientific incursion in our lives, from cellphones to genetic engineering.

History IN PERSPECTIVE

PLAYS ON SCIENCE

Theatre's preoccupation with science and technology can be seen in the many plays that take these subjects as their theme or even use scientific ideas as a structural model. Karel Capek's *R.U.R.* (1920) projected a world in which human life was replaced by robots (in fact, some trace the first use of the word *robot* to this play) who later declare war on the human race. Spurred by the horror of World War I, Capek sought to warn the world of the possibility of society becoming a technology-driven war machine.

Bertolt Brecht's *Galileo* (1939) is one of many plays exploring the relationship of the scientist to the political power structure and how knowledge can be compromised for self-interest. World War II and the destruction caused by the atom bomb inspired a host of plays exploring the social and political responsibility of the scientist in a morally ambiguous world. Heinar Kipphardt's documentary drama *In the Matter of J. Robert Oppenheimer* (1964) used documents from the proceedings of the United States Nuclear Energy Commission to demonstrate the results of passing awesome atomic knowledge to the military for its pursuits. The play poses many important questions: Who owns scientific knowledge, the scientist who discovers it, or the government that supports the research? Should a

scientist decide how knowledge should be used? In *The Physicists* (1962), Swiss playwright Friedrich Durrenmatt presents a nuclear physicist who pretends to be insane in order to be shut away from officials who would use his discoveries for destructive political ends. In the end, all of his attempts to prevent his discoveries from falling into the wrong hands fail, and the play ends in nuclear cataclysm. All of these plays deal with the moral burden that comes with scientific knowledge.

Some plays don't just take science as a theme, but reflect scientific principles in their structure, such as Tom Stoppard's *Hapgood* (1988), in which the plot mimics particle motion. In Michael Frayn's *Copenhagen* (1998), the play's scenes mirror the uncertainty principle in physics, showing alternative and incompatible versions of a famous meeting between theoretical physicists Niels Bohr and Werner Heisenberg.

The EST/Sloan Science and Technology Project sponsors plays that deal with science and technology. In 2003, a project called Technology Plays challenged playwrights to write a seven-minute play on the subject of man and technology, performed for one spectator at a time using only machines. The six plays included *Greetings from the Home Office* by Richard Dresser, in which the spectator, sitting in a cubicle, is cast as a new company employee and barraged by messages from a phone, intercom, and computer that give contradictory information about the boss, a colleague, and a secretary, leaving the spectator uncertain what to believe. Plays about science and technology and plays that use technology can push the boundaries of theatrical forms.

In this famous production of Bertolt Brecht's *Galileo,* which explores the relationship of the scientist to the political power structure, actor Charles Laughton in the title role works on an invention. Directed by Joseph Losey at the Coronet Theatre, 1947.
Photo by Keystone/Hulton Archive/ Getty Images

The introduction of new technological methods in the theatre can't help but stimulate a similar critical debate, even as it forces us to redefine the limits of the art form. We have always referred to theatre as "live" performance, but what does that mean at a time when we can perform live on television or the Internet, and when recorded media can be incorporated into "live" theatre. As we expand our ability to use technology, we must also question how we define the unique experience of live theatre.

KEY IDEAS

- Theatre has always used available technologies to heighten its expressive power.
- Sometimes theatre artists develop new technologies to achieve certain effects; at other times new tools inspire innovative theatrical ideas.
- Today's new media compete with the theatre, find their way into productions, and create the cultural background that frames our theatrical experiences.
- Technology refers broadly to any skill, art, or craft we use to shape our physical environment and facilitate our cultural practices. High-tech devices use less physical human effort than low-tech devices.
- Theatre practitioners and audiences adapt to new technologies as they become integrated into theatrical practice over time. What was once technical innovation can become standard practice.
- Technology enhances a production when it works in conjunction with other artistic elements to illuminate meaning. When technology supplants the acting and text, it may transform the theatrical event.
- Some theatrical traditions revel in spectacle; others reject technology and highlight the human presence.
- Film, television, and other new media compete with theatre and have usurped its central position in the world of entertainment, shaping the way we understand theatre.
- New technologies are entering every aspect of theatrical production, from how artists think and plan a show to the very nature of the theatrical event. Computers aid designers and stagehands; microphones amplify actors' voices; and film, projections, video, and virtual characters are part of a director's palette of possibilities. Some theatre practitioners make integrating new technology an integral part of their overall aesthetic.
- New technologies may be changing the nature of theatre by disconnecting audiences from actors and mediating live performance.
- Technology is forcing us to question what we mean by "live" performance.