California State University, Northridge

AUDIO DESIGN FOR THEATRICAL PURPOSES

A thesis submitted in partial satisfaction of the requirements for the degree of Master of Arts in Theatre
by
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This thesis is dedicated to Dr. Bellman, Mr. Slutsky, Ms. Backlin, all the sound symposium people who worked so diligently and creatively; and to my family.
ABSTRACT

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Audio for the live theatre has usually been limited to "dead cues:" unalterable cues that the actor must respond to rather than the cue responding to the actor. Thus, the element most characteristic of theatre--real time--is removed. Lighting can be altered from performance to performance; audio, for the most part, cannot.

It is the premise of this thesis that sound is capable of being a major expressive element in theatre, like lighting and scenery. There are two major reasons why audio in the theatre has not fulfilled its capabilities: one, is the poor audio technology that exists in most theatres today, and two, the reluctance of theatre people to experiment with the new technology. Where then is the audio technology? In the recording industry millions of dollars worth of highly advanced equipment exists, with new equipment in constant development.

From the premise that sound can be a major expressive element in theatre, and that the technology to create it is available in the
recording industry, a sound symposium was developed to explore this relationship.

The sound symposium had as its goal the interfacing of two groups of people: people from the audio industry who have developed and learned to use the equipment and people from the theatre who are, as a group, almost unaware of the equipment's existence and potentialities. To this end, an array of equipment was assembled with the intent of interfacing it into the theatrical environment. Sound problems in Rhinoceros were chosen to give the technology a theatrical context in which to work. Rhinoceros was chosen for two reasons: it requires a wide variety of sounds and performances were scheduled shortly after the symposium ended (an ideal opportunity to apply the technology to an actual production). Several specific sound problems were extracted from the play and solutions presented to the symposium audiences. After the symposium, sound design for the actual production of Rhinoceros continued, utilizing findings developed from the symposium.

The thesis documents these activities, investigating findings, experiments, and theatrical application. It is divided into five sections: 1) a time-line sequence of events that led up to the symposium; 2) documentation of what occurred at the symposiums; 3) the sound design concept for Rhinoceros; 4) evaluation of findings and theatrical application from the symposiums, conclusions, evaluation of Rhinoceros, possible spin-off research; and 5) appendices that include a glossary and a Rhinoceros sound plot.

The audio equipment available to the recording industry can be applied to the theatre. It was demonstrated through an actual design-
research project that audio is a necessary and viable element for a total theatrical experience. The real time element, belonging almost exclusively to the theatre, can open avenues for audio that have never been dreamed of.
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INTRODUCTION

Audio design for theatrical purposes has, for the most part, been confined to augmentation and the use of pre-recorded sound effects that cannot be altered during performances. Augmentation is the reinforcement of sound created by a live source. Audio for the live theatre has usually been limited to "dead cues"—unalterable cues that the actor must respond to, rather than the cue's responding to the actor—or to simple background music and "sound effects." With a 'dead cue' there is little possibility of changing within a cue—making it longer or shorter, or working with the actor's voice as he speaks. Thus, the element most characteristic of theatre—real time—is removed. Lighting can be altered from performance to performance; audio as it exists in theatre today (excepting volume) usually cannot.

Sound is an essential element of almost every theatrical form. As in the case of the visual elements of a performance, the usefulness and effectiveness of sound is measured by the extent to which it is controlled. To exploit the visual element, the theatre utilizes such things as scenery, properties, special architectural arrangements, stage machinery, lighting instruments, and systems of lighting control. The effort to control the auditory element has brought forth kettle drums at the back of the theatre, mechanical noisemaking and effect machines, and pre-recorded sound effects. The twentieth century has brought a vast increase in acoustical knowledge and electronic and
mechanical facilities for the control of sound. Yet the theatre has somehow managed to keep audio design in a primitive state.

The audio element has been difficult for theatre to cope with. Perhaps it is a fear of the power of sound, perhaps a fear that it may overwhelm the actor or mask him. Whatever the reasons, audio design has been neglected as a viable part of the total theatrical experience.

Sound in the theatre can have the following functions: it can transmit the human voice in speech or song (adequate audibility is always the first requisite); it can establish locale (bird songs, traffic noises); it can establish atmosphere (wind, rain); it can create and sustain mood (combinations of devices used for locale and atmosphere, distortion of speech, soft music); it can serve as an independent arbitrary emotional stimulus (music); it can serve as an actor (voice of the Living Newspaper); it can reveal character (unspoken aside); it can advance the plot (sound bridges between scenes or episodes). However, theatre has as yet undertaken no elaborate control of these functions. Within the last ten years, new devices have come out of the sound recording industry which can offer the theatre ways of controlling audio.

It is the belief of this thesis that sound is capable of being as major an expressive element as lighting and scenery in the theatre. There are two major reasons why sound has not attained this capability:

one is the poor audio technology that exists in most theatres and the
other is the reluctance of theatre people to experiment with the new
technology. If sound can be a major expressive element in the theatre,
then where is the technology to make it possible? The technology is
not presently available in the theatre because most theatre sound
systems are totally inadequate. When we move into the recording in-
dustry, however, we discover that millions of dollars worth of theatri-
cally applicable, highly advanced equipment exists, with new equipment
in constant development. The recording industry includes broadcasting
studios, recording studios, and mixdown studios. Based on this
premise, that sound can be a major expressive element in theatre-- and
that the technology to create it is available in the recording indus-
try-- a sound symposium was developed in the Department of Theatre,
California State University at Northridge, to explore this relation-
ship.

The sound symposium was conceived by Dr. Willard Bellman and Mr.
Robert Slutsky in an attempt to bring the technology of the recording
industry to the awareness of theatre people. This symposium initially
was to unfold over a two-day period, on two Saturdays in January, 1977.
When it was learned that the Audio Engineer Society (AES) were to have
a meeting the Tuesday between these Saturdays, they were invited to
hold their meeting at Northridge, and be presented with a mini-sym-
posium. After the wheels had begun turning for these events, Dr. Bell-
man learned that a production of Ionesco's Rhinoceros was to be staged
in March. Because this play has many sound problems, he suggested to
the director, Ms. Helen Backlin, that *Rhinoceros* be used as a testing ground for some of this technology to be demonstrated at the symposiums. Consequently, the symposiums took on a problem-solution format, whereby the sound problems in *Rhinoceros* served as a focus for the use of the equipment. Dr. Bellman then sought a Master of Arts candidate to document the entire activity in the form of a thesis. I as this Master's candidate began my documentation in November, 1976. My task was to carry a cassette tape recorder and record all activity connected with the symposiums and *Rhinoceros*. In mid-December, it was learned that the sound designer for *Rhinoceros* could not fulfill that obligation. I was asked if I might like to perform this additional role, and I accepted. Thus, my Master of Arts degree not only included writing a thesis, but also performing as sound designer for the production of *Rhinoceros*.

This thesis is the documentation and evaluation of the activities connected with the symposiums and the sound design for the production of *Rhinoceros*. Some conclusions concerning audio design for theatrical purposes have been drawn from the findings of these activities. It is the intent of the thesis to expand the potentialities of audio design for the theatre by not only exploring the technical capabilities of the recording industry within a theatrical context, but pose some theatre-audio problems for future research.

The thesis is divided into four main sections: 1) a time line sequence of events that led up to the symposiums; 2) documentation of the symposiums; 3) my sound design concept for the production of
Rhinoceros; and 4) evaluation, conclusion and a list of research possibilities for the future. An appendix and bibliography follow. In the appendix is included a glossary that has been compiled in order to define engineering or recording industry terms in theatrical language.
TIME LINE SEQUENCE OF EVENTS

The following section will provide a time line sequence of events that led up to the symposiums.

An array of equipment was gathered together, loaned by manufacturers from around the country. This equipment was not necessarily new to audio engineers, but was probably totally new to most theatre people. Because the equipment utilized for the symposiums was loaned, the final array received and the date of arrival were at the manufacturers' discretion. The final equipment array included the following:

- console (Cetec Audio, designed and constructed for theatrical use)
- Time Warp device (MicMix)
- digital delay units (Lexicon)
- omni-directional wireless microphone (Hollywood Sound Systems)
- Varispeech (digital device, Lexicon)
- two track Sculley tape deck
- A7 speakers, A3 speakers, JBL speakers (CSUN Theatre and Music Departments)
- Putney synthesizers (CSUN Music Department)
- reverberation unit (spring echo chamber, MicMix)
- oscillator (CSUN Theatre Department)
- Altec amplifiers (CSUN Theatre Department)
- graphic equalizers (Parasound)
- hand-held Vega microphone (Hollywood Sound Systems)

GENERAL OVERVIEW OF THE SEQUENCE OF EVENTS

November 29: meeting between Dr. Bellman, Mr. Slutsky, and myself on information to include in the mailer

December 12: first meeting of personnel involved in setting up the symposiums: students, manufacturer representatives, and audio people.
Two groups evolved: technical and program setting

January 12: equipment hook up and program material discussion

January 13: Cetec console and Time Warp arrive and are set up in the sound booth; experimenting begins

January 14-16: experiments in sound booth

January 17: other equipment begin to arrive; console moved down into the orchestra pit; experiments continue

January 18: Rhinoceros sound design discussed; experiments continue; more equipment arrives

January 19-20: experiments continue; equipment arrives

January 21: experiments and program are set for the first symposium, January 22

January 22: first sound symposium

January 23-25: experimenting in conjunction with the first symposium's findings; program set for the AES demonstration

January 25: AES demonstration

January 26-28: program set for the second symposium, January 29; experimenting

January 29: second sound symposium

January 30-31: break down and return of equipment (some equipment remained for use in the Rhinoceros production)

February 1-24: sound for Rhinoceros completed and rehearsed with cast

February 25-27, March 1-5: Rhinoceros performances
At the November 29 session, a discussion was held to establish goals, responsibilities of the personnel involved, and a projected time line. Mr. Slutsky expressed a concern as to the number of pieces of equipment to be demonstrated: if we receive too much equipment, the symposiums would turn into an equipment show and would defeat the real time application. (Real time is an engineering term which may be defined as dramatic or virtual time--live time as opposed to recorded time.) A concern was expressed as to the interrelating problems of the theatre audience and audio engineer audience. It was thus resolved that the two Saturdays would combine both technical and artistic considerations. Dr. Bellman suggested that the symposiums follow a problem-solution format in order to give the technical people a context in which to apply the gear. Mr. Slutsky and Dr. Bellman would serve as co-hosts in order to maintain some form of continuity in the symposiums. Dr. Bellman would handle artistic considerations; Mr. Slutsky would tackle the technical considerations.

Dr. Bellman and Mr. Slutsky noted that theatre audio consists of four major categories: 1) pre-production work (recording effects in a non real time situation that would eventually be played in a real time situation); 2) purely technical considerations; 3) creative distribution of pre-recorded effects and real time dynamic effects; and 4) documentation, or logging, of tests, experiments, and findings. The goal
of the symposiums was to stimulate directors and audio people to realize the potentialities of audio design for the living theatre. Thus the symposiums would need to concentrate on the real time aspects of the equipment rather than on the effects that one could create with the equipment. It was noted that there are two categories of recording: One is recording that has as its final objective a tape or disc that would be played at another time in some other way, such as pop music (this aspect of recording the symposiums should avoid) and, two, recording that has as its objective sounds that would be played in a real time situation (this was the aspect of recording that the symposiums should be concerned with).

The November 29 meeting basically surveyed the intention of a sound symposium, the problems to watch out for, and the definition of some basic audio problems as they relate to the theatrical environment.

December 12

The December 12 meeting was called to introduce the personnel who would be involved in the development of the symposiums, to set some goals, and to define some problems. Mr. Slutsky stated the premise of the symposiums and the purpose of the December 12 meeting: "A lot of equipment has been made available to us from the recording industry. We are going to try and apply this equipment to real time theatrical conditions. We will divide the personnel into two teams: program and goals, and technical problems." Dr. Bellman headed the program and goals team, while Mr. Slutsky headed the technical team. The program
and goals team were to concentrate their efforts on locating people to present papers, organizing the symposiums, developing experimentation guidelines so as not to let the testing get out of hand, documentation, and methods of organizing in order to get an interchange of ideas between the audio and theatre peoples. It was suggested that preliminary sessions on basic sound principles be set up for those students who were interested in participating, but had little audio knowledge. The technical team would provide a list of equipment, develop a single line (design for placing equipment and speakers), and be responsible for power placement. Mr. Ron Schwartz, a representative from Disneyland, suggested that a "shopping list" of equipment be created--a list that would describe what each piece of equipment was capable of doing.

The technical team considered problems of interfacing gadgets with the hard system, the hard system being console-to-amplifier-to-speaker. Questions concerning grounding and power supply were considered. It was decided that the array of equipment would be placed in the orchestra pit, where all the power would be concentrated. The problem of equipment being in two physical places was considered; the array of equipment loaned would be situated in the orchestra pit, but the amplifiers and three tape decks were upstairs in the sound booth. Mr. Byron Bauer from California State University, Los Angeles, was given the task of developing a system of patching the equipment into the console. The console would be the central piece of equipment; the outputs of the console would agree with the joystick positions on the PDS system; most of the equipment should enter the console at line level, with a few
modules reserved for looping.

The program and goals team discussed the demands a script would place on the equipment. Knowing the tools we would have available to us, what does the director want? Develop a strategy outline for utilizing the equipment. It was hoped that a goodly number of directors would pose problems that the technical team would attempt to solve. A procedure for experimentation was discussed-- because the real time experiments would be fairly new to the theatre world, we should 1) set up the experiment; 2) work it out; and 3) evaluate its effectiveness before continuing to the next experiment.

It was pointed out that the symposiums and experimentation would need to solve a series of sound problems that related to Rhinoceros as well as solving general sound problems that emerged out of the first symposium. The element to keep us on track was the production of Rhinoceros-- to bring the equipment tests to the reality of the theatre. Several experiments were proposed at this time. Mr. Slutsky asked: "How can one make the walls in a theatre appear to move?" Ms. Backlin stated a sound problem that related to Rhinoceros: "As the play progresses, the set gets smaller and smaller, but sound grows and grows until the audience is engulfed in a sea of sounds." A question was asked by Dr. Bellman: "How many sound placements can we generate at one time before we generate chaos?" He also suggested that we experiment with an actor's voice being hooked up to a wireless microphone. It would be up to the artistic team to propose these kinds of questions, and the technical team to attempt solutions.
The purposes of the December 12 meeting were to set a course of action for the symposium personnel to follow, outline some basic problems that we should expect to encounter, and encourage the symposium personnel to gather an audience.

January 12

The January 12 meeting was called for two purposes: one, to discuss a procedure for equipment hook up (a second hook up procedure would take place for the equipment that remained for the Rhinoceros production), and, two, to locate some program material to process through the equipment.

Wiring should be completed before January 17 (day when most of the equipment was arriving), so that it would be ready to accept the equipment. The projected course of action for January 17 would be to hook up the equipment, grounding everything through the console. After the equipment had been hooked up, a method of labeling all the cables and where they plug in needed to be devised. It was noted that no matter how the equipment was turned on, the power amplifiers must go on first, and be shut off last.

The problem of appropriate program material began to make itself evident at this time. Mr. Bauer assumed the responsibility of locating program material. It was suggested that sounds to be used as program material should 1) have good dynamic range; 2) sound good when in movement (either panned or delayed); and 3) include some live sources, an actor on a wireless microphone for example.
The January 12 meeting basically prepared the symposium personnel for the January 17 week of equipment hook up and associated problems.

January 13

On January 13 a discussion between Mr. Slutsky and myself took place, consisting of three main topics: 1) the operation of the Cetec console; 2) audio design for the production of Rhinoceros; and 3) theatrical audio problems. The following is a summary of this discussion.

The Cetec console was designed and developed for use in the theatre. It is capable of serving three functions: 1) create effects; 2) reinforce live sources; and 3) playback pre-recorded material. The left side of the board is comprised of input modules. Each module includes feeds to four busses (two foldback busses, one echo-send bus, and a panner) and equalization for high, middle, and low frequencies. Mr. Slutsky stated that in theatre we do not mix down (as is done in the recording industry), we mix things together. Also, we should avoid stereo signals as much as possible as theatre is not merely stereo; its use of directional sound can be more complex than stereo. No console has ever really been designed for the theatre. Most mixing boards are designed with more input than output capability because of the demands of the recording industry. However, in theatre, there is a possibility of more outputs than inputs-- which could have some interesting possibilities in theatrical console designing.

