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WAITING FOR A ROBOT GODOT: A CYBORG THEATRE CASE STUDY

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There exists a long and rich history of technology being integrated with theatre, dating back to the ancient Greeks. These have ranged from tools used in the mechanics of theatre (winches and revolves for example), the integration of complex props into performances, the use of realistic mannequins and puppets, to the use of technological themes within the narratives themselves. Historically, following Aristotle's elements of drama; theatrical forms that rely on technological effects are named as a 'spectacle', and are often considered as entertainment rather than serious drama (Lauren, 2013). This paper discusses the use of 'physical' robots as a natural next stage of theatre, and describes a case study of a cyborg theatre performance.

This paper follows on from a previous paper that extensively discussed the theoretical implications of cyborg thespians (Waiting for a Robot Godot: Theoretical Musings on Cyborg Theatre). The paper describes the technical process involved to produce a well-known play using robots and provides a brief comparative analysis and interpretation of the performance.

The initial play chosen for this robot experimentation was a relatively recent example of tragicomedy, Samuel Beckett's *En Attendant Godot*, rewritten and translated as *Waiting for Godot*. Beckett's version of tragicomedy doesn't strictly follow the classic definition, but it does provide plenty of tension between comedy and tragedy, without completely submitting to either (Strauss, 1959).

INTRODUCTION

Theatre is often defined as a form of literature which incorporates acting and stagecraft elements with text. The effectiveness of the theatre (which when conducted may be considered a play or drama, according to actual type) is based on the delivery of text through the actors and how the audience observing the performance responds. Gassner (1955) argues that the importance of the theatre is that it provides a sensually different atmosphere than that

which is provided when merely reading a play script. This project has attempted to push the boundaries of what is traditionally defined as theatre; providing a sterile environment where emotionless mecha perform on a stage, robotically reciting the lines – allowing an interesting re-examination of Gassner's 'sensually different atmosphere' of theatre.

Although theatre has been around for thousands of years, robots have inhabited the Earth for only a couple of decades. Interestingly, the word 'robot' derives from Karel Capek's 1921 play "Rossum's Universal Robots" (Capek and Capek, 1961). According to Garreau (2005), a robot is defined as a "digitally driven creature that can sense and move". There are millions of robots in day-to-day use all around the world, and the rate of take-up of these systems is increasing rapidly (IFR, 2016). Over time, it has been the goal for creators and manufacturers to expand the definition of what a robot is; in other words, the tasks robots are able to perform are continually expanding with manufacturing, hospitals and space exploration seen as common areas of interest for robotics (Presher, 2010 and Behnke, 2008). It is generally felt that robots have emerged into an era of 'weak' Artificial Intelligence (A.I.) where currently they can imitate humans without being independent (Beck et al, 2010). Either through autonomous means, or extensive exhaustive programming, robots have the potential to better everyday life. However, robots also have the potential to entertain and an emerging medium for robotics is the use of RoboThespians, or cyborg theatre.

The first dedicated robotic theatre has recently opened at the Copernicus Science Centre (2016) in Warsaw, Poland. Although this playhouse which opened in 2010 is relatively new, robotic acting has been occurring in other countries for many years. For example, in 2008, it was reported by BBC that Mitsubishi had created a robot named Wakamaru which spoke lines of script in Japanese. Wakamaru, a humanoid robot, performs in plays which emphasize the relationship between "humanity and technology" (BBC, 2008).

The author, along with a number of graduate students, has produced a number of short theatrical performances using robot thespians at the State University of New York. The analysis in this paper will focus on two NAO robots acting out the parts of Pozzo and Lucky in one scene from the Samuel Beckett play *Waiting for Godot*. The script was used verbatim from a play manuscript but the movements of the robots was defined by viewing previous theatre performances. Media of publically available recorded interpretations allow a comparative analysis of the robot performances with those of human actors.

WAITING FOR GODOT

> 'Because the play is so stripped down, so elemental, it invites all kinds of social and political and religious interpretation with Beckett himself placed in different schools

> of thought, different movements and 'ism's. The attempts to pin him down have not been successful, but the desire to do so is natural when we encounter a writer whose minimalist art reaches for bedrock reality. 'Less' forces us to look for 'More,' and the need to talk about Godot and about Beckett has resulted in a steady outpouring of books and articles.' (Berlin, 1999)

Waiting for Godot is an absurdist play by Samuel Beckett, in which two characters, Vladimir and Estragon, wait for someone called Godot. It is impossible to provide a conventional plot summary of *Waiting for Godot*, which has often been described as a play in which nothing happens, a lucid testimony of nothingness (Sastre, 1967 and Szanto, 1974). Godot's absence, as well as numerous other aspects of the play have led to many different interpretations since the play's premier. It has been named as one of the most significant plays of the twentieth century (Berlin, 1999).

The simple setting of the play makes it ideal for a robot performance such as the one undertaken in this experiment. There is only one scene throughout both acts. Two men are waiting on a country road, by a tree throughout the play. Whoever Godot may be, Vladimir and Estragon seem eternally at his mercy as they fill the days waiting for his arrival.

Traditionally, the play *Waiting for Godot* has used only male actors, and there is scarcely any reference to women. Samuel Beckett was not open to most interpretative approaches to his work. He famously objected when, in the 1980s, several women's acting companies began to stage the play. *"Women don't have prostates",* said Beckett, a reference to the fact that Vladimir frequently has to leave the stage to urinate (Ben-Zvi, 1992). Beckett even went so far as to ban female acting companies in Europe from performing his plays, the courts overturned this ban and a number of female productions have since been performed (Knowlson, 1996).

Boxall (2004) has claimed that Vladimir and Estragon's relationship is quasi-marital:

> "They bicker, they embrace each other, they depend upon each other [...] They might be thought of as a married couple."

When Estragon reminisces about his occasional glances at the Bible and remembers how prettily coloured were the maps of the Dead Sea, he remarks :

> "That's where we'll go, I used to say, that's where we'll go for our honeymoon. We'll swim. We'll be happy."

Throughout *Waiting for Godot*, the audience encounters religious, philosophical, classical, psychoanalytical and biographical references (Knowlson, 1996). There are ritualistic aspects and elements taken directly from vaudeville and there is a danger in making more of these than what they are: that is, merely structural conveniences, avatars into which the writer places his fictional characters. Cronin (1997) states that the play: *"exploits several archetypal forms and situations, all of which lend themselves to both comedy and pathos."*

Waiting for Godot is often considered by philosophical and literary scholars to be part of the movement of the Theatre of the Absurd, a form of theatre which stemmed from the Absurdist philosophy of Albert Camus (Esslin, 1980). Absurdism itself is a branch of the traditional assertions of existentialism, and posits that, while inherent meaning might very well exist in the universe, human beings are incapable of finding it due to some form of mental or philosophical limitation.

Broadly speaking, existentialists hold that there are certain fundamental questions that every human being must come to terms with if they are to take their subjective existences seriously and with intrinsic value. By and large, the theories of existentialism assert that conscious reality is very complex and without an "objective" or universally known value: the individual must create value by affirming it and living it, not by simply talking about it or philosophising it in the mind. *Waiting for Godot* may be seen to touch on all of these issues (Friedman, 1970).

Absurdist theatre discards traditional plot, characters, and actions to assault its audience with a disorientating experience. *Waiting for Godot* remains the most famous example of this form of drama and hence an ideal play to use for this robot theatre experiment where the play, and the motives of the characters, are open to interpretation.

ROBOT TECHNOLOGY

Robot technology is moving in the direction of autonomy. That is, robot developers are working toward making robots that can act on their own, independent of specific direction (such has a remote control or button press) from a user. This type of "smart technology", as it is sometimes called, has been used in major technological areas such as space exploration, but has also begun to make its way into the everyday life of humans (Bernstein and Crowley, 2008). There are many different types of autonomous robots: mechanical (or physical) robots, and software agents (softbots) which are an everyday part of our internet experience in cyberspace (Zhao, 2006). This article focuses on physical robots, particularly those aspects that involve human interaction and communication.

Recently, the field of robotics has started developing physical robots that interact with humans in everyday settings. These robots are known as social robots. Social robots hold a variety of different functions, including aiding the elderly, acting as tour guides, and even tutoring (Fior, 2010). The robots can also have emotional roles, acting as companions, allowing people to cope with negative states such as depression, loneliness, and disability (Libin and Libin, 2004). The use of robots in these areas has begun to open up a whole range of other areas of human endeavor to mechanical devices, including challenging areas of the arts and humanities that were traditionally the exclusive domain of humans (Hatano et al, 1993 and Barakova and Lourens, 2010).