The most confusing aspect of the Cetec board is the Pre Set Dis-
The PDS module makes it possible to rehearse and preset audio output signals. It was designed to control the outputs of the Cetec console where complicated changes in mix content and signal placement are required. It can be used as a remote device from the house to control volume. One of the major problems in mixing a theatrical production is the inability of the mixer to hear what the audience is hearing. The PDS was designed to help combat that problem.

When the topic turned to audio design for *Rhinoceros*, I asked Mr. Slutsky how all this equipment could be applied. He responded: "Let us attempt to set up some guidelines for the utilization of the equipment. First let us take a scene from *Rhinoceros*: the final monologue in which Berenger must deal with being engulfed in a sea of rhinoceroses. Let us say he goes through three states of being: 1) not being sure if he has done the right thing (by not joining the rhinoceroses); 2) desiring to join but not being able to; and 3) determining never to join-- not capitulating. He believes he should not be a rhinoceros, slips into the possibility of becoming one, then escapes from it. Let us set up a hypothesis: when Berenger is in doubt, he begins to sound like a rhinoceros. How can we establish this in the audience's mind? One, we can equalize the actor's voice. Let us say his voice will get deeper the more he is in doubt. The operator attenuates the high and middle frequencies, boosting the low frequencies. Berenger hears his voice getting deeper, causing him to have more doubts. Here we have an example of actor-operator interplay in real time! Second, we can
slow the speed of his voice. Using the Time Warp or another device, we can force Berenger to slow the rhythm of his speech. Third, we can move his voice. Let us say that when a human transforms into a rhinoceros, his voice appears to leave his body. Berenger's lips are moving, but his voice appears not to be where his body is. Now we have set up ways for becoming a rhinoceros: 1) the voice deepens; 2) the voice slows in pace; and 3) the voice appears to leave the body. As Berenger realizes he will not become a rhinoceros, he begins to grab his voice back—return to reality by making his voice go the way he wants it to. The operator would then reverse the process and when Berenger is himself again he has won the battle of non-capitulation. What we constantly need to ask ourselves throughout the weeks of experimentation is: Can we do something theatrically with this equipment other than just make weird noises? When approaching the sound design for Rhinoceros ask yourself questions like: Is there but one rhinoceros sound needed throughout the play? Is it linear? Does it get louder and louder? Do the rhinoceroses have feelings? And so on."

Mr. Slutsky then remarked that the most difficult challenge that we the symposium personnel will face is focusing ourselves on specific tasks—specific theatrical audio problems that the program and goals team develop and the technical team attempt to solve. If we give ourselves no specific tasks, it will be an experiment in nothing. We also must document the experiments. Theatre concerns itself with repeatability. If we cannot repeat what we create, it will have little value for the theatre. Therefore, we must approach this equipment in two
stages: first, to play around with it at random, just to see what it does; then focus the experiments on the accomplishment of specific tasks. This is why the production of *Rhinoceros* is such a marvelous opportunity. *Rhinoceros* is a theatrical production that can concentrate random experiments on specific problems.

January 13 was also the first day of experimentation. The equipment available for these initial experiments was the Cetec console, the Time Warp device, a hand held microphone, an audio oscillator, and a turntable— all patched through the Cetec console. These initial experiments were conducted with a live voice being processed through the Time Warp. Mr. Slutsky suggested that we keep in mind what we are doing to and with our voice as we hear it processed. Two problems emerged: Will the actor adjust his voice to compensate for what he hears? How much voice alteration can occur without losing intelligibility? It was discovered at this time that one tends to change the way one speaks to compensate for what one is hearing. As loss of intelligibility occurs, one will tend to change one’s rhythm in order to regain intelligibility. Thus, an actor will unconsciously alter his own vocal rhythm in order to understand what he is saying.

To further these live voice experiments, a group of rehearsing *Rhinoceros* actors were invited to the sound booth. One by one each attempted to keep his normal speech patterns as his voice was being manipulated through the Time Warp. It was discovered that the actors tried to keep up with their own voices. In an attempt to allow the
actor to continue his normal speech patterns no matter what the distortion introduced, the console operator began with no distortion (flat) and slowly mixed in the Time Warp. It was discovered that the equipment was more powerful than what we were willing to do with it.

Because of the console's poor human engineering for the theatre, distortion levels could not be subtly handled. The volume control slider, for instance, did not have enough movement capability (needed more linearity). Thus subtle changes in volume levels were not easily accomplished.

These initial experiments resulted in some questions that I posed to Mr. Slutsky: E.g., would an actor need to whisper into his wireless microphone in order for the audience to hear just the processed voice? Mr. Slutsky answered that it would depend on the size of the theatre and the skill of the operator to balance the live voice and the processed voice. How can this audio equipment be applied to real time theatre versus the dead cues we are used to, e.g., if a sound cue is on tape, can it be made to work in real time? Mr. Slutsky answered that by creating a tape loop, a sound operator can follow the action on stage and let the cue run until the action dictates its removal. What we are accustomed to is a sound cue that is recorded at a stipulated length of time, say ten seconds. This gives the action on stage ten seconds to complete itself. Real time rhythm is thus destroyed by a dead cue. Another possible real time application of tape cues is in volume control. For example, the rain might increase in volume as the actor becomes more and more agitated.
Mr. Slutsky remarked that the kinds of experiments we are attempting at the symposiums are new. The actor needs to be trained to work with the equipment. A musician controls his own instrument to produce music. Here, the actor is allowing a technical operator to play his "instrument" (his voice). This is a frightening realization for actors, and one of the reasons why audio in theatre is at such a primitive level. Both the operator and the actor need time to learn to orchestrate themselves in relation to one another. In order to develop audio for the theatre to its fullest capabilities, we need to start training operators and actors as musicians are trained. The ideal situation would be to train for one or two years on each gadget that we receive.

The key to real time audio in the theatre is early rehearsing. If the audio people wait until tech week (the week in which technical aspects of a production are integrated with the actors) to integrate their sounds into a production, they will be lost. It would be like waiting until the last week to learn the melodies of an opera. The actor and operator are like an accompanist and a singer. They must be orchestrated together, learn to perform with one another. This inevitably will elevate the operator's position: the designer "sets up the keyboard" and the operator becomes a musician, an interpreter of what the designer has composed. As of today, it is a rare and unique individual that understands both the artistic and technical aspects of audio for the theatre.
January 15 and 16

Console and Time Warp experiments continued on January 15 and 16. Experiments that would possibly apply to the production of Rhinoceros were conducted. Source materials used were sound effects recordings. Two sound cues needed for the production were found on a sound effects record, church bells (specifically the tolls of Big Ben) and a cat and woman scream. These sounds were processed through the Time Warp and recorded onto a Rhinoceros work tape. It was hoped that by processing these dry effects (sounds that have little or no distortion), a distortion technique would be discovered that could serve as the "line of terror that threads through this play" (as expressed by the director, Ms. Backlin). Other experiments concerned processing recorded animal sounds through the Time Warp and taping the results in an effort to locate a believable rhinoceros "trumpet."

At this time the notion of a "subliminal rhinoceros" was discussed: a low frequency rumble created by the oscillator that could be felt more than heard. This "subliminal rhinoceros" in combination with an elephant "trumpet" were processed through the Time Warp and recorded onto the work tape.

January 17

January 17 was the day that most of the equipment was to arrive. It was hoped that all wiring and hook up could be completed by the
afternoon so that some initial experiments could begin. The reality of a symposium began to take form. That morning personnel began working on wiring, grounding, and moving the console and Time Warp from the sound booth to the orchestra pit where most of the equipment was to be placed. It was learned that many pieces of equipment would not arrive until later in the week, so it was concluded that the technical team would hook up all currently available equipment. Towards the late afternoon, the system was ready to be turned on. Initial experiments consisted of random experiments with a tape prepared by Mr. Bauer, processed through the Time Warp, oscillator, and a digital delay unit. Mr. Slutsky suggested that the operator begin flat and slowly mix in distortion in order to focus the otherwise random playing around. It was thus discovered that intelligibility can be retained if a dry sound is mixed in with the distorted sound. For example, if an actor is speaking as his voice is being distorted, intelligibility can be retained if two channels are mixed: one channel of natural voice and one channel of distorted voice.

On this day it became evident that not enough effort had been put into locating program material to be processed; we had been so worried about gathering equipment that the search for good program material had been neglected.

January 18

On January 18, we found problems with several of the console's modules, as well as general problems in circuitry and speaker hook up.
Thus no experimentation took place on this day-- the day was devoted to solving problems in hook up. However, a sound design meeting between Dr. Bellman, Mr. Slutsky, and myself occurred. Highlights from this discussion follow.

The discussion concerning Rhinoceros dealt with three problems: the Daisy-Berenger scene in Act III, the Boeuf scene in Act II, and a foundation or basic rhinoceros sound. The basic problem in the Daisy-Berenger scene was one of perspectives: Daisy hears sweet sounding rhinoceroses that lure her into transformation and Berenger hears ugly sounding rhinoceroses that repulse him. Dr. Bellman suggested that one track on a tape have low gallumping sounds that would serve throughout the play as rhinoceros herds. On another track, an assortment of trumpetings and snortings would be processed through the Time Warp. It would be the different Time Warp settings that would determine the quality of those rhinoceros sounds, thereby creating ugly and sweet rhinoceroses. Then, after having made the sounds, they could be located in different places in the theatre. Thus, electronically, the signal would go from tape to Time Warp to some method of locating those sounds. Sweet sounds could emanate from speakers closest to Daisy; ugly sounds could originate from speakers closest to Berenger. At this point, Mr. Slutsky stated that it would be necessary to keep in mind that the rhinoceroses Daisy hears make a sensual sound that allows the characters to want to transform, i.e., the sound must also appeal to the audience-- the concept of Muses would be a good symbol
to use. At the same time this sound must also be frightening, in order for the audience to understand Berenger's perspective. This is where the Time Warp and all the other gadgets will come into play—they will alter the rhinoceros sounds giving them gradations, e.g., elongate the sounds, stretch them out, or anything agreed upon as the dramatic convention for rhinoceros sounds. Mr. Slutsky emphasized that we as sound designers must keep in mind that it is the actor who must give all of this verbal validity. Dr. Bellman suggested a possible consideration would be to put a wireless microphone on Daisy as well as on Jean and Berenger. As she hears the sweet rhinoceroses and begins to succumb to their lure, her voice begins to alter (distort); thus, not only does she hear them, but she begins to sound like them. This brings to mind a possible audio experiment: that we have an actor come in for the symposium rehearsal, put the wireless on him and let him project at full volume and do whatever he wants to. Watch what happens to him—his facial expressions, the way he operates—as he works with no restrictions. Then give him specific tasks, such as tone his voice down without losing his actor's energy. Find out if he can handle that kind of a dramatic transition. This may be limiting to the actor because it is usually the actor's voice that carries the emotion, and a good actor will use it as a good tool. This kind of experimentation needs to go on early in rehearsals in order to be workable.

Mr. Slutsky suggested that in connection with a foundation rhinoceros, whatever the source would be, a procedure should be fol-
lowed: set up patterns of rhinoceros sounds, such as grunt--snort, pant--snort, etc. Whatever the pattern, keep in mind that it should have a beginning, middle, climax, and denouement. Then, to create variation, use the recording industry's technique of overdubbing: mixing more and more sounds in. Lay these sounds into tape loops so that they can play indefinitely. In this way, the operator can bring the sounds in and out, in real time, as they are needed. Better still, consider the possibility of two loops: one track of rumblings and one track of trumpets and snorts.

The final Rhinoceros sound problem discussed on this day was the Boeuf scene in Act II. Mr. Boeuf, already changed into a rhinoceros, follows his wife to the office where he calls to her to transform and be with him. The sound problem is one in which Mrs. Boeuf recognizes his call as meant for her, i.e., he speaks to her. Mr. Slutsky suggested that as a possible solution for this problem, use an actor's voice as the foundation rhinoceros sound. Process his voice, his words, through the Time Warp. Mix in his voice, his words unprocessed. The combination of a flat source and a processed source should give a fairly intelligible result.

The discussion then turned to the progress being made in terms of goals that had been previously set for the symposiums. Mr. Slutsky predicted that the personnel involved with the symposium should expect to be singularly frustrated--that the things we would want to do and try would not materialize; we just will not have the time or the chance to do all that we want to do. The important value will lie
in what we attempt to do and the documentation that may result. Our strength will lie in the attempt at artistic application of the equipment. If we can show the directors who attend the symposiums some of the techniques we are discovering, such as the wireless experiments, perhaps we can propel theatrical audio design toward the creative, expressive element it is capable of being.

January 19

January 19 was a day to complete hook up of the system and experiment for Rhinoceros effects as well as general effects. Some initial voice experiments began with the actor playing Jean speaking through a hand held microphone. Some of these experiments included 1) Jean's voice processed through the Time Warp and the digital delay unit; 2) Jean's creating rhino trumpet sounds, processed through the Time Warp; 3) mixing Jean's dry voice with his distorted voice (the distortion created by processing his voice through the delay unit; a problem appeared as a result of this experiment: subtlety in distortion proved very difficult to achieve); and 4) Jean's trying to be a rhinoceros and creating a series of pantings, trumpetings, snortings, and grumblings. These experiments were taped and it was thought that they might serve as the foundation rhinoceros for the Boeuf scene, and perhaps for the entire play. Then the problem of a "subliminal rhinoceros" was tackled. Some low frequency tones were generated by the Time Warp and the oscillator. The tone desired was to be felt rather than heard. However, the speakers broke at about twenty Hertz,
i.e., the speakers went into distortion because the tone exceeded the speakers' capability to perform. Even though a felt tone could not be achieved, the resulting sound was thought to have possible application as a herd of rhinoceroses stampeding.

Dr. Bellman suggested that the rhinoceros sounds be divided into four categories and made into tape loops: 1) rumblings and stomping to be created by the Putney, or Time Warp, or oscillator, or running a recording of horses galloping at half speed or any combination of these; 2) dry trumpetings and snortings; 3) trumpetings and snortings that were processed as Daisy's theme; and 4) trumpetings and snortings that were processed as Berenger's theme. These could then be used in conjunction with a live voice.

The evening of January 19 was devoted to experiments with a live actor. This actor, Mr. Bill Jensen, was to perform with the equipment as part of the symposiums' demonstration. His comic routines were processed by the console operators. Equipment used in conjunction with his voice to create effects included 1) the echo chamber for his "god effect"; 2) the delay unit for his "Swedish effect"; 3) the Time Warp for his "ocean effect"; 4) the Varispeech for his "outer space effect"; and 5) a "jet plane effect" created by combining the Time Warp and the echo chamber.

January 19 was a day of great amounts of experimenting. At this point all the equipment that was used for the symposiums (except the two track Sculley tape recorder) had been assembled and connected.
January 20

January 20 was a day of general experimentation in relation to Rhinoceros, and a meeting of the personnel involved in the symposiums' panel discussions. One experiment involved creating low frequency rumbles using the Putney synthesizer. The problem was to find a low frequency pulsation, randomize the rhythm, and thus create the illusion of a subliminal rhinoceros herd. Although the Time Warp and oscillator had generated low frequency tones, they were thought too rhythmic. The Putney proved capable of solving this problem. Another problem solved by the Putney was the creation of a rhinoceros gallop. An experiment conducted with members of the Rhinoceros cast involved creating a series of sounds that would be processed and possibly used for the production. The recording session lasted for almost two hours and consisted of a variety of tasks for the actors: 1) stomping about the stage; 2) carrying on different kinds of conversations; and 3) vocalizing rhinoceros trumpets, grunts, and pantings. It was hoped that these sounds would eventually be processed and serve as the foundation sounds for the entire production. Meanwhile, the Putney proved capable of creating rhinoceros trumpet sounds. If all else failed, this could (and did) serve as the foundation rhinoceros.

The January 20 panel discussion meeting was comprised of Dr. Bellman, Mr. Shawn Murphy (professional sound designer), Ms. Backlin, and myself. This meeting served as a rehearsal for the panel dis-
cussions that would take place at the two symposiums and the AES meeting.