SOCIAL ROBOTS

For a social robot to function in a fitting manner it "orients itself to the mind of an individual and acts upon the individual for purposes of eliciting certain behavior and emotion," with the resulting goal of the human "partner" believing that the robot has a mind (Nass et al, 1994). This orienting function of emotion is extensively used in film and theater to align the audience with the actors and performers.

Theater almost always involves interaction and communication. To interact and communicate effectively with a human audience from the stage, it is important that social robots have certain key traits. Perhaps most crucial is the idea of a social robot being sensitive to, or aware of, the social context in which they are embedded (Dautenhahn et al, 2006). Understanding the audience's activity and intent are necessary components of interaction for robot actors to allow them to respond appropriately and in a timely fashion (Okamura et al, 2010). For example the same robot may not be necessarily found appropriate for all performances. Some audiences find them annoying and irritating while some may find them delightful and fun (Feil-Seifer et al, 2007 and Feil-Seifer et al, 2011). Most of which relies on the appropriateness of the robot and the ability to flexibly adapt to different types of situations.

If we are to successfully use robots in the realm of theatre there is little doubt that these robots must learn from actors and directors in order to understand the importance of context. Essentially, in order for robots to gain contextual knowledge and become aware of their surroundings, they must become more "human-like" (Snae and Brueckner, 2007).

HUMAN-LIKE ROBOTS

Research has shown that humans prefer human-like robots (over machine-like robots) to perform in human-like capacities, such as: actor, instructor, sales representative, office clerk, food carrier, museum tour guide, and hospital messenger (Goetz et al, 2003). Communication mechanisms rely on many aspects of 'human-like' sensory, cognitive, and emotional attributes including natural language processing (speech) and gestures and movement (Libin and Libin, 2004 and Zhao, 2006). According to Mori (1970) humans generally view movement as a significant sign of life. Thus movements must be made to the humanoid's physical appearance in order to establish a sense of life. For example, ARRI's Humanoid Lab is working on a humanoid robot thespian named LILLY, that can exhibit "facial expressions, enhanced eye movement, eye contact, and speech synthesis". LILLY is also able to mimic human expression and emotion and features state-of-the-art visual systems (Rajruangrabin et al, 2008).

Human-like robots must also be approachable and non-threatening. Many recent social robots have been created with a 'friendly' interface driven design (Alexander, 2011). Essentially, without a human like appearance any attempts to pass information or alter the human's behavior and emotional state by the robot will often fail from the lack of trust felt by the human (Okamura et al, 2010). Among all factors of human-like robots, the appearance of the robots is the most important. Studies have offered evidence that perceptions of the robots can change, simply by altering how they appear (Calinon and Billard, 2006). One study showed that just by adding a lab coat and stethoscope, a robot can appear to be increasingly medically competent (Feil-Seifer et al, 2011 and Zhao, 2006).).

In summary, to perform in theatre, robot thespians should be capable of performing the same activities as humans on a stage, including similar degrees of movement throughout the body.

THE NAO ROBOTS

The NAO is a humanoid robot created by Aldebaran Robotics – it takes advantage of the fact that by simply looking human, it is more likely that human viewers will attribute the robot actors with more human-like qualities than machine-like qualities. A NAO robot (Figure 1) has 25 individual servo motors offering many degrees of freedom, which allows the robot to move in a similar manner to humans. The 57cm tall robot has the ability to visually and verbally recognize humans, the dual cameras embedded in its eyes allow the robot to 'see' its surroundings. The NAO robot can also respond to a human by recognizing sounds using two audio microphone/speaker units, positioned on each side of the head and is capable of delivering speech using a variety of text-to-speech and recording mechanisms.

Figure 1: The Nao Robot.

The NAO robots are unable to change their facial expression; they are also unable to independently change their gaze (Niemuller et al, 2011). The NAO robot is able to use different LED colors in the eyes to depict changes in expression, but it is appreciated that this may not much of an emotional dynamic range.

Communication was seen as a critical component of this project to create robot theatre. Research has shown (perhaps via a naïve biology mechanism), that humans attribute verbal communication to robots if they have mouths. According to one study, the attribution of verbal communication is enough for people to start a conversation with the robot (Fior et al, 2010).

Experiments have indicated that the perception of robots can change if they act inappropriately and out of context (Goetz et al, 2003). NAO robots can be programmed to react in several types of manners. Since its degrees of freedom are similar to that of a human's, biomechanical modeling can mimic human emotional body language. Also, advanced audio controls can adjust the delivery tone of speech.

The NAO robot has been used to a limited extent theatrically, they have been used in research projects around storytelling and comedy. Recently, the robots were used by French researchers to narrate stories to children. The researchers report that the NAO robots possesses the ability to carefully and closely mimic real life human behavior, and are capable of reproducing human-like gestures. Using 89 different story segments with different speech styles, an elaborate lexicon was produced (Gelin et al, 2010).

A social roboticist named Heather Knight has presented a NAO robot as a comedian in a stand-up comedy show. The robot not only told jokes, but could actually pay attention to the audience and determine whether the audience was laughing and then adapt its comedy routine on the fly (Knight, 2011 and Knight et al, 2015).

Cyborg theatre is still a relatively new concept that is on the frontier of Artificial Intelligence and although examples are currently limited, there are a number of future projects being planned for humanoid robotic actors. This paper describes one particular robot theatre experiment performed at the State University of New York.

IMPLEMENTATION

This case study example shows two robots interact with each other during a performance piece *Waiting for Godot*. This particular analysis will focus on the two NAO robots acting out one of the scenes with the characters Pozzo and Lucky. The particular scene from the play being considered is a monologue from Pozzo shortly after he enters the stage in Act I. Pozzo is the owner of a slave named Lucky. Lucky has been given the daunting task of continuously carrying Pozzo's luggage and responding to every given command. Pozzo is often displeased with Lucky, and Lucky is subjected to abuse.

A set of miniature props were created including a stool, a whip, a rope, a basket, and a cloak. Intricate handling of props is a potential problem for robot thespians. For example, in many productions of this scene, Pozzo checks a pocket (fob) watch, in our robot production the robot checks the time on a wristwatch. Clothing can also be a particular issue for robots and can encumber movement, hence in this scene the coat which Lucky helps Pozzo don was replaced with a cloak/hood.

The two NAO robots performed the specified scene from *Waiting for Godot* using a combination of pre-programmed timing and visual or verbal cues. A software program from Aldebran Robotics entitled 'Choregraphe'© was used to program the movement, cues and the recitation of the lines for each robot.

As previously stated, the movements of the two NAO robots playing Pozzo and Lucky from Samuel Beckett's 'Waiting for Godot' are based on available online material from actual productions.

A televised version of *Waiting for Godot* performed by the San Quentin Drama Workshop (SQDW) in 1987 was selected as a primary source to define the robot thespian movement, since this version was directed by Beckett himself. The key movements of both Pozzo and Lucky were recorded, and programmed into the robots. The relationship between the character movements and the different spoken passages of Pozzo's monologue was also observed and recorded from the filmed version of this scene. Similar to movement, spoken

lines were also timed and recorded based on when they began and when they were completed.

The development of a robot theatre performance is dependent on accuracy; the robots need to be in exact positions on the stage to allow props to be passed between them. Therefore, the timing of movement and delivery of the lines was deemed to be a key feature underlying the programming the robot performance. To ensure that every line was said in sequence and none were skipped, the lines were programmed as a series. In other words, when one line ended, the next would begin. The next line could not be delivered until the last line had been finished. Individual chunks of programming code were created, and these were linked together to form a timed movement flowchart, where all of the robot actor's cue were set, so that individual sections of the code would run in the correct order. Figure 2 shows a small section of the programming flowchart controlling one of the robots, each icon in the figure represents a section of programming code. To give some idea of the complexity of the task involved in programming the robot thespians, it should be noted that this section of the flowchart controls no more than a few seconds of the performance of one robot.

In the initial performance the text to speech capabilities of the NAO robots was used to generate the audio for each of the lines delivered during the performed scene. Lines were timed with a stopwatch to validate that lines by the robot weren't being spoken too slow or too fast.