Dr. Bellman began by stating that the January 22 panel discussion should concern itself with audio design problems relating to Rhinoceros. He suggested that we stay with artistic considerations and leave technical solutions for the second Saturday. The first Saturday panel, and especially the AES panel, would aim their talks to people who would be generally unfamiliar with a design production meeting. However, it must also be realized that the theatre audience would be people who usually experience sound design by having the stage manager draw up a list of sound cues required by the script, giving it to a technician, and the technician's recording dead cues onto a tape. Thus, by implication, we would also be educating the theatre audience. Dr. Bellman suggested that we keep in mind that two different kinds of audiences would be addressed: theatre people and audio engineers. The language of each group of people is quite different. This problem of language is one of the key hindrances to communication between these two groups. It is necessary for both theatre and audio people to learn one another's language if any valuable interchange is to take place. Such a term as real time, an engineering term, means nothing to theatre people; and a term like virtual or dramatic time means little to engineers. Yet these terms are almost synonymous. Thus one of the goals of the panel and ultimately the symposiums should be an attempt to bridge the language barrier. At this point a mock panel discussion began. The following points were discussed.
Ms. Backlin began by stating her concept of the play: The play is about people turning into rhinoceroses. The point of the play is that conformity of any kind, any "-ism", is wrong--anything that destroys individual free thinking is a menace. She then proceeded to state her concept of the sound: The sound starts off small, getting larger and larger until sound engulfs the entire theatre at the end—it's like a flower that blossoms. Two problems: How can we make the audience feel threatened by this engulfment and how do we attain distinguishable rhinoceroses, such as what Daisy hears versus what Berenger hears?

I continued with a question pertaining to the reality of the rhinoceros sound: Should it be a genuine rhinoceros sound or a symbolic one? i.e., should the foundation rhinoceros sound like a genuine rhinoceros, or could this sound be a synthetic one generated to theatrically represent a rhinoceros? Ms. Backlin replied that it should sound like a real rhinoceros at the beginning of the play, but by the end it should sound completely symbolic or surrealistic. Mr. Murphy asked: If we begin with a realistic rhino and then move away from that realism, how would it sneak up on the audience? I suggested subliminal rhinoceros sounds that would be under the first sound cues; not recognizable, but when becoming consciously audible, they would not take the audience by surprise. Ms. Backlin continued that in the last two acts, distortion could go as far as we could stand it. But in Act I the single rhinoceros sounds heard should be on a realistic
level as the fear of them would not have taken hold yet. Mr. Murphy suggested that a genuine rhino sound not be used for two reasons: one, the problem of quality in the recording, and two, the advantage of taking the distorted rhinoceroses as far as possible at the end of the play.

Mr. Murphy then asked: If at the end of the play the audience is engulfed in sounds of drastic distortion, how will we contrast that from the beginning so that the end has the most impact in terms of sound? He suggested that a sound designer should put these questions to himself: Do you solve this problem by bringing up the level? Do you solve this problem from a directional point of view rather than the level? i.e., single directionality at the beginning of the play, multi-directionality by the end. He suggested that when we produce the rhinoceros sound cues, we put the reverberation of the signal on a different channel and slowly take the reverberation out into the house, so that the audience is not hearing the cue out in the house, just its reverberation.

The next problem discussed was one of identifying the rhinoceros: how is the sound identified as a rhinoceros? Ms. Backlin stated that in the script the actors repeat, "Oh! a rhinoceros," over and over for about thirty seconds. Once the characters see the rhinoceros, they identify it.

Ms. Backlin then stated a specific problem that occurs in Jean's transformation scene: What can we as theatre people do to make that transformation as believable as possible as far as sound is concerned?
The actor has a naturally powerful voice, but how can we make those sounds even greater? Is there a way through technical means of doing things to that actor's voice to make it more "rhinoceritic?" To take it out of the human voice range by the end of the scene? Mr. Murphy suggested wiring him with a wireless microphone. Ms. Backlin wondered what that would do to the actor: Would he have to compensate for augmentation; would he have to change his vocal intensity? This idea of a wireless microphone raised other questions: Would it pick up nearby actors? Do we hang microphones on all the actors? These technical considerations should be saved for the second Saturday.

Mr. Murphy suggested that because the actor portraying Jean was the strongest actor vocally, we should consider using him to do all our rhinoceros cues: use him as our foundation rhinoceros.

In terms of the Daisy-Berenger themes, Mr. Murphy suggested that we take the same basic effect, alter it by, for example, a quarter tone, put the themes on different tracks and give ourselves the capability of mixing these sounds around the theatre, so that the audience would have the impression that they were hearing both Daisy's and Berenger's rhinoceroses.

The next question raised was one pertaining to individual rhinoceroses. I suggested that it may be possible to have actors up in the sound booth producing real time rhinoceroses as they are needed for the show in progress. Mr. Murphy replied that we could begin with different rhinoceros sounds with the intention of making them one by the end of the play. He continued that we make clear to our symposium
and AES audiences that there are lots of ways to solve these audio problems. Also, it must be kept in mind that the actor is the primary symbol in the production.

I pointed out that the third act has sound all the way through, at varying levels. Mr. Murphy suggested that we should be careful of trapping ourselves into not having developed sound that is believable—a matter of consistency. We must have enough sounds introduced by the third act so that a consistency can be maintained, i.e., the vocabulary has been developed in act I and II, and now it would be used in act III. He noted that it is important that sound design not only be consistent with itself, but consistent with the other design elements—lighting, sets and costumes.

Ms. Backlin questioned: Would it be acceptable to open the sound into the entire theatre? Mr. Murphy replied that what would bother him would be to suddenly have sound in the house where it had not been before. If the audience is already psychologically oriented to sound from the stage in front of them, introducing sound into the house would ultimately destroy the play. The way around this problem would be to sneak the sound up on them, so that sound is in the house from the beginning, but at an almost imperceptible level. A possible way to accomplish this would be to use a speaker in the attic. It is nearly impossible to tell where a sound is emanating when it comes from this position.

Mr. Murphy concluded this mock panel by stating that there are two things that can stand in a designer's way: How skilled are those
who operate the show, and thus how complicated can the design be, and the kind of system the sound is played through. He added that only one rationale should be used for doing live sound cues versus taped cues: if it is impossible to create real time rhythm with tape.

January 21

January 21 was an intensive day of experimentation and program setting. The first symposium, January 22, demanded that a general scheme of demonstration be set.

The Sculley tape deck finally arrived. Up until this point, someone was needed upstairs in the sound booth to change and rewind tapes. The arrival of the Sculley proved a great convenience.

The morning of January 21 was devoted to the Rhinoceros people's completing their program. After many hours of experimentation with the devices in attempting to discover a believable rhinoceros gallop, one of the operators picked up a hand held microphone and began tapping on it with his fingers. That became the most believable rhino gallop up to that point.

Dr. Bellman suggested the "soda fountain" concept: that many tape loops be created for the operator to tap into at any given moment, mixing together any sounds that he would deem necessary, for example, one loop of rhino gallops, one loop of rhino trumpetings, and one loop of rhino pantings. These loops would run continuously, so that the operator would need only to manipulate gain levels. In this manner, the operator could tap into the loops at any given moment, mixing the sounds
together.

The first wireless experiments with the actor portraying Jean occurred on this day. One of the initial problems was the wireless picking up the other actor. Two solutions were proposed: that the actors not be close to one another; and that the wireless operator ride gain, i.e., take the level down when the two actors were close to one another.

On this day the 'lure' was created. An untuned violin processed through the Varispeech and Time Warp, recorded at 15 IPS and slowed to 7½ IPS created this 'lure' effect. The 'lure' was to serve as the 'Cosmic Rhinoceros' that lured the characters on stage into transformation (conformity). It was to serve as the Master Symbol that would tie the audio design together. At the beginning of the play the 'lure' would occur almost inaudibly for short periods of time. As more and more of the characters succumbed to transformation, the 'lure' would become more audible and play for a longer period of time. By the end of the play, the 'lure' would run almost continuously at a definitely audible level. This 'lure' would serve as sound's symbol of "the black line of terror that underlies the play."

It was decided that the second symposium would present two scenes from Rhinoceros: the transformation scene and the last scene between Daisy and Berenger ending with Berenger's monologue.

The afternoon of January 21 was turned over to the rehearsal of the equipment demonstration. This rehearsal was led by Mr. Slutsky, with Mr. Bauer at the console (Mr. Chris Bellman assisting). The tape
that Mr. Bauer compiled was used as source material for most of the demonstration. The first task was Digital Placement (the ability to move sound be delay).

Digital Expansion was the next task tackled. Using the tape as source material, we hoped that through the digital delay the room walls could be made to seem to move in and out. A live voice on microphone was tried, but it sounded more like a giant echo than an illusion that the room was expanding. With taped sources, however, the effect worked.

Equalizing was the next task to be demonstrated: first using the three equalizer knobs on the console, then the Parametric equalizer. Equalizing can be used for coloration.

Mr. Bauer's tape was used as source material to demonstrate the other pieces of equipment: the Time Warp, the Varispeech, the digital delay units, and the echo chamber.

The final experiment involved a voice on a wireless microphone being processed through the Varispeech. The idea was to start with a flat, straight voice and slowly bring in distortion, the actor attempting to maintain his natural rhythm without following the rhythm of the distortion. It was hoped that a discussion of the dramatic qualities possible with such a device would follow.

January 23-28

January 23 through 25 involved program setting for the AES meeting. The two Saturday symposiums were telescoped for the Aes
presentation. January 29 through 28 was a continuation of Rhinoceros experiments, to be presented at the second symposium.

The theatre during this week had to be given over to the Rhinoceros cast for rehearsal, so experimentation time was cut down by more than half of what it had been the previous week.
THE SYMPOSIUMS

The following is a summary of what took place at the two Saturday symposiums and the AES meeting:

The three activities followed a similar format: introduction and statement of purpose, presentation of the problem in the form of scenes from Rhinoceros, a panel discussion concerned with specific audio problems related to Rhinoceros and general problems of audio in the theatre, discussions and demonstrations of the array of equipment, experiments demonstrating the use of this equipment, and a question-and-answer session.

The January 22 symposium introduced the sound problems in Rhinoceros, presented speakers who discussed audio in the theatre, and demonstrated the array of equipment. The January 29 symposium presented some possible solutions to the audio problems in Rhinoceros, discussed sounds created for Rhinoceros, and attempted some audio experimentation with the audience. The AES meeting compressed these two Saturdays into one evening. Events of these three days will be combined and only the more important points will be reported, following the basic format above.

The Introduction

Dr. Bellman delivered the introduction. He defined theatre as an art form in which human beings, known as actors, move and speak on the stage, creating virtual human beings who thereby create virtual
history. This is accomplished in front of a live audience. The essential element in theatre is therefore the living, breathing, speaking actor. Theatre appeals to two main sensory channels: visual and aural (auditory). Visually, theatre is highly developed both artistically and technologically. The arts of scenography, design, costumes, actor movement, are all highly defined. The technology that accompanies all this is highly advanced, e.g., lighting control can now be assisted by computers. When we move into the auditory end of theatre, we find a different situation. The art of the actor is well developed; his voice is highly refined. However, when we look into the technology of audio in the average theatre, we find an appalling situation, especially if one happens to be familiar with technology in other areas of audio. Many theatres are considered to be adequately equipped if they have a portable tape recorder and a turntable with a crystal pick-up—equipment thirty to forty years out of date.

Why is the audio technology so poor in theatre? The economic problem is not the only reason, although it does contribute to the lack of development. The main problems are suspicion on the part of theatre people concerning audio equipment (the average director would prefer a live gun shot or door slam to recorded ones because they can count on the reliability of the live effect) and the fact that recorded sound for theatre has, for the most part, a very inflexible length. If the stage action conforms to some mechanically stipulated bit of time, whether it be a scene change or recorded sound effect, the real time rhythm set by the actors is generally upset. Such "dead
cues" in the theatre are greeted with a great deal of displeasure. These then are the main problems one enters into when one encounters the problem of providing sound in the live theatre.

In the recording industry, on the other hand, incredible things have been developing. Devices that are capable of manipulating the human voice and time itself have been developed. Great progress has been made in the area of auditorium tuning, i.e., making sound in a theatre more audible.

Thus we come to the purpose of the symposium, to bring together two groups of people: people from the audio industry who have developed and learned to use this equipment and people from the theatre who are, as a group, almost unaware of its existence and potentialities.

However, we run into a problem. The language these groups speak is not the same language. For example, theatre talks about virtual or dramatic time: not time by the clock, but time that exists psychologically in our bones as we sit in a theatre and witness a play unfolding before us. This translates roughly, in engineering terms, into real time. Some audio terms like fidelity, delay, frequency response, etc., are, for the most part, foreign to theatre people. However, terms like dead cue, virtual time, and freedom of the actor (the freedom for the actor to do things in his own rhythm) are foreign to audio people. In the theatre, there is a phrase: knowing what 8:30 means. This is a special kind of deadline. One cannot go back to re-record, or mix a couple of times more.

One of the most critical problems in bringing sound technologies
to the theatre is the problem of real time or virtual, dramatic time. What this comes down to is that the actor is the primary communicative channel in the theatre and everything else must play along to his rhythm. Sound in the theatre should happen in real time--it should be adjustable to the moment-to-moment kinds of changes that the actor makes as he develops a role.

The goal of the symposium is to present a problem in terms of theatre. The problem is Ionesco's *Rhinoceros*, which is a show that involves almost continuous use of sound. The problem will be further elaborated in a panel discussion, which will deal with the kind of interchange that takes place between a director and a sound designer. Some available tools will then be shown; some basic principles on which possible solutions may rest will be discussed.

The problem-solution format was developed as follows:

At the January 22 symposium, the transformation scene from *Rhinoceros* was presented completely dry, i.e., sound cues were merely read. For the AES meeting, and the January 29 symposium, a wide variety of sound effects were created. Thus we started on the process of doing what the director had suggested, trying to make the sound take the part of one more actor in the cast. Another scene was added to the January 29 symposium because it illustrated some other sound problems and some other potentialities of the equipment. These were theatrical scenes in process.
Presentation of the Problem: Scenes from Rhinoceros

Ms. Backlin introduced the play Rhinoceros and presented the audiences with some of the sound problems. The scenes were then performed.

Ms. Backlin stated that Rhinoceros is a play about rhinoceroses. But more than that, it is a play about human beings turning into rhinoceroses. The action takes place in a small French town, where everyone except Berenger turns into a rhinoceros in the space of only a few days. This transformation is metaphorical, symbolical, and also literal. The germ sprang from the Nazi period, but it applies to all ideologies and "isms:" it is the giving up of individual free thinking to conform to some "ism." The play is Ionesco's plea for humanity to remain individual thinking beings and not to follow the crowd. He does this through comic means: this is a very funny play. Underneath, however, there is a thin line of terror that increases almost imperceptibly as the play progresses, until the final moments when Berenger realizes he is alone: alone in a sea of rhinoceroses. Rhinoceros requires a wide variety of sounds. The main technical problem is to bring the rhinoceroses alive--to make the sounds as much an actor as the actors on stage--how do we do that? Sound is an evocative stimulus as far as the senses go. When we hear sounds our imaginations can take over and help in creating the existence of those rhinoceroses. Ionesco feels the same way, for he has approximately fifty sound cues. A few of the sound problems as expressed by Ionesco are:
"Powerful noises of moving rhinoceroses are heard, but somehow it is a musical sound...."

"The noise of rushing feet and the panting breath of the animals. But all these disquieting sounds are nevertheless somehow rhythmical, making a kind of music...."

"The rhinoceros noises have become melodious."

"From below an anguished trumpeting is heard...."

"A sound of rapid galloping is heard approaching; trumpeting and the sound of rhinoceros hooves and pantings...." 2

These are just some of the examples of the kinds of problems we are encountering.

In the transformation scene that will be presented, a different kind of sound problem exists: how to make believable the transformation of Jean's human voice into a rhinoceros voice so that, by the end of the scene, the audience can believe Jean has transformed into a rhinoceros.

For the January 22 symposium, the transformation scene was presented with the sound cues merely read. For the AES meeting, sound cues were incorporated into the presentation. Of the sound cues presented on this evening were slightly refined and presented for the January 29 symposium. The device used to help Jean's transformation was a wireless microphone processed through a digital delay unit. The

progression of the transformation was achieved by settings of the delay manipulated by the operator as the scene unfolded.

The January 29 symposium presented the transformation scene with additional sound permutations: Jean's voice processed through a digital delay unit, the console operator following the actor's movement (panning), the 'lure' incorporated into the scene emanating from the two house speakers. In addition to this scene, the final scene in Rhinoceros was presented with sound. In this scene, there is a problem of getting the rhinoceros sounds and "musical" sounds to work together. The scene incorporated sounds created by a group of actors having a human conversation, processed through the Varispeech and digital delay, recorded at 15 IPS and played at 7½ IPS. The 'lure' was also used in this scene. Mr. Chris Harlan operated the Sculley tape deck, Mr. Chris Bellman the console, and the writer the digital delay unit.

The Panel Discussion

After the presentation of the scenes, a panel discussion occurred. Discussions took place at all three activities. The panels concerned themselves with specific problems in Rhinoceros and eventually expanded into audio problems in general. They attempted to simulate what occurs at production meetings. It was believed that these discussions would shed light not only on how to solve specific audio problems, but also on the language difficulties that arise when audio and theatre people speak with one another. Highlights from these
The January 22 panel involved three people: Ms. Backlin, Mr. Murphy, and myself. Ms. Backlin began by stating the main technical problem: bringing the rhinoceroses to life. As the play goes along, the set gets smaller and smaller, but the sounds grow.

I then proceeded to outline my sound design concepts. For consistency, I have divided the play into three movements. The first movement involves human crowds who are upset by the rhinoceroses. The second is the transformation scene that serves as an example of how all these humans transform. For the third movement, I would like to take the human crowd of the first movement, distort their voices, and have them become the sea of rhinoceroses. It was pointed out by both Ms. Backlin and Mr. Murphy that distortion should occur almost imperceptibly. At what points will distortion occur? It would appear that once distortion began, one could not move back from it. Mr. Murphy added that it would be necessary to know what style the play would open in and what style it would end in, in order to come to grips with different levels of distortion. I proceeded to discuss my Master Symbol, the "Cosmic Rhinoceros," a being that lured the people on stage into conformity. This lure is outside the confines of the script, but would serve to tie the three movements together. It would occur from the house and would incorporate elements of rhinoceros sounds, only very abstract.

A discussion on sound originating from house speakers ensued.
Ms. Backlin asked: Should the rhinoceros occur from the proscenium arch to backstage, and little by little leak the rhinoceros sound out into the house, so that by the end of the play the whole theatre is alive with rhinoceroses? How early should the audience be prepared for sound in the house if the sea of rhinoceroses at the end of the play is to occur without being distracting? I suggested that the image of a 'lure', emanating only from the back house speakers, would help to prepare the audience for sound in the house. Ms. Backlin wondered if the audience would be aware of where the sound originated. Would they be sitting in a sea of sound from the beginning? Mr. Murphy suggested that perhaps we could create a totally unconscious effect and introduce it early. It would be heard, but not realized. An indirect speaker in the attic would be the best place for such a sound to originate. His attitude about sound in the house is that one must be careful when interrupting the fourth wall in proscenium-style staging.

This led to a discussion on speaker location. In terms of the Boeuf scene, Ms. Backlin questioned the location of speakers. Because the illusion must be that the sound is coming from below, how can this be accomplished if we do not have a basement? How aware is the audience of exactly where the signal comes from? Mr. Murphy replied that, vertically, not at all; the perception of change in the vertical plane is much less pronounced than in the horizontal plane.

The subject turned to the use of wireless microphones. Ms. Backlin asked: If an actor works himself up as a rhinoceros, and if
he knows on a certain line that the wireless will be live, what will he do technically? Does he have to stop the rise of his emotion? Or is the machinery so sensitive that it can play along with him? Mr. Murphy replied that whether the actor knows a microphone is live, the minute he hears the system turned on he will change. The problem may be solved if we spot mike, i.e., place many microphones on the stage area and amplify only those sounds that are within the reach of one of those mikes.

A concern for realism was expressed. I asked how real are the rhinoceroses in terms of lighting and set design. Ms. Backlin replied that the images should be hulks, not distinct rhinoceroses. The acting should correspond with the sound, in that at the beginning it is flat; but as the play progresses, characterization deepens, as the sound deepens. Mr. Murphy added that because a climax of sound occurs in the transformation scene, it would be a wise idea to use Jean as a foundation rhinoceros to create all the other rhino sounds. In this play, there is no reason specifically to deal with reality in a direct way, only a need to create a basic reality to start from. Why sacrifice a potentially good consistency for a real rhinoceros? At this point a member of the audience disclosed that he had lived in the jungles of Africa for two years and not only does a rhinoceros rarely trumpet, but the sound it creates is more of a "bleating" sound than a "trumpet" sound. It thus became quite evident that the kind of sound Ionesco was referring to was not a genuine rhinoceros sound. The problem of reality is a dramatic reality, varying between semi-
naturalism all the way to things that could only be construed as a rhinoceros in the context of this particular production under its own particular situation.

I commented on the possibility of having live actors create the needed sound effects in real time. By creating live rhinoceros sounds as the play unfolded, for example, actors creating these sounds could respond to the rhythm of the characters on stage. In this way, dead cues could be almost eliminated.

Mr. Murphy then asked who the operators were. The operators were a critical consideration when designing sound; if a complex design is created that an operator cannot perform, the design is worthless.

The AES panel followed the same basic pattern of discussion. Mr. Murphy commented on the fact that sound must play a consistent part in the total theatrical illusion. He claimed that in the transformation scene just presented, the distortion occurred much too early. How can distortion be made to creep up on the audience more slowly?

As the discussion began to turn to technical considerations, Dr. Bellman added two people to the AES panel: Mr. Ron Schwartz and Mr. Robert Slutsky.

Mr. Schwartz pointed out that when an audience member walks into the theatre and sees audio equipment in the room, he psychologically wonders when the "stereo spectacular" will begin. The question arises: How can this equipment be supportive of the actor and not the star of the show?

Mr. Slutsky noted that one of the things we have discovered with
this equipment is that it does not interface rapidly with the live actor. It is therefore necessary to include sound from the moment blocking begins. In this way, the equipment can be worked along with the actor, and interfacing can occur.

The emphasis for the AES meeting was the real time application of audio equipment with a more technical slant.

The January 29 panel elaborated on the problems presented during the January 22 symposium. The panel discussion opened with Dr. Bellman's asking Mr. Murphy for his reaction to where the design is and where it is going (in relation to the two Rhinoceros scenes presented).

Mr. Murphy responded with six questions: How will we deal with sound in the house? Do we want live sound? Will there be one basic rhinoceros or many? More specifically, if sound is wanted in the house, how will it be dealt with? Will the sounds have different textures, will they be based on one sound? If live actors are utilized, what is more desirable: repetition of cues from night to night or very different cues from night to night?

Ms. Backlin replied that she would like to begin experimenting with the live actors as rhinoceroses, which would imply slight variations from night to night. Theoretically, this is more theatrical than a preset tape that runs the same every night. However, these people should sound like individual rhinoceroses and not like a chorus of rhinos being conducted by one rhinoceros.

Mr. Murphy brought up another question: Is there a time in the
rehearsal period after which sound should be there, but earlier should not be? Ms. Backlin replied that during the breakdown-of-scenes rehearsal period it is doubtful whether sound would be helpful. However, if the Rhinoceros sound people wanted to experiment, they were welcome to do so.

Mr. Schwartz asked the question: Having been through the project thus far, what kind of acting space would we choose? Ms. Backlin replied that although the play was written for a proscenium stage, she would have liked to experiment on a thrust stage. In order to have the sound engulf the entire theatre, the thrust style offers many more possibilities. I responded that I would like to attempt the production in the round. The audience members would be able to see other audience members-- I would like to develop the sound around that opportunity: "rhinoceroses" sitting across from other "rhinoceroses."

Dr. Bellman questioned the effect that this application of sound would have on the actor and his method of creating a character. One thing we have already discovered is an inevitable and immediate pace change in the voice to adjust to whatever that sound is doing. One thing that makes the Varispeech frightening for instance, is that a skilled operator can keep the actor changing.

Mr. Slutsky noted that in the recording industry this gear is used in a different, less frightening way. A performer is recorded dry and in the mixdown such effects as reverberation, delay, and slapback echo are mixed in. It appears that we are taking this one step further by giving an ability to the actor to manipulate his voice as the effects
are being produced: both dry and effects sounds in real time. How are the actors handling this situation? There must be some feeling of this equipment intruding? How does Jean feel about all this? Ms. Backlin replied that the actor portraying Jean is working well with it. The use of his lower registers has proved more effective than using his higher registers. He does not appear to be uncomfortable with the equipment and has begun to experiment with it. We need, in this transformation scene, to find specific places in the scene where Jean is a rhinoceros, then Jean again, then a rhinoceros, then Jean, and the battle continues until he finally completes the transformation.

Mr. Slutsky wondered how the other actor was responding to the wireless microphone. Ms. Backlin replied that placement of each actor must be worked out carefully. When the mike becomes live, the actors are apart; when the actors are together, the mike is off.

Dr. Bellman posed a question to the two operators, Mr. Chris Bellman and Mr. Chris Hayes: Where would they like to be, ideally, in order to mix this show? Mr. Hayes replied: in the center of the house. Dr. Bellman asked what kinds of problems they were running into trying to mix from the orchestra pit. Mr. Hayes replied that there is trouble mixing the dry signal and the effects because they as operators were too close to the actors, and were therefore not getting the audience's sense of direct sound. Mr. Slutsky added that aesthetically the operators were too close. This bridged into a discussion concerning equipment and operator location.

Mr. Schwartz noted that in terms of equipment location, sacrifices
have to be made. The most important thing is the total production, not just sound system requirements. Mr. Murphy suggested that we change one thing: make this a professional production. Then how would these problems be dealt with?

Mr. Slutsky noted that sound can have remote control devices just as lighting has remote control dimmers. For example, the Cetec console has a PDS system that can be removed and used as a remote control device to set relative values. In terms of equipment and operator location, because many of the mechanical devices generate their own noise, they should be placed in an enclosed space. One operator could manipulate those devices, while another operator sits in the house with the remote controls on his lap. Thus, there are technical solutions that are capable of solving some of those problems. Mr. Murphy added that this would not be a bad idea, but the question of how competent the house operator is arises. Mr. Ken Fause, a representative from Audio Concepts, pointed out that it is very difficult to set values within a one dB range. There is a technique using the Senhauser Head, where microphones are placed on a foam head which gives a stereo picture. This is placed in the house as a means of recreating the house space for another enclosed space, most likely the sound booth. However, the thrill of the theatre is nothing between you and the actor other than air. He believes a technician should experience that same sensation. From the audience, a comment was made that most theatres already existing do not have provisions for these kinds of sophisticated equipment. Theatres should be designed making provisions for this kind of sound
A question concerning operator training for the theatre was posed by Mr. Eric Neufeld. Mr. Schwartz responded: "He used a term-- how to train the operators or technicians. We are, perhaps, in an area where operator or technician is not quite the right term. We have here some of the same problems that are presented in a production of an opera or a musical-- balance problems. Rather than an operator, we are talking about a performer." Dr. Bellman elaborated with an analogy to music. A transition is occurring in theatre and in theatre technology. Traditionally, operators have been regarded as intelligent robots: they read cue sheets, time the cues, work with something that is totally pre-established. In the meantime, the world of music has operators who are called interpreters. The point is, one "plays" a violin, not "operates" one. We in theatre have reached a point where we are looking for people who play a lighting board or a sound control system. We are still stuck in a professional situation where concepts are encrusted in economic problems. We really have to talk about two worlds and how we bring them together.

Mr. Dick Thompson from World Stage commented that now we are beginning to define the difference between a broadcast recording audio system and a theatre sound system. Questions are arising such as: How does the equipment work? How and where will it be located? How can we make it 100% reliable? Operator training? A whole area of human engineering is opened that we must look at.

He added that audio in theatre can be analagous to lighting.
Lighting has been developed over a period of about seventy-five years. Audio today is in a trial-and-error period as lighting was when it first got off the ground. There are such problems as design of the equipment and how it is laid out, arrangement of controls so that there is some kind of theatrical logic to it. Also, how does the sound designer, in developing his design, develop a method of cueing? How should it be written? How should it be developed? How can these methods be logged? How should the cues be given? What psychological and physiological problems are involved? Perhaps the designer should realize the limitations of the sound system and/or the operators and design with that in mind.

In terms of equipment design, Mr. Slutsky suggested that a theatre audio console satisfy three requirements: 1) a device on which one can create effects; 2) a system that can be used for reinforcement when required; and 3) a system that can recreate those effects in real time. In terms of reinforcement, much has developed—tuning a room, i.e., measuring the resonance points in a room and adjusting the audio system to avoid emphasizing those resonant points—and in the rock industry. It is a science that can be studied and observed. In terms of recording, a whole world has been explored: techniques of multitracks; techniques of delay; variable speed; echo chambers; and microphone techniques. The last point, and the one that we are playing with here, belongs uniquely to the theatre—real time situations. If we as theatre people are going to devise systems for our use, it is necessary for us to explore these other areas before we say we have an
answer to this whole problem of audio in the theatre. We have a two-track tape deck, should it be four or eight? Should we be using recording studio techniques in making rhinoceros sounds? Should we explore the rock reinforcement area as it pertains to some of the larger auditoriums in making sound move? What we are saying at this symposium is that we are just beginning to scratch the surface and we should definitely explore these other areas where audio has been carried to a quite sophisticated level.

Mr. Murphy commented on the idea of a three system concept. He believed Mr. Slutsky was correct in that regard. However, it was Mr. Murphy's contention that these should be three separate systems because of space, functional problems, time, and cost. When the three systems are incorporated into one console, a compromise occurs because it is being asked to do three things.

A rather subdued argument developed between Mssrs. Slutsky, Murphy and Schwartz as to the functions of a reinforcement system versus a playback/effects system. It was contended by Mssrs. Murphy and Schwartz that speaker location would be different for reinforcement than for effects. Mr. Murphy believed that reinforcement comes from the house, effects emanate from the stage. Rhinoceros is merely an exception to this rule. As the argument became more and more heated, Dr. Bellman requested that the director Ms. Backlin speak.

Ms. Backlin stated that if a performance is really a good one, it involves not only the actors on stage but the audience as well. There is a give and take constantly. Thus, any production can be considered
as an all-over production. If the audience is an integral part of a performance and contributes to it, why can't audio be opened to the entire theatre? Mr. Murphy replied that it cannot because it is not being done with everything else. If a fourth wall situation is set up, sound should be kept inside, unless there is a very good reason to open it up. It appears that there is a good reason in Rhinoceros. Mr. Slutsky commented that sound in the house can be made as imperceptible as lights in the house. The same justification for lighting in the house can be made for sound in the house. Mr. Schwartz pointed out that there is a problem with hanging speakers around a theatre: "Because it is there, it better be used." This becomes a critical issue: knowing where to use the speakers. Having sound equipment is like having lighting equipment: just because one has it does not mean it must be utilized.

Mr. Slutsky stated that the main disagreement is between the practical and theoretical: he proposed a theory, not a solution. The theory would involve a situation where dramatic justification calls for stepping over the line: there is technology and there is creativity-- we walk a razor edge between the two. Mr. Murphy added that a very good reason must exist in order to justify stepping over the line. Also, it must be understood that the actors can handle the sound. Otherwise a situation occurs where a poor performance makes the effects all that more obvious, which makes the performance even poorer.

Mr. Chris Foreman, an audio engineer and a technical writer, commented that the "Cosmic Rhinoceros" justifies sound in the house and
that putting sound in the house for the effects versus keeping it on stage is a technique and not a matter of technicalities, or the science of it. Here the sound system has become another actor. Most of the problems are not technical--they are political. The challenges he sees are philosophical: Should sound be located in the house, on stage, or in both places? Where should the mixing booth be located? What are the methods of doing sound cues? What are the definitions of a reinforcement system versus an effects system? The final result of all these questions will depend on who operates the board. He questioned the possibility of trying out people as actors try out--especially because sound is being thought of as another actor. Has the equipment been brought together so that as much of the controls as possible can be operated by one person? Mr. Slutsky added that an operator with a musical background is implied, because what we are attempting to do is to SCORE the sound.

A question from the audience pertaining to sound systems design was raised: What is a good concept in designing systems? Mr. Schwartz answered that it would depend upon where the system is placed: professional house, educational environment, repertory situation. Each locale has very different requirements and budgets. Mr. Murphy added that anyone who designs a system hangs on to what he thinks is an ideal sound system.

Mr. Slutsky concluded that from a manufacturer's point of view, theatre is a difficult market to design equipment for. The theatre market tends not to have a great deal of money and tends not to make up
its mind very well. We are thus stuck with a situation where we borrow equipment wherever we can. PDS was developed specifically for the theatre, but few have been sold because of the lack of understanding audio technology. We should set up situations where theatre people can learn the fundamentals of audio, especially if we are ever to expand the potentialities of audio design for the theatre.

At the conclusion of the panel discussions, a break occurred at all three activities. After the break, technical papers were delivered.

Papers Presented

On January 22 two theoretical papers were presented by Mr. Jim Ryan and Mr. Ken Fause. Mr. Ryan addressed his comments to the theatre audience in an attempt to explain some audio concepts and terminology. Most of Mr. Ryan's discussion occurs as definitions in the glossary section.

The title of Mr. Fause's paper was "The Ideal Theatrical Sound System." Highlights of this paper follow:

The criterion by which an ideal sound system is designed should concern itself with the questions: What do we want to do? What should an ideal sound effects system do? It should: 1) be capable of live origination and stored elements; recordings— to be used as possible source media; 2) have a dynamic range capability; 3) position single or multi-channel source elements to create an image anywhere within the theatrical space; 4) be able to vary the apparent dimension of the sonic
image over a continuous range from a locatable point to a non-locatable point; 5) vary the elements in the frequency versus the amplitude domain, equalizing; 6) provide for creation of reverberation and delay; 7) provide for memory of control settings; 8) provide for static images, dynamic images, generating its own source media. The equipment should be transparent to the operator, i.e., permit him to create artistic effects rather than technical manipulations. There should be a provision for reinforcement capability. Speakers should be capable of varying locations. Gain tracking should be in two dB increments; resettability should be in the range of one dB accuracy; phasing should be accurate; it should have a preset system; and it should have equalizing capabilities, all of these to be capable in real time. And, lastly, the system should be simple to operate and robust enough to withstand theatrical demands.

Following these papers, discussions pertaining to pieces of the equipment occurred. The first speaker was Mr. Ron Noonan, president of Lexicon, speaking on the digital delay and Varispeech.

The digital delay system can be used for three functions: 1) for permanent sound reinforcement application (for naturalness and intelligibility of sound distribution); 2) in recording studios as a signal processing tool used during mixdowns; and 3) in the live performance area (to change the acoustics of an auditorium and as an effects gadget).

The digital delay was originally developed at M.I.T. for medical
purposes. But an audio engineer came along and suggested that if the frequency range could be increased and if it were made to delay audio signals, it could prove profitable in the audio market.

What happens in a digital delay unit is the conversion of an electrical signal into a number. That number is picked up and stored in a digital memory, like a mini-computer. It is put in the memory, to be taken out at a later time. When it is taken out is determined by the switches--how much delay they are set to. These switches tell the machine that after so many clock cycles, that value will be taken out, converted into an analogue signal, and put out into the sound system. The quality of the sound is independent of the amount of delay: the audio quality is not degraded. This means that delay has an ability to retain sound for an indefinite period of time and can be recreated with no loss of quality other than what one gets from a millisecond.

The other Lexicon unit, the Varispeech, is basically a pitch-shifter. It allows for the shifting of the pitch of audio signals over a fairly wide range. It was originally designed as a reading machine for the blind. At this time, pitch-shifting has limited professional application for two reasons: one, it has a limited frequency response and two, the dynamic range is in the order of sixty dB. However, with careful use, it is excellent as a special tricks device. Varispeech works by digitizing sound and putting it into a random access memory in much the same way as the delay unit (except without high fidelity). The data go into the memory at any rate desired by the user. The signal is taken out at a constant rate.
A representative for the Sculley tape deck, Mr. Phil Flad, spoke on the requirements needed for a good theatrical tape recorder: 1) satisfactory quality; 2) in order to prepare a show, an open reel is necessary, with a 7 1/2 IPS minimum; 3) it should be a standard machine that is easily serviceable; 4) it should have as many tracks as the budget can afford; 5) it should have separate erase, record and playback heads, and an ability to playback from the record head; 6) it should be able to receive the maximum track width; 7) it should have a variable speed oscillator; and 8) a DC motor is more desirable than an AC motor because speed can be varied with more ease. All of these requirements can be found in the Sculley models.

A discussion of the Putney Synthesizer followed, presented by Mr. Eric Neufeld.

Most synthesizers are of the analogue variety rather than the digital kind. The Putney used at the symposiums is an early English model, small, costing approximately $1000.00.

Sound has four characteristics by which all sounds can be identified: 1) frequency or pitch; 2) amplitude or level; 3) timbre, tone quality or the amount of harmonics; and 4) time. All of these characteristics are defined on a synthesizer and controlled by knobs. On an analogue synthesizer, each of these traits can control another trait. For example, the keyboard can be used to put out voltage that can control the frequency of one of the oscillators.
A synthesizer can either process a signal or create its own signal. Sources available in the Putney are a white noise source (and a filter to control it), and oscillators that electronically produce a tone in a variety of wave forms. These wave forms are a sine wave (no sharp edges, pure tone), a sawtooth wave (contains the most harmonics and is the easiest to filter), and a square wave (contains odd harmonics and sounds similar to a clarinet). Once a source is generated, it can be shaped by any of four devices: 1) the envelope generator (it controls the amplitude of the signal— the attack and decay time of a signal); 2) a spring reverberation; 3) a filter; and 4) a ring modulator (it allows for the modulation of two different sources together, letting their frequencies control each other).

The rest of the equipment was introduced by Mr. Robert Slutsky.

**Equipment Demonstration**

The first demonstration was the application of the joystick on the Cetec console to pan sound around the room via the eight speakers. Mr. Slutsky stated that sound can be made to appear to move through the use of the digital delay. Using a mono signal, he asked Mr. Bauer (the board operator) to move the sound around the room using delay. Mr. Slutsky requested that the audience point to the location of the sound as it moved about. Initially, they were pointing in different directions, depending on where they were sitting. For example, some audience members heard two sources at once; some could not hear movement...
at all.

The next experiment was to expand the room digitally. Take the room (call it reference) and first make it expand digitally; bring it back to reference; then expand it by using echo; then back to reference. When the audience was asked if it appeared that the room grew larger, half answered yes, and half answered no. Members of the audience suggested that there may be too much delay, and the top end of the echo return should be rolled off.

The next demonstration was digital spatial shifting: feed a dry signal into speaker #1, 85 ms. delayed signal into speaker #2, a 150 ms. delayed signal into speaker #3, and a 205 ms. delayed signal into speaker #4. The experiment was successful; the room did appear to become more spacious, but it was suggested that the highs be rolled off on the rear speakers as high frequencies tend to attenuate faster than low frequencies. Thus a "cathedral effect" will be better achieved.

The equalizer on the console and the parametric equalizer were the next devices demonstrated. The console equalizer can be used for coloration. It has three knobs that control the highs, middles, and lows. The parametric equalizer allows for equalizing more selective frequencies. Broad band versus narrow band equalizing followed. Equalizers can be used as processing devices to create effects as well as for sound reinforcement, for getting more gain out of a system before feedback occurs.

The January 29 demonstration and experimentation of the equipment array followed the same basic format as January 22 for two major rea-
sons: over 50% of the January 29 audience had not attended January 22, and there was not enough time between January 26 and 29 to do a great deal of new experimentation and refinement of existing experiments.

A synthesizer expert, Mr. Ted Peterson, produced some fascinating sounds on the Putney for the January 29 audience. For example, he created a sound that cannot be produced by any other musical instrument. What he did was isolate certain harmonics of some fundamental tones, and put them through the envelope generator. The resulting sound was a kind of 'watery-drip' sound that spanned several octaves. The value of synthesizers lies in the fact that they can create sounds that have never been created before. Mr. Peterson was asked to create a rhinoceros gallop and pan it around the room. This was accomplished and subsequently became the rhinoceros gallop that was used for the actual production.

After the Putney experimentation, Dr. Bellman requested that the Precedence Effect be attempted, i.e., the first sound to be heard takes command of the ear. The idea was to take that rhinoceros gallop just produced by the Putney and move it around the room utilizing delay. Then it was hoped that the room could be made to appear larger (using delay) and then take the rhinoceros around an illusionary larger room. Dr. Bellman requested that the audience scatter themselves about the theatre and point in the direction that the rhino was moving. It worked better than anticipated. This same experiment was than attempted using a live human voice. This worked better than the rhinoceros gal-
lop because lower frequencies (which were used in the rhinoceros gallop) are more non-directional. Dr. Bellman concluded that we had at least tested this equipment with this arrangement of speakers in this theatre, and that in this theatre the Precedence Effect works for over 50% of the audience (dependent upon where one is sitting).

Rhinoceros Sounds Created For The Symposums

Dr. Bellman introduced the discussion of sounds that had been created for Rhinoceros by stating: "Should one generate tools and wait for the artist to use them or should one wait for the artist to generate a need for the tools and then go out and invent them? This is the old chicken and egg routine that is answered by saying 'both'. We have here a situation where, at least in terms of the theatre, a set of tools has already been generated and the artists are almost unaware of them, let alone being able to master them. The use of these tools is compounded by the fact that they fit together in a variety of patterns, and each one of them is a creative device unto itself. We shall now share some of the sounds that were generated in the process of trying to solve problems related to Rhinoceros. This will give us a chance to demonstrate two things: some of the possibilities of the equipment and something about the choosing process we are going through now."

The first sounds were church bells processed through the Time Warp. The sounds started dry, and the Warp was slowly mixed in to create a subtle distortion by the end of the ringing.

The second sound was an elephant trumpet processed through the
Time Warp. The hope was to create an anguished trumpeting. This sound was rejected as it sounded too much like an elephant or lion, and not enough like a dramatically acceptable rhinoceros.

The third sound was an attempt at finding a rhinoceros herd. Ten actors stood in front of two omni-directional microphones, and were told to carry on a conversation speaking only in vowels. They were given three states-of-being: light talk, angry because you were doing all the work, and hostility. They were processed through the Vari-speech, ring modulated through the Putney, recorded at 15 IPS, and slowed to 7½ IPS. The hope was, that by distorting the human vocal quality, a dramatically acceptable rhinoceros sound could be achieved. These sounds were utilized for the Daisy-Berenger scene performed for the January 29 audience. However, for the actual production they were rejected because instead of the actors, the Putney was used as the foundation rhinoceros. The Putney was also used to create the rhino herd needed for the Daisy-Berenger scene. Consistency was the reason.

The fourth sound was the ten actors carrying on a normal conversation processed through the Putney and digital delay. They sounded like frogs, so the effect was rejected.

The fifth sound was four actors trying to trumpet like a rhinoceros. They were recorded at 15 IPS and slowed to 7½ IPS. They were rejected because they sounded more like cows than rhinoceroses.

The sixth sound was eventually incorporated into the actual production. One of the actors grumbled the name, "Louise." In the Boeuf scene, Mr. Boeuf calls to Mrs. Boeuf to transform and be a rhinoceros
with him. The director gave Mrs. Boeuf the first name of "Louise." Through distortion, this "Louise Call" was made almost unintelligible—the goal was to create a call that was distorted, yet would retain the rhythmic pattern of the word "Louise." The actor articulating the word "Louise" had a bass, resonant voice. He was recorded at 15 IPS and slowed to 7½ IPS. This "Louise Call" was used in the office scene when the "anguished trumpeting" of Mr. Boeuf was heard.

By courtesy of Disney Studios, a tape of man-made rhino sounds was given to us. However, these sounds were rejected as sounding too man-like.

The 'lure' was created by untuning a violin and processing it through the Time Warp. This sound eventually found application as the "Cosmic Rhinoceros" that lured the characters on stage into transformation.

The major problem in developing sound for Rhinoceros was source: to find a foundation rhinoceros to put through these devices. At first we looked for a genuine rhinoceros trumpet. Because a rhino trumpets rarely, we had believed that an elephant trumpet may have been suitable. This elephant cry was put on a work tape, dry, and then processed through the Time Warp. (A low frequency tone from the oscillator was added to the background of this processed elephant in the hopes that the oscillator could be used for a subliminal rhinoceros.) However, the elephant was rejected because it sounded too much (even after processing) like an elephant or lion. Then we turned to the string instrument domain, specifically a violin. The violin was un-
tuned and the G string sounds were recorded dry. This was then pro-
cessed through the Time Warp and became the "Cosmic Rhinoceros" that
lured the characters on stage into transformation. This cosmic rhino-
ceros was a symbolic rhinoceros, employing elements of sounds that had
a semblance to a trumpeting effect. It was outside the confines of the
script, and served as the lure that enticed the characters into trans-
formation (conformity). Although this "Cosmic Rhinoceros" had been
discovered, as of January 29, we were without a source or foundation
rhinoceros (the dramatically real rhinoceros). So we moved over into
the human area and dry taped a variety of human vocal sounds, hoping to
discover a foundation rhino sound.

During the presentation of sounds developed for Rhinoceros, Mr.
Slutsky stated: "Should these effects be just weird, different, or
unique sounds just because they are weird sounds or should they have
some connection with the action of the play?" I answered that our
problem and frustration was in finding the proper source rhinoceros,
beyond the equipment. We had been taking different sources, mixing
them through the equipment, in an attempt to achieve a dramatically
believable rhinoceros. Once that source is found, we could then take
off in any direction-- musical, sad, happy, anguished rhinoceroses.

Mr. Slutsky added: "Can any dramatic quality of the voice with-
stand processing, i.e., if actors are emoting in some form, will the
dramatic content of their voices withstand processing; and how much of
the processing will they withstand and still give that dramatic quality
to the audience?" He suggested that an experiment be set up whereby one
takes a piece with dramatic quality and processes it through each one of the devices to find out how much it can withstand before it becomes unintelligible. Does the intelligibility factor and the dramatic quality go hand in hand?

**Question And Answer Session**

All three activities concluded with a question-and-answer session and general concluding remarks given by the co-hosts, Dr. Bellman and Mr. Slutsky.

Few questions were asked at the January 22 symposium. At the end of this day's symposium, Mr. Slutsky's voice was processed through the Varispeech. He attempted to speak in a relatively normal manner as the Varispeech operator manipulated the knobs. It was hoped that the audience could thus see some of the vocal effects possible with this device. A 'volunteer' was asked to try and speak while the operators manipulated his voice. Mr. Bill Jensen (who had been rehearsed and planted in the audience) walked to the stage and presented his comedy routines while the operators processed his voice through the devices.

At the conclusion of the experimentation section for the AES meeting, Mr. Slutsky introduced Mr. Jensen as "Professor Jensen, an audio expert from M.I.T." He was to 'rebut' an article in the AES Journal, written by an attending AES member. As Mr. Jensen ad libbed this rebuttal, the operators distorted his voice. This led into the comedy routines of Mr. Jensen. These comedy routines served as an example of how the audio technology assembled for the symposiums could be inter-
faced with a live actor in real time. Two major points were under consideration: one, if the actor would alter his dramatic rhythm to compensate for what he heard and, two, when loss of intelligibility occurred. Mr. Jensen rarely altered his dramatic rhythm; rather, he attempted to incorporate what he heard into his sketches. The major problem was intelligibility. Many lines were lost due to a great deal of distortion. When more natural voice was mixed in with the distorted voice, intelligibility returned. At the conclusion of this presentation, the question-and-answer session took place.

Mr. Chris Foreman asked if any definition of boundaries had been pre-arranged for this particular equipment array. I answered that because of the dual goals demanded of the equipment-- those sounds for Rhinoceros and those for the symposiums-- boundaries could not be fully explored. In terms of creating sounds for Rhinoceros, I knew what I wanted, but because no one really knew the equipment, many hours were spent in trial-and-error permutations.

A comment from an audience member involved a suggestion for the transformation scene: "It would be more realistic if the actor's natural voice were combined with distorted voice." Another suggestion was to bring more gain on the natural voice when Jean went off into the bathroom. A third comment was that the equipment was actually capable of tracking volume shifts in the voice; it was the wireless microphone's compressor that held this back at a constant level. It was suggested that the wireless be run through the envelope generator on the Putney. Apparently an audience member could not tell that panning had occurred
in the transformation scene (following the actor as he moved). At this point Mr. Slutsky stated that we were attempting to use volume shifting rather than delay for sound movement.

(There are two interrelated ways of determining where a sound comes from. One is volume shifting, probably the simpler method for sound direction control. For example, say there are two sound sources that are approximately equidistant from the listener. By adjusting the volume of these two sources with a pan pot the apparent source of the sound can be shifted, e.g., from the left speaker, the right speaker, or a phantom source in the middle. Thus, if sound sources are somewhat equidistant, so that the time interval from source-to-listener is about the same in any direction, location of sound can be determined by volume. The second way is by delaying the sound (Precedence Effect), i.e., the first sound to be heard will take command of the ear.)

The closing remarks were delivered by Mr. Slutsky and Dr. Bellman. Mr. Slutsky stated that the theatre is a place where actors perform. The equipment here is to add to that. There is a lot of technology here that can be used in a variety of ways. The root of all this is whether we can take this equipment and make something in the theatre that works. Given the context of what we want to accomplish, we as theatre people can tell whether something works. This equipment can over-do it (it is powerful); it deals with the actor's strongest tool, his voice— and we are manipulating that tool. But within given rules and within a dramatic context, these can be powerful tools. Given time to experi-
ment, a library will develop. Actors need to train their voices with audio equipment as they train to find their light. We need more playwrights to write scripts like Rhinoceros that utilize audio in such a creative manner.

Dr. Bellman stated that he hoped in the very near future we could look back on what we had done, much as we look back on salt water dimmers, resistance dimmers, and the style of acting that included declamation, and say, "Weren't they primitive in those days." We have not even scratched the surface of what is available here. Do you create the technology and wait for the artist, or do you create the art concept first and wait for the technology? We must get at the job of getting as much as we can out of both. We hope we have an opportunity to do this again.
AFTER THE SYMPOSIA: DESIGN FOR RHINOCEROS

The production of Rhinoceros required a sound design that would serve almost as another actor. The sound had to be so designed as to have the capability of interweaving with the live actors on stage, i.e., the kind of flexibility that happens in real time. Thus the problem: a sound design so flexible and adaptable as to integrate itself in real time as if it were an actor. This problem manifested itself in three areas, technical, artistic, and organizational.

The technical problems were 1) sound creation (what equipment to use); 2) consistency in the sound creation (what and how to use the equipment to maintain a consistent sound design); and 3) execution (panning problems; sound localization: where to locate the sounds created; what equipment to use as playback equipment; location of mixing booth and operators, i.e., problems in riding gain).

The artistic problems included 1) source material: What source to be utilized as the foundation rhinoceros (which would be processed to create subtle differences between musical rhinos, angry rhinos, anguished rhinos), what source to use as a dramatically believable rhinoceros gallop (should the source material tend towards a more realistic rhinoceros sound, or more "symbolic" sound?); 2) the creation of a sound design concept that would be consistent with itself, meet the requirements of Ionesco and the director's concept of the play, and be consistent with the other design elements (sets, lights, costumes); 3) organizing the sounds; and 4) cuebook notation and operator training:
how shall these sound cues be notated, and how will the operators be trained to perform these cues (communication between designer and operator, and ultimately between actor and operator)?

As the sound designer for the production, I was faced with an unusual problem. Sound for *Rhinoceros* was needed for two purposes: as demonstration material for the January symposiums, and as an integral, creative element for an actual production to be performed in March. Since the demands of the symposiums were of a first priority, sounds were created as needed for those scenes that were to be demonstrated. It was hoped that they could be adapted to the actual production. The two scenes that were to be demonstrated at the symposiums were the transformation scene and the final scene in the play (the Daisy-Berenger scene).

Because most of the equipment borrowed for the symposiums would need to leave at the end of the symposiums, it was hoped that the *Rhinoceros* sounds needed for the actual production could be discovered, taped, and completed in the two-week experimentation period. As a design concept had not as yet evolved, a cue-by-cue method was used whereby sounds were created on a trial-and-error basis. This method was based on the "library" concept, whereby if enough sounds were generated on tape perhaps the sounds needed for the actual production could merely be extracted from them. With this library concept in mind, the two scenes that were to serve as demonstration material were the first design problems tackled.

The transformation scene had three requirements: 1) as the actor
portraying Jean transformed into a rhinoceros, his voice needed to be distorted in real time. This problem served as an example of the essence of what the symposiums were about: applying the technology of the recording industry to a real time dramatic situation; 2) bathroom sounds offstage (recorded sounds); and 3) rhinoceros herd at the end of the scene, engulfing Berenger (recorded sounds). The Daisy-Berenger scene had two requirements: Daisy's musical rhinoceroses and Berenger's horrible rhinoceroses; and rhinoceros sounds engulfing the entire theatre by the end of the scene.

For the transformation scene, the problem of Jean's transforming was solved by providing him with a wireless microphone and processing (distorting) his voice through either the digital delay unit (for the AES meeting) or the Putney synthesizer (for the January 29 symposium) in real time. A framework of distortion was set for these events in which the operators added 'embellishments.' The use of the digital delay proved acceptable, but not subtle enough. The smallest turn of a knob resulted in a highly noticeable distortion. The goal was to make the distortion as subtle as possible. The Putney synthesizer proved capable of accomplishing this subtlety. This instrument became the device that processed Jean's voice for the actual production. The bathroom sounds needed for this scene were solved by taping a babbling brook and attenuating the low frequencies out with an equalizing unit.

Both scenes demanded the sounds of rhinoceroses. This problem was solved by using a low frequency pulsation from the oscillator. However, for the actual production, this sound was not utilized because
it sounded too machine-like. The Documentation Section on Rhinoceros Sounds Created For The Symposiums details the sounds utilized for the symposiums.

The Sound Design Concept

After accepting the role as sound designer for the production of Rhinoceros, it became my task to develop a sound design concept from which the sounds could be created. During the second week of experimentation, after many hours of trial-and-error testing, a sound design concept for the production began to emerge. The following is my design concept from which the sounds were eventually created:

The Master Symbol for the design was the lure of conformity, a Cosmic Rhinoceros, outside the framework of the script, that enticed the characters on stage into transformation. This lure was to be the element that tied the sound design together.

The sound design unfolded itself to me in a musical analogy. Thusly, the script itself was divided into three movements: before Jean's transformation, the transformation itself, and after the transformation. Each movement would have an overriding theme, to be tied together by the lure.

In the first movement, the theme would revolve around dramatically believable, almost realistic, sounds. Only single sounds would be heard. A crowd of people would witness the single rhinoceros. To foreshadow the third movement, a subliminal rhinoceros would weave in
and out of this movement. The lure would appear rarely, and then in an almost inaudible manner.

The second movement would focus on an actual transformation. As the transformation progressed, the lure and subliminal rhinoceroses would become more and more audible. By the end of the transformation, the subliminal rhinoceroses would be an audible rhinoceros herd. It would be in this movement that the actor's voice would experience distortion in real time. His voice would become more and more unintelligible as he became more and more like a rhinoceros. The theme of this movement would revolve around the distortion of a human voice.

The third movement would revolve around the theme of capitulation. The human crowd of the first movement has now capitulated and become a rhinoceros crowd. The single realistic rhinoceros has now become a multitude of symbolic rhinoceroses. The lure has become more audible, menacing, and insistent. The sounds in this movement would have a core of terror; they would be abstract sounds that would have only a small resemblance to the realistic sounds of the first movement. However, the first movement would introduce all sounds that would eventually become distorted and symbolic in the third movement.

Creation of Sounds and Organization

Once this concept became solidified, creating the vision was the problem: how to get from the abstract to the concrete. The problem of source material still existed. But a new problem became evident: where and when to use taped sounds; where and when to
use live sounds. It was originally hoped that most of the sounds used for the actual production would be created by actors on microphones in the sound booth, processed through the equipment that remained for the production. As it became evident, however, that not enough time existed to rehearse these live effects with the actors, the creation of recorded effects began.

Mr. Ted Peterson, a synthesizer expert, and I undertook the partnership in creating the recorded effects. After much experimentation with the digital delay unit, the Varispeech, and the Time Warp, the Putney synthesizer proved the most versatile and creative tool in the creation of most of the sounds needed for Rhinoceros. (It was also the only processing device that remained, besides the Cetec console.) A sound plot, describing the sounds needed for each movement, can be found in appendix number two. Each sound described includes the method of creation.

The Putney synthesizer also functioned as a real time processing device and a creator of rhinoceros sounds. The transformation movement incorporated the Putney as a processing device. The actor portraying Jean was provided with a wireless microphone. His voice was processed through the Putney and distorted. The Putney also served to create a single rhinoceros trumpet. This trumpeting appeared in real time during all three movements as embellishments to the taped sounds.

The rest of the sounds were on five "show tapes" (five tracks) and were controlled by one console operator. Early in the sound organizing process, we had come to the conclusion that the traditional
show tape format would not work; that while many of the sounds needed for Rhinoceros would wind up on tape rather than created live, we would not get trapped in the "dead cue" syndrome characteristic of most show tapes. Consequently, an organizational method needed to be developed in order to create these "show tapes." The "soda fountain" concept, articulated during the weeks of symposium experimentation, became the method by which the sounds were organized. This concept originally involved the creation of many tape loops. These loops would play continuously, and at moments established by the designer, the operator would tap into certain loops mixing the sounds together. In this way pre-recorded effects could be made to work in a real time situation, i.e., the actors need not change their rhythm to compensate for dead cues. However, when it became evident that tape loops would not be feasible, the "soda fountain" idea had to be modified. Thus, sounds were created on five tracks (to be played on three tape decks: two with two-channel capability, one with one-channel capability). By taping the sounds to run longer than ever needed, and juggling the tracks so back-up sounds were always available, the "soda fountain" concept was made to work. In essence, we had created a series of tapes containing wholesale amounts of sounds. They were somewhat like tape loops, only organized onto five tape reels. The final sounds created for Rhinoceros were indeed workable in real time.

**Notation**

Once the tapes were created, the problem of notating the cuebook
became evident. Appendix number two includes an example of how the cuebook looked. It was hoped that the orchestration concept would find application in the notation. Because most time and effort was spent in the creation and organization of the sounds, the cuebook unfortunately was not as well orchestrated as it could have been. However, it provided a basic structure from which to work. This structure allowed for an improvisatory atmosphere, whereby a framework of tonality and dynamic levels was provided, but 'riffs' and 'embellishments' could be determined by the operators. By opening night, the operators rarely referred to the cuebook-- rather, they depended on memory, watched the action on the stage, and responded according to the real time rhythm initiated by the actors. In addition, because the sounds had been organized following the "soda fountain" method, the console operator was able to supply a variation in sounds from night to night, just as the actors varied from night to night-- an audio design successful in real time.

**Technical Considerations**

The equipment used for the actual production consisted of three tape decks, two with two-track capability and one one-track; the Cetec console; one Putney synthesizer; a Sony wireless microphone; and eight speakers, two backstage, two in the louvres, two in the orchestra pit, and two flown at the back of the house. There were three operators, one at the console controlling gain and mixing, one at the Putney processing Jean's voice and creating real time effects, and one upstairs
monitoring tapes. The console and Putney were located in the house. In order to integrate real time effects with the stage action, it is necessary for the operators to see and hear the stage action as the audience members do. Thus, three important elements dictated the need for the console in the house: 1) appropriate mixing and balancing; 2) gain control; and 3) panning or moving the rhinoceroses around the stage and ultimately around the theatre.

The training of the operators proved a very pleasant task. Because all three operators had had acting and musical training, they were quite sensitive to the needs of the production. The console operator had a great sensitivity to gain control, the Putney operator a sensitivity to when, where, and how much distortion should be created.

The major problem in the show was panning. Because most of the rhinoceros sounds were low frequencies, it was difficult to identify the movement. Also, the theatre was a relatively small theatre and the natural reverberation tended to locate sound at other places, which made identification of movement difficult. Movement could be identified, however, if one sat in certain sections of the house.

The interfacing of sound with the live actors met with few problems. The sound was able to integrate itself into the entire production and be a supportive element of the dramatic illusion.
EVALUATION

The Evaluation section will be divided into three main sections: symposium evaluation, Rhinoceros evaluation, and potential spin-off questions and research.

Theatre is a place where live actors perform. To this end, all things else are supportive—lights, sets, costumes, sounds. The actor's rhythm is the dramatic rhythm—real time is the live actor performing in a virtual world that he presents. For the most part, this element, real time, uniquely belongs to the theatre. It is this element that inspired the creation of a sound symposium: a real time exploration and application of audio technology to the theatre.

The sound symposium brought two groups of people together: theatre people who dealt with the artistic aspects of theatre, and audio engineers who had the technology to put the artistic aspects of sound to practical use. The task these two groups of people were asked to consider was the real time application of audio technology for and in the theatre.

To such an end, the symposium personnel, over a two week period, experimented with an equipment array to interface it with the live actor. From this experimentation three areas of problems, findings, and application have been generated: 1) Mechanics, or technical considerations (further subdivided into two parts: experimentation and equipment problems, findings, and application); 2) a category which I have termed Human Engineering Considerations; and 3) Artistic Considerations
and Conclusions.

Mechanics

The mechanical experiments evolved out of the question: "Can we make the walls of the theatre appear to move, i.e., can we change the shape of the room through audio?" This question was posed to the technical team, and through the process of trial-and-error, the room was made to appear to "grow." This effect, which was termed the "cathedral effect," was achieved through the use of the digital delay unit. However, it was suggested that the effect can be improved if an equalizing unit is employed to roll the highs off the rear house speakers. Because high frequencies attenuate more over distance than low frequencies, rolling the top off rear speakers will help in the illusion of a cathedral. This problem, solved by the technical team, has a potential theatrical application in that the auditory space can be made to appear to enlarge or shrink. For example, in the production of Rhinoceros, the director Ms. Backlin, had a concept whereby as the play progressed, the visual space would shrink and the auditory space would expand. This "cathedral" experiment could conceivably find application in this situation.

An outgrowth of this question of room expansion led to sound directionality, whereby sound is made to appear to emanate from one source, but is actually emanating from somewhere else. With such an effect in mind, a question was posed: "Can the walls of the room be made to appear to move in and out, as if they were breathing?" How-
ever, in order to attempt a solution a non-directional reference point would be needed—specifically an attic speaker. Because not enough time was available to hook up an attic speaker, this experiment was dropped. It thus becomes an area of spin-off research and exploration.

Other than the room expansion experiments, most of the mechanical experiments were general trial-and-error experiments to discover what the processing devices could generate. These general experiments included ideas from the manufacturers' manuals and general turning of knobs. What these general tests attempted to accomplish was to find and document some specific capabilities of each piece of equipment. Documentation creates the potential for repeatability. Once repeatability is possible, theatrical application becomes viable, for theatre requires and demands repeat-capability. Most of these effects were applied to taped music and presented to the symposium audience. The theatrical application of these effects need more exploration.

The equipment array assembled for the symposiums included processing devices, a mixer (console), amplifiers, and speakers. A single line for this equipment was developed that would lend application to the theatre. Because most of the equipment had for the most part never been applied to a theatrical environment, half the time was spent in just hooking it up and technically setting up the experiments. Much time was spent in working out hums, buzzes, and noises. Because the interfacing of this equipment for the theatre environment was relatively new, much time was spent in learning how to run the equipment. In terms of some specific capabilities discovered, the following are some
findings and possible application of the equipment array.

It was discovered that the Putney synthesizer was the most versatile piece of equipment. It not only can generate its own signals, but can also process outside signals, a dual function that no other piece of equipment assembled for the symposium could accomplish. However, due to a lack of knowledge of the Putney, not much experimentation during the two-week period took place. (The section under Equipment Demonstration gives a further explanation of how the Putney works.) Because of this versatility, theatrical application is increased. For example, for the production of Rhinoceros, the Putney was utilized as both a real time creator of effects and as a processing device for a live actor's voice. The artistic application of this duality will be discussed later.

The second piece of equipment, which was the subject of the most experimentation, was the digital delay unit. This unit was used as the technical solution to the problems of room expansion, used to add dimension to taped music (in the semblance of reverberation), and used to process signals as an effects generator (in the general experimentation sessions). This device, however, lacked the kind of subtlety that was discovered in the Putney. For example, when the digital delay at one time, and the Putney at another time were used to process Jean's voice in the transformation scene of Rhinoceros, the Putney was capable of more subtle distortion than was the digital delay. Also, the cost of a delay unit is about five times that of the Putney. However, in terms of the "cathedral effect" and sound movement (panning-by-delay, which
roughly translates into the Precedence Effect), the delay unit is the only possible device.

The spring reverberation unit was used to add dimension to recorded and live sources. When struck, it can create crashing effects. For the theatre, this unit could be utilized when crashes are needed, and to add depth and quality to live and recorded sources. For example, this unit could find application in the production of *Rhinoceros*. As the auditory space begins to expand, reverberation of signals could be sent into house speakers. Thus subtlety of sound could be achieved.

The Time Warp proved a fascinating device until it began to generate its own noises. When the Warp first arrived, it processed signals without generating its own sounds. As the days went on, it grew progressively worse until it generated its own sounds (in the semblance of a pulsating tone). However, it came to our attention that this particular Time Warp had been sent to the symposium before testings could be completed. Thus its potentialities were never completely explored. However, next to the Putney, the Time Warp appeared to have the most versatility as a processing device. It is capable of processing signals to create very strange and bizarre effects. For example, this device found application as a processing tool for the comedy routines of a live actor. It was used to create the 'watery effects' of 'Jacques Cousteau.' It also found application in the creation of the 'Cosmic Rhinoceros.' Most of the effects discovered with this device related to the distortion of signals that resulted in weird, strange, 'out-of-this-world' sounds.
The Varispeech proved a wonderful device to create humorous voice distortion effects. In terms of processing recorded sources, it was less adaptable to interfacing than was the delay unit. It was used for example, as a processing device for the comedy routines of a live actor. It raised the pitch and increased the pace of his voice, which was used in the 'martian effect.' Its application to the theatre, for the most part, would result in humorous effects.

The Cetec console, designed for theatrical purposes, served as the central piece of equipment, whereby all the other devices were hooked in and, for the most part, controlled. An interesting feature of this board are the Preset On buttons, which control input signals. Any input channel switched to a Preset On group will turn on when the corresponding master button is depressed. By assigning distinct Preset On groups to the same submaster bus, preset mixes may be selected and cross-faded. Since theatre demands real time movement, the Preset On control allows for input presettablility. In this way, one could go from one relatively complex condition to another in a matter of milliseconds, just by pressing a button. Application was found once again in the comedy routines of the live actor. By merely pressing a button, the console operator went from the 'Jacques Cousteau' effect (involving the Time Warp, reverberation unit, and gain set) to the 'god' effect (involving the Varispeech, reverberation unit, and gain set). For the theatre, this is essential; real time demands this kind of split-second capability.

As a result of these mechanical findings, several conclusions can
be drawn. First, more theatre sound control boards need to be built. They should have input preset capability (i.e., go from one condition to the next by pushing a button); they should have a more output capability than a recording studio console; knobs on theatre boards should be so arranged as to accommodate real time mixing; more linearity (i.e., subtle movement capability) in gain control is necessary to create the audio subtlety that theatre demands. A more detailed discussion on the Ideal Theatre Sound System occurs in the section on Papers Presented.

Second, the best position for mixing a show is in the center of the house. Central mixing allows the operator to respond directly to the dramatic rhythm of the actors. For example, in the production of Rhinoceros, the mixing booth was located at back house center. Consequently, volume rarely overwhelmed the actor, and the board operator responded (with almost 100% accuracy) with sound cues that followed the dramatic action.

Lastly, it was discovered that the equipment needs to organize itself to the standards of the theatre. Patching needs to be simplified so as to decrease the time spent on technical problems; such theatrical standards as presettabil i ty, repeat-capability night after night, reliability of equipment performance, general human engineering for theatrical demands are a few of the requirements that a real time situation needs.

It must be kept in mind that most of these mechanical experiments and findings revolved around real time application of audio technology
to the theatre. The technology must be supportive of the primary illusion: the dramatic action.

**Human Engineering Considerations**

From the mechanical findings and application, we move to what I term the human engineering category. This category concerns itself with three areas: 1) sound localization and sound movement; 2) cue notation; and 3) operator training.

Sound localization and sound movement or panning were by-products that evolved from the question of room expansion. The experiments involved with sound movement were of two kinds: panning-by-delay and panning using volume shifts with the console's pan pots. Several general experiments were attempted, which found specific theatrical application. It was believed that panning-by-delay (roughly synonymous to the Precedence Effect) would result in a cleaner, more distinct sense of movement than panning by volume shifting. However, the technical permutations in just setting up panning-by-delay were complex as compared to panning by volume shifting. This complexity consequently hindered the Precedence Effect experiments.

Panning by volume shifting proved simpler to set up. It was used effectively when moving sound from house speaker to stage speaker. However, panning from one stage speaker to another stage speaker proved less effective than from house to stage speaker. The major reason was that not enough physical space existed between the two stage speakers. Panning by volume shifting was used in the transformation scene at the
AES presentation. The board operator attempted to make the sound follow the actor as he moved. Although the illusion of sound moving was difficult to distinguish, location of where the sound was emanating was identifiable.

From the experiments on sound location and sound movement several conclusions can be drawn. First, sound needs to move over a certain amount of physical space in order for the movement to be distinguished. For example, in the production of Rhinoceros, the rhino galloping from one speaker to the next was distinguishable only from certain sections of the house. Second, low frequencies tend to be less distinguishable in panning because they are more non-locatable than high frequencies. Third, sound location and sound movement for and in the theatre are important elements in the creation of auditory space. Where sound is located, where, how, and when it moves, are important considerations in the interfacing of audio technology with the theatre. Real time dramatic movement needs real time audio movement, or at least the potential for it.

Cue notation, or a method of explaining/writing sound cues, takes on different characteristics when applying this equipment array to a real time situation. In dead cue notation, the method is fairly straightforward: warn cue, ready cue, go cue, fade cue, out cue. However, when we remove the dead cue and replace it with real time cues, the notation must take on a different nature: the cue notation must not only give the vital statistics of a dead cue notation, but be flex-
ible enough to allow for the operator to respond directly to the stage action. It was discovered that a musical analogy lends itself to this situation. Notation should be laced with pianissimos, fortés, attacks, fermatas, etc. In this way, the designer (who is really a composer) gives the operator (who becomes more an interpreter, or a musician) dynamics of interpretation. Musical notation allows for the kind of interpretive 'freedom-with-control' needed for real time theatrical application. Dead cue notation thus becomes the 'notes' that need to be played; musical dynamics give the operator an interpretative outline in which to operate. In addition, improvisation sections should be communicated-- the potential for the operator to respond to the dramatic action with 'embellishments.'

This leads into operator training. In the theatre, a technical operator is usually relegated to the position of an intelligent robot. In dead cue situations, this can almost be justified. However, when we move into the area of interpreter, the operator becomes more a musician than an operator-- he must 'play' his instruments in response to the dramatic action. This can be analogized to an accompanist and singer, whereby the accompanist must respond and balance his playing to the rhythm of the singer. The operator/interpreter would need to develop a sensitivity to sound balance in relation to stage action. He would need to learn to perform on his instrument-- to know his instrument technically well enough to be freed of the technical and be able to concentrate on the creative application. He would need to learn the notation system. In short, he would need to be an actor and a
musician. In the production of *Rhinoceros*, for example, the three sound operators had some acting and musical knowledge. Consequently, their sensitivity and understanding of real time response to the dramatic action were highly refined— the console operator rarely overwhelmed the stage action. He played the sound superbly. Most of the training of these operators lay in teaching them the technical workings of the equipment. It must be noted that 'communication' between the actor and operator/interpreter is vital. In the final analysis, there needs to exist an ability for the operator/interpreter and the actor to respond to one another in real time.

An interesting conclusion can be drawn from these observations: when the audio technology (sound) is interfaced with a theatrical real time application, it appears to take on musical characteristics: in designing ('composing'), in notation ('scoring'), in operator training ('performer lessons'), in application ('performing with/on the equipment/instruments'), and in execution ('performing in conjunction with other performers'). Perhaps sound as art lies within the musical field. Such a conclusion would have ramifications for theatrical application of audio technology. An entirely new method of thinking, creating, training, executing, and communication would result as a consequence of this musical analogy/adaptability.

**Artistic Considerations**

We now come to the artistic considerations: problems, findings, and application. The key problem from which all experimentation evolved
was the interfacing of the audio equipment with the live actor. To such an end, the thrust of real time experimentation revolved around the actor hooked up with a hand held mike or a wireless mike, and processed through the devices. The key question in relation to the problem of interfacing the actor and the equipment was: "How will the actor respond when his voice becomes a tool that someone else manipulates?"

It was discovered that the live actor with a microphone will unconsciously adjust his rhythm to the rhythm of his processed voice. This finding has several considerations: Is the actor creating tricks with his voice before processing? Is he speaking naturally before processing? How much adjustment occurs when the voice distortion is subtle? How much occurs when distortion is slowly faded in? How long must an actor work with real time voice distortion in order for adjusting to be virtually non-existent? Such questions were only partially answered by the symposium experiments and thus lend themselves to spin-off research and documentation.

Documentation of the results as each knob is turned on a device needs to take place. Such documentation would allow for repeatability -- an essential element in the theatre. By starting dry and slowly fading in distortion documenting each permutation, patterns can be discovered.

One of the major problems in interfacing a live actor with the devices is intelligibility. First experiments so completely distorted the voice that intelligibility was almost nil. However, it was eventually discovered that by mixing in a channel of natural voice with the
processed voice channel, intelligibility could be controlled. Such a finding has great applicability to the theatre. For example, in the transformation scene, Jean's natural voice and processed voice could be subtly balanced by the operator so as to create the illusion of transformation, yet retain intelligibility.

For the symposium presentation, comic routines were presented by a live actor, whose voice was processed through the devices. This is an example of an actor doing tricks with his voice before processing. The result was low intelligibility. The main reason for this was a lack of rehearsal time for the actor and the operators. Those comic sections that were given rehearsal resulted in excellent interfacing between the equipment and the actor.

An example of real time voice processing is in the production of Rhinoceros, in the transformation scene. At key points in the scene (established through the rehearsal period), the Putney operator processed (distorted) Jean's voice to help augment and add dimension in the transformation from human to rhinoceros. It must be pointed out that the progress of distortion can be reversed. At one point during the symposium it was believed that once distortion began, it had to continue in order to maintain consistency. This proved untrue, as distortion of Jean's voice was brought in and out quite successfully. The operator of the Putney, sensitive to subtlety, created an excellent balance between distortion and non-distortion. A heightened sense of dramatic appreciation resulted. Many attending audience members had no idea how the vocal transformation took place. This is a superb example
of how well audio technology can be utilized in a theatrical situation.

Conclusions

Pulling the experimentation, human engineering, mechanical, and artistic sections together, several conclusions can be drawn about audio technology in and for the theatre. One of the major barriers to overcome in the development of audio design for theatrical purposes is language. Theatre people need to learn the language of the recording industry in order to deal with the technology, and the technicians from the recording industry must learn the language of the theatre if they are to develop and market equipment specifically designed for the theatrical environment. One of the key terms found in engineering that has direct translation in the theatre is real time: dramatic or virtual time set not by the clock, but by the dramatic rhythm of the actor.

Several methodologies for equipment application were developed. From the symposium came the problem-solution format. This was a method of operation that the symposium presentation followed. Problems were posed, solutions were attempted by the technical team. The thrust of the problems lay in developing sound for a theatre production: specifically, Rhinoceros. By giving the equipment specific tasks to perform, it was hoped that some insight would be gained as to some definitions and problems in interfacing the equipment in the theatre. The problem-solution format also gave the two symposium teams (artistic and technical) a format of operation. The audio problems in Rhinoceros
were utilized to give the equipment array a focus: real theatrical problems to solve. Such an opportunity to apply theory to a real situation is rare.

A trial-and-error process was used in the experimentation, testing, and solution-finding sessions. Because the interfacing of this technology with the theatre is relatively new, trial-and-error was the best process in the working out of problems. From this process the library concept evolved, whereby all audio experiments, tests, etc. would be generated onto tapes, and a library of sounds would thus be created. At least fifteen rolls of tape documenting the sounds created now exist. Also, a library of device settings was generated. The major importance of these tapes is the theatrical context from which they were derived; whether the sounds created were for specific task solving or just general experimenting, they all exist within the framework of a theatrical environment, with equipment hooked up to be compatible with the theatre. The possible theatrical application of these sounds still need investigation and can be considered as spin-off research. These tapes are available upon request from the Theatre Department at California State University at Northridge.

Documentation of symposium problems, findings, experiments, tests, solutions, theories; artistic and technical considerations-- have been written up. Through documentation is the potential for repeatability: a critical element in the theatre.

One of the important findings evolving from the documentation of
the interfacing of a live actor with audio equipment is a theory of progressive distortion, whereby each turn of a knob on each device would need documentation as to the result— from flat (or natural voice) through a balance of natural and distortion, through complete unintelligibility. Such a documentation process would be a spin-off project from these findings.

Designing concepts evolved as a result of applying the audio technology to an actual theatrical production. The 'soda fountain' idea emerged, whereby sounds are laid on many tracks, in tape loops, and the operator needs merely to tap into the tracks. Such a concept lends itself to the real time application of recorded sources— an area that has usually been concerned with dead cues. The orchestration concept evolved as a result of designing Rhinoceros. This musical analogy involved composing sounds, scoring the sounds (notating), and performing the sounds (musicians). Thus, designing audio for the theatre, utilizing equipment such as that used at the symposium, could employ methods of scoring and orchestrating, rather than just listing sound cues and then recording them to be played as dead cues.

In order to achieve dramatic quality from the audio technology, a dramatic context must first be posed. In order to give credence to the equipment array other than just generating weird and interesting sounds, a dramatic context is needed. The theatre must give this audio technology a framework and problems from which to work. More scripts like Rhinoceros are needed; more theatrical experimentation with the recording industry's technology is needed; methods and documentation
of findings need to occur in order to create the possibility of repeatability. 100% reliability in equipment performance is necessary for theatrical purposes. The quality of sounds processed, generated, and ultimately played must give the illusion of being performed in real time. Sounds that sound as if they have been taped, or contain hums, buzzes, and noises, defeat the real time capability of the audio technology. More real time experimentation interfacing the actor and the equipment is needed. It has been shown through an actual production that taped sounds can have first rate quality, that real time processing and effects can be interfaced with an actor's voice. All these tasks, developed from a dramatic context.

One of the most important findings, evolving from the need for dramatic context, was that the equipment array was more powerful than what we as theatre people were willing to do with it. Because it needs to be supportive of the dramatic illusion, the key to all this audio technology is subtlety: such phrases as "sneak-up", "slow fade in and out", "more subtlety", etc., were constantly employed when theatrical application occurred. The power and permutations of this equipment array is perhaps ten-fold that of lighting. In order to interface this technology with the theatre, early rehearsing is necessary-- tech week (i.e. the week given to the technical considerations of a production) is too late. The actor needs to learn to utilize audio space and the accompanying technology, as he has learned to find and use light.

As audio for real time theatrical application develops, two important conditions must exist: 1) a method of documentation should
occur in order to insure repeatability; and 2) subtlety should be the mode of operation to insure dramatic support and not overwhelm the action.

Evaluation of Rhinoceros

Because of the application of some of this technology to an actual theatre production, the answer to the question: "Can we dramatically do something with this technology other than generate weird and unusual noises?" is "Yes." The following is an evaluation of that actual production: Rhinoceros.

This evaluation will unfold in three sections: the generating of sounds utilized in Rhinoceros, the rehearsal of sounds in conjunction with the actors, and the performances.

The sounds created for the Rhinoceros scenes presented at the symposium were, for the most part, not the sounds that were utilized for the actual production. The major problem in the creation of sounds was finding the right source material. For the symposium scenes three sources were utilized: taped animal sounds, actors' voices, and a violin. All these sources were processed through either the delay unit, the Time Warp, the Putney, the Varispeech, or a combination of them. The section on Sounds Created For Rhinoceros details how these sounds were processed and why they were rejected.

At the close of the symposium, it was disclosed that the only pieces of equipment that would remain for the actual production were the console and the Putney synthesizer. Thus, the problem of processing
was solved: it would be just the Putney. However, source material still remained a dilemma, as the rhinoceros sounds generated for the symposium were not satisfactory. It was hoped that the actors would serve as source material and that they would be used during the actual performances, creating live effects that could be processed through the Putney. However, due to a lack of time, experimentation with actors in the sound booth never materialized. So, the second choice was the Putney. And it was the Putney that finally became the source that created most of the sounds heard in the actual production. It was used not only as an effects generator, but also processed Jean's voice during the transformation scene. In conjunction with Mr. Ted Peterson, a synthesizer expert from the music department, the five show tapes utilized for Rhinoceros were generated over a period of four weeks, at least fifteen hours a week. It has become evident that the creation of sounds for real time application require a tremendous amount of time and patience-- it is akin to composing.

In developing the sounds, the process of composing involved two aspects: 1) the ideas and sounds, verbalized (abstract design); and 2) the practical method of creating the design concept (technical). Briefly, the sounds for Rhinoceros were divided into three movements. Under each movement two types of sounds were needed: sounds that the operator could tap into (improvisational in nature) or real time processing of the actor's voice, and sounds that were absolutely demanded and needed for the progression of the play to occur. Each type of sound was composed in about the same manner-- sounds developed on the
Putney by Mr. Peterson; the nature and characteristic of the sounds needed verbalized by myself. By such a method of composition, the sounds were created. Appendix number two includes a sound plot utilized for Rhinoceros, and how the sounds were created.

Once the sounds were created, work tapes had to be recorded, a method of cueing had to be developed, and the training of the operators had to be accomplished. The cueing proved too skeletal--more musical notation would have given the potential for more subtlety of sound dynamics. Training the operators proved surprisingly easy. Since all three were actors with some musical background, their sensitivity to the dramatic action proved quite acute. The lack in cue writing was made up in the sensitivity of these operators. The Putney operator, Mr. Michael Llach, not only processed Jean's voice, but created rhino "yells" on the Putney to supplement the taped rhino sounds. In terms of cueing, the Putney operator was told to follow the dramatic action and process Jean's voice and create rhino "yells" within a given framework. This approach, for the most part, worked. The major element of subtlety kept the Putney operator supporting the dramatic action, and only rarely did the Putney volume overwhelm the stage.

Headphones were used to communicate between the two booths--no major problems resulted. The tape monitor did most of the talking, phrasing his communication in such a way that the Putney and console operators merely needed to say "yes" or "no."

During the performances, sound proved effective. Volume rarely overwhelmed the dramatic action, the cues came in and left at appropri-
ate times. The major problem lay in panning. Because of the small size of the theatre and the low frequencies of most of the rhino sounds, half the audience could not distinguish sound movement, just sound location. On closing night, the telephone did not ring. This was the only sound cue that was not controlled by the sound crew—someone backstage had forgotten to plug it in. Here was an example of the importance of sound cues: The actor portraying Berenger covered, the sound crew adjusted the rhinoceros sounds, and the play progressed. A real time situation handled superbly.

It was suggested by several audio experts that sound in the house could prove distracting, especially if speakers were visible. This for the most part proved untrue. When sounds emanated from the back speakers, very few audience members turned their attention away from the stage and to the speakers. Once again, subtlety is and was the key.

One design problem involved the acoustical space enlarging as the physical space grew smaller. By slowly bringing sound into the house, this acoustical space did expand. However, more subtlety was needed. Perhaps if the 'Subliminal Rhinoceros' was incorporated, more subtlety may have been achieved. An attic speaker would have helped in non-directional sound and may have proved the key in creating a 'feeling' sound rather than an 'audible' sound for the subliminal rhinoceros.

After the run of the production, a questionnaire was distributed to about fifty students, theatre and non-theatre majors. About seventy-five per cent of these people believed the sounds to be rhinoceroses
(at least in the context of the play). Dramatic believability was the concern, and for the most part, the sounds were dramatically believable.

At the conclusion of *Rhinoceros*, it became evident that even the best sounds cannot be integrated into a production if the actors do not acknowledge their existence. There were moments in this production when the sounds did not work simply because the actors did not acknowledge their existence. The moments that the rhinoceroses appeared to be alive were when the actors verbally and bodily reacted to their existence. When an actor physically or vocally reacts to a sound, that sound takes on dramatic significance. It becomes a part of the virtual world of the actor and contributes to his real time rhythm. The interplay of actor and sound is the key element for successful real time audio design.

A unique experience was born in the three months that were the symposium and *Rhinoceros*. There existed an attempt to bring the aesthetics of theatre in combination with the technology of the recording industry, in the hopes of opening a new creative vista for the theatre. Our strength lay in the equipment unfolding to us, playing and using it within a theatrical context. We had an opportunity to establish some artistic application: to show directors some of the artistic abilities that are capable with a wireless mike, a Putney, a mixing console, etc. Very rarely does an opportunity to apply theory arise. *Rhinoceros* proved the testing ground, and the test succeeded.
According to those questionnaires, the sound for Rhinoceros proved an exciting, welcome addition to the dramatic action. This alone should give inspiration as to the potentialities of audio design in real time. More scripts like Rhinoceros are needed. Progress in the theatre—add dimension to the real time aspects of theatre in the auditory space, as it has been accomplished in the visual space. The key for audio is subtlety. With the success of Rhinoceros, it is believed that audio is and will be a viable avenue of creative expression in and for the theatre.
Some possible areas of research, resulting from the exploration conducted at the symposium may include the following:

1) more real time experimentation with the live actor hooked up to a wireless microphone: How does he handle or adapt himself? What kinds of actor training methods need to develop in light of this technology? In what ways does the actor's rhythm change in relation to the technology? How much distortion can the dramatic content of an actor's voice withstand? Does dramatic quality and intelligibility go hand in hand?

2) more exploration and experimentation into actor-operator communication: What forms of communication occur between an actor and operator/interpreter? What forms of verbal and non-verbal communication are needed between an actor and operator/interpreter in real time? How does an operator learn to respond to an actor's dramatic rhythm? How can an actor better communicate with an operator and ultimately the sounds themselves in real time?

3) more experimentation with localization and movement: How much sound placement can be generated before chaos occurs? What are the implications of room expansion? Of spatial expansion? Of the illusion of the room pulsating? How important is a non-directional reference point?

4) more research and development in the area of human engineering for theatre sound systems.

5) more exploration into the musical analogy of designing, creating, and
notating audio in and for the theatre.

The audio equipment available to the recording industry can be applied to the theatre. It has been demonstrated through an actual design-research project that audio is a necessary and viable element for a total theatrical experience. This has been a pioneering project in that audio design is virtually a non-existing component in the theatre. The real time element, belonging almost exclusively to the theatre, can open avenues for audio that have never been dreamed of. The goal, to enhance the total theatrical form and not overwhelm or destroy it, was accomplished.
APPENDICES

I. GLOSSARY

II. SOUND PLOT FOR RHINOCEROS

III. BIBLIOGRAPHY
GLOSSARY

The following is a glossary that has been compiled in an effort to define engineering or recording industry terms in theatrical language.

analogue: a device where an electrical signal is treated mechanically as voltages, magnetic waves, etc. Through the manipulation of a mechanical means the original signal is changed. For example moving a fader, spring reverberation unit, etc.

attenuate: to cut, or take away. To weaken or reduce in force, intensity, effect, quantity, or value.

bus: summing bus. Can accomodate more than one input.

channel: device through which sound is mixed.

dead cue: inflexible, mechanical cue that cannot respond to the rhythm set by live actors. Fixed, unalterable cue.

dB: (decibel) a logarithmic scale describing sound levels. The decibel has no actual numerical value, but is used only to express a ratio between two powers, voltages or currents. When using decibels, it is customary to employ a reference voltage or power level to which the measurement is referred. The following is a chart giving examples of dB levels and the power it translates into:

<table>
<thead>
<tr>
<th>Level Change in dB</th>
<th>Equivalent Power Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 dB</td>
<td>1.3 times</td>
</tr>
<tr>
<td>2 dB</td>
<td>1.6 times</td>
</tr>
<tr>
<td>3 dB</td>
<td>2.0 times</td>
</tr>
<tr>
<td>6 dB</td>
<td>4.0 times</td>
</tr>
<tr>
<td>10 dB</td>
<td>10 times (10^1)</td>
</tr>
<tr>
<td>15 dB</td>
<td>32 times (10^1)</td>
</tr>
<tr>
<td>20 dB</td>
<td>100 times (10^2)</td>
</tr>
<tr>
<td>30 dB</td>
<td>1,000 times (10^3)</td>
</tr>
<tr>
<td>40 dB</td>
<td>10,000 times (10^4)</td>
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<tr>
<td>50 dB</td>
<td>100,000 times (10^5)</td>
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<tr>
<td>60 dB</td>
<td>1,000,000 times (10^6)</td>
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<tr>
<td>70 dB</td>
<td>10,000,000 times (10^7)</td>
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<tr>
<td>80 dB</td>
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<tr>
<td>90 dB</td>
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<tr>
<td>100 dB</td>
<td>10,000,000,000 times (10^10)</td>
</tr>
<tr>
<td>110 dB</td>
<td>100,000,000,000 times (10^11)</td>
</tr>
<tr>
<td>120 dB</td>
<td>1,000,000,000,000 times (10^12)</td>
</tr>
</tbody>
</table>

Examples of dB levels:

- 120 dB: painful
- 110 dB: rock music
- 95 dB: subways
- 75 dB: average traffic noise
- 65 dB: conversational speech
- 35 dB: library
- 15 dB: broadcasting studio

3 Chris Foreman, "Power...How Much Is Enough?" Recording Engineers/Producer (vol. 8, no. 2, April, 1977), p. 84.
delayed sound: reflected sound, reaching the listener at a different time than the original sound; had to travel farther than direct sound.

digital: a device where an electrical signal is broken down into a numerical coded form and is treated arithmetically rather than mechanically.

digital delay: technique by which a sound is delayed in time. Can be used for reinforcement of sound; can be applied as a signal processing tool to produce special effects and enhance sounds.

digital placement: ability to move apparent sound source by delay.

direct sound: directly from source to listener; no reflections.

dynamic range: the difference in dB between the loudest and the softest levels in a performance.

equalization: filters (boosts or attenuates) various audio frequencies.

foldback: send back to; typically refers to sending a signal back to the stage monitors.

frequency: a number of cycles per second (Hertz) is frequency; pitch. The sine wave is the basis for defining frequency.

frequency response: characteristic of a sound system describing how it behaves when it is given an input which consists of changing frequencies.

gain: amplitude; volume.

Hertz: term used to refer to cycles per second.

human engineering: of or pertaining to the designing of equipment for ease of control.

input: a term used to describe when a signal is put into a piece of sound equipment.

interface: the combining of elements in a harmonic fashion.

IPS: inches per second (speed of tape)

line level: in a sound system, signal levels are divided into two general categories: mike levels and line levels. Line level is used to indicate inputs and outputs for pieces of equipment which have already gone through some type of preamplification.
matrix: a type of patching or patch bay.

mixing: combining of sounds.

module: movable, self-contained component of a piece of equipment.

output: a term used to describe when a signal is taken out of a piece of equipment.

panning: movement of sound from one apparent location to another.

patch bay: a localized network of inputs and outputs for equipment. It is used for the selection of paths for signals.

real time: dramatic or virtual time; live time as opposed to recorded time; element characteristic of theatre, presentation occurring live.

reverberation: echo; bouncing around of sound waves.

signal: electrical impulses. When sound waves are converted into electrical impulses they are called signals.

single line: simplified equipment hook-up plan.

white noise: all frequencies present at once in equal volume.
SOUND PLOT FOR RHINOCEROS

This appendix includes a sound plot used for Rhinoceros and an example of how the cuebook looked. The sound plot appears in three ways, one, a preliminary sound plot compiled following the script stage directions (including method of sound creation, two, a sound plot following the three movement sound design concept (listing the essential sounds in each movement), and three, an example of the final sound plot utilized for the production (how the sounds were organized for the show).

Examples from the cuebook include samples from the third movement.
Preliminary Sound Plot

description

Act I, Scene 1
Church Bells

Rhinoceros Noise
a noise, far off, swiftly approaching beast panting in its headlong course, and of a long trumpeting. Noise becomes loud, very loud

segue of intense noise of a powerful heavy animal galloping at great speed, heard very close; the sound of panting noise dies away swiftly.

Noise of Running People, Cries of "Oh" and "Ah"

hooves, trumpetings, etc. distant course of the animal as noise fades.

a sound of rapid galloping is heard approaching again, trumpeting and hooves and panting.

noise of people fleeing, "ohs" and "ahs" as before

Piteous Mewing then Equally Piteous Woman Cry

method of creation

Putney: keyboard for tones

Putney: keyboard for pitch and rhythm (gallop); movement of joystick for rhino "yell"

Ten actors running and shouting, re-recorded to equal the sound of a multitude of people.

Act II, Scene 1
Crumbling Staircase, Rhinoceros Noises, Anguished Trumpeting

Crashing sound recorded and processed through the Putney. "Louise Call." Actor vocalizing the name Louise, recorded and processed through the digital delay unit, and slowed
<table>
<thead>
<tr>
<th>Description</th>
<th>Method of Creation</th>
</tr>
</thead>
<tbody>
<tr>
<td>horrible trumpeting</td>
<td>from 15 IPS to 7½ IPS.</td>
</tr>
<tr>
<td>violent but tender trumpeting</td>
<td>Fire engine siren and braking sounds taken from a sound effects record</td>
</tr>
<tr>
<td>Noise and Hooting of Fire Engine.</td>
<td>Sound of babbling brook taken from a sound effects record, and processed through an equalizing unit (sweep tuning)</td>
</tr>
<tr>
<td>Brakes applied abruptly just under the window</td>
<td>Trumpeting sounds created by the live actor on a wireless mike and processed, live, through the Putney</td>
</tr>
<tr>
<td>Bathroom Tap</td>
<td></td>
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<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Noise from bathroom, Trumpetings Objects falling, shattered mirror, etc.</td>
<td></td>
</tr>
</tbody>
</table>

**Act III**

- rhinoceros noises; a considerable number of rhinoceroses passing under up-stage window
- panting of animals (becomes louder)
- rhinoceroses galloping under up-stage window
- rhinoceroses passing under down-stage window
- distant rhinoceros noises
- louder rhinoceros noises passing first under up-stage window and then the down-stage window
- increasing noises of rhinoceroses going around and around the house

A Great noise of traveling Rhinoceroses Recorded trumpets playing off-
description

Trumpets and Drums are heard. Wall Crumbling

powerful noises of moving rhinoceroses but somehow it has a musical sound

Telephone Ring

Trumpeting coming from telephone

Trumpeting from radio, in the distance other trumpets like echoes

noise from everywhere, rushing of feet, panting breath of animals, loudest noises come from above. Stamping, plaster falls, house shakes, noise diminishes into musical background

Melodious Rhinoceros Noises

Fresh trumpeting, hectic racing

method of creation

key and equalized to sound "tinny" (low frequencies attenuated)

Created by prop telephone, off-stage, live

Putney: use of joystick to create rhino "yell" live

Singing, recorded and processed through the Putney

Clarinetts and trumpets recorded, processed through the Putney
The Design In Three Movements

I. Before the Transformation

1. pre-show music to incorporate subliminal sounds that will appear audibly later in the show

2. church bells

3. single rhinoceros galloping and panting, "realistic"
   a. reaction to: crowd offstage
   b. result of: cat killed

4. funeral music for cat

5. crumbling staircase result of a particular rhinoceros: Mr. Boeuf

6. "Louise Call"

7. fire engine

cadence into intermission music

II. The Transformation

1. bathroom noises: water running

2. live processing of Jean's voice

3. scene to end with first rhinoceros herd

III. Non-Capitulation

1. rhinoceros herds
   a. musical (daisy's theme)
   b. ugly (berenger's theme)

2. rhinoceros band (fire house breakthrough and music)

3. live telephone ring

all movements to be tied together by the "cosmic rhinoceros" (the "lure") appears subliminally in the first movement, audibly the second movement, almost continuous in the third movement.
Final Sound Plot

ACT I: Scene 1

Band 1: Bush, 6 sec
Band 2: Crowd, 3 min
Band 3: Car Chases, 1 min
Band 4: Scene Change

ACT I: Scene 2

Band 5: Rhino Yells, Left Channel
Band 6: Rhino Yells, Right Channel
Band 7: Fire Scene Breaks, Right Channel

ACT II: Scene 1

Band 8: Tap Water, Left Channel
Band 9: Tap Water, Right Channel
Band 10: Scene Change, Music

ACT II: Scene 2

Band 11: Multiple Yells, Left Channel
Band 12: Single Yell, Left Channel
Band 13: Rhino Howl, Left Channel

Band 1: Fri, Scene 3
He hesitates, goes to the divan, lies down, and instantly gets up again. He goes to the table where he takes up a bottle of brandy and a glass, and is about to pour himself a drink. Then after a short internal struggle he replaces the bottle and glass. No, no, where's your will-power? [He wants to go back to his divan, but the rhapsodises are heard again under the upper-stage window. The noise stops; he goes to the little table, hesitates a moment, then with a gesture of "Oh what's it matter!" he pours himself a glass of brandy which he drinks at once. He puts the bottle and glass back in place. He coughs. His cough seems to worry him; he coughs again and listens hard to the sound. He looks at himself again in the mirror, coughing, then opens the window; the crying of the animals becomes louder; he coughs again. No, it's not the same! [He takes down, draws the window, feels his bandaged forehead, goes to his divan, and seems to fall asleep.]

[Dudard is seen mounting the top stairs; he gets to the landing and kneels on Beringer's door.]

BERENGER: What is it?
DUDARD: I've dropped by to see you, Beringer.
BERENGER: Who is it?
DUDARD