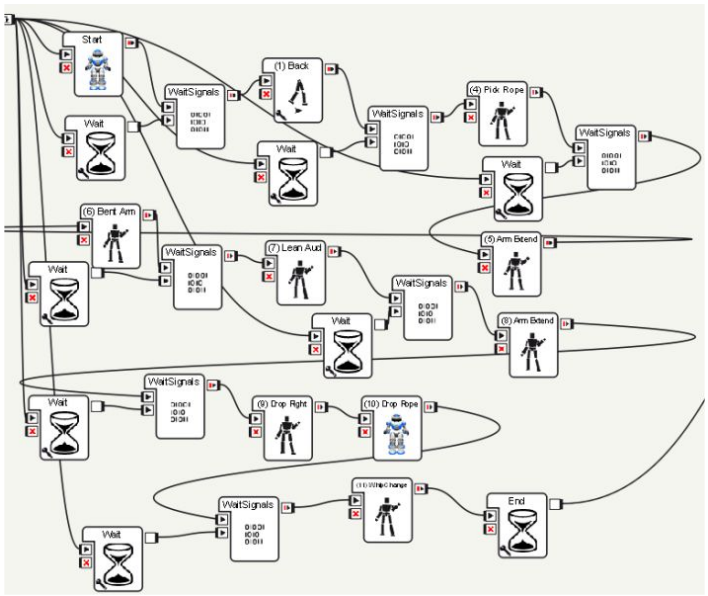

Figure 2: A Portion of the Robot Control Flowchart Linking Individual Sections of Code

Figure 3 : Cyborg Thespians in a Scene from the Production of *Waiting for Godot*

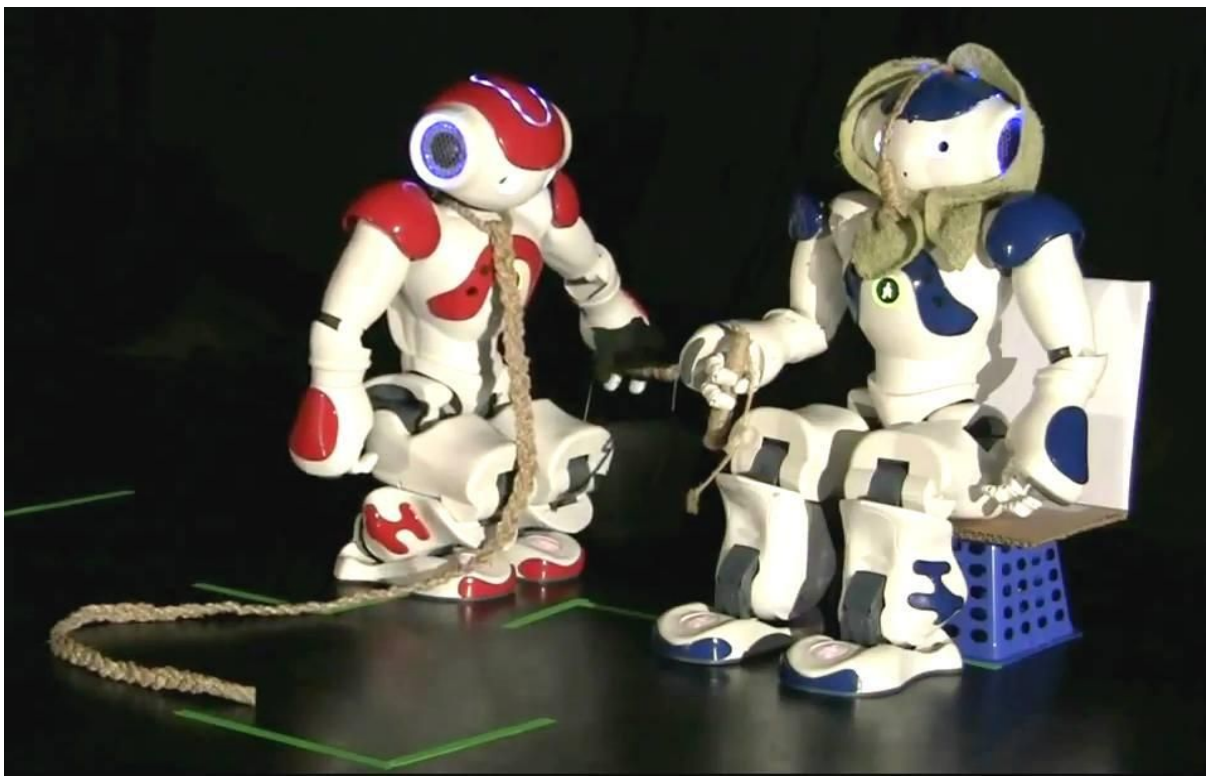

Figure 4 : Cyborg Thespians in a Scene from the Production of *Waiting for Godot*

(Scenes from the play Waiting for Godot performed using cyborg thespians can be viewed at https://www.youtube.com/watch?v=ZhTwKRjYXbo)

A small number of the gestures performed by actors in the SQDW performance were carried out extremely fast, at a speed which was impossible for the NAO robot performers to replicate. The gestures were still performed in the robot performance, but at a slower speed. The speed of the robot movements was limited since overly fast movements have the potential to damage the robots' servo motors.

A number of dress rehearsals of the scene were performed in the robot laboratory. When the cyborg performers were ready, the robots were filmed performing the play on stage in the university theatre department's acting laboratory. Scenes from the production are shown in Figures 3 and 4.

DISCUSSION

During the performance of each scene from the play *Waiting for Godot,* a number of technical aspects were deemed worthy of assessment during the performance of this play. The experiment was deemed a success, and the play ready for public viewing, when all of the following criteria were met.

- Firstly, the length of the scenes should be approximately the same length as real, recorded versions of the 'Waiting for Godot' pieces. The length of the production was deemed important because this will indicate how successful the robots were at moving into position and making correct movements.
- Secondly, the NAO robots must deliver all the lines from the play correctly, at the appropriate times, without missing any or making mistakes.
- Thirdly, the cyborg thespians must also complete the passing, grabbing, and picking up of props successfully. The success of props and lines will be a pass/fail condition, since these usually work in succession.
- Lastly, once the programing and preparation is completed, the robots should be able to perform the piece in one complete sequence. The overall performance of the scene can be viewed (in a technical capacity) as a pass/fail for every time both robots are run.

After weeks of preparation (one my think of this as rehearsal time) the robot thespians were ready for a public performance. Feedback was also obtained from audience members after the performance using simple questionnaires. For this initial experiment it was decided that this rough feedback mechanism would be sufficient to give some initial indications of any problems that the audience encountered with the performance.

There was a general feeling among the audience members that robots still need to improve in regard to movement. It was felt that the NAO robots did not possess as many degrees of freedoms as humans. Watching the video of the human performers, some movements were deemed too difficult for the robot to perform on stage – for example, the ability to rotate the lower body. Walking is a very common movement on stage, but the NAO robots walk differently than humans. It is very obvious in the robotic version of *Waiting for Godot* that this affected the experience of the audience who noticed these unnatural movements.

Grasping is also difficult to perform, as the human hand is very complex and is inherently difficult to replicate. For example, the NAO robots only have 3 fingers. One acts in opposition from the other two. Joints in the fingers cannot act independently in these robots, this created problems in the nuanced manipulation of some of the props.

The physical appearance of the cyborg thespians on stage was not seen as a problem by the audience. In the feedback, the audience were very accepting of the robot actors from the start of the play. It was felt that part of this was due to their engagement with the innovative nature of the robot performance. Interestingly, a number of audience members stated that they saw the robots as genderless.

Probably the biggest issue for robots while performing theatre is the lack of consciousness. Robots don't know where the director wants them to start a scene. They won't automatically figure out where they need to walk to, or altering their movement direction perhaps in response to something changing on set. If robots were truly autonomous, with strong A.I., they would behave more like true human actors, altering and improvising as the situation dictates. A sense of consciousness however is not the same as volition. That is, being able to learn and to improve, is not equivalent to a free will. It is arguable that many actions and lines produced are dictated so by a director or writer. Thus, one could argue that actors themselves do not possess volition. They merely follow a set of choreographed movements and repeat memorised lines.

CONCLUSIONS

> *"We always find something, eh Didi, to give us the impression we exist"*
>
> (Estragon in *Waiting for Godot)*

In conclusion, the NAO robots were able to stage a performance of scenes from *Waiting for Godot* successfully. A number of issues were identified by the audience members, mainly relating to movement of the robots. Of course, the larger research question, even in a simple

experiment such as this, is the efficacy of using robots as actors to perform in plays such as this and their effect upon an audience.

It is apparent that when an audience compares cyborg and human theatre, they will probably compare what the robotic actors lack to (what they believe are) perfected, human actors. Therefore, this comparison is biased since currently robots still lack autonomy, human motion and advanced language processing. However, robotic theatre still offers a degree of control and precision not available in human theatre. As in the human theatre, the success of the cyborg theatre will primarily depend on the response of the audience.

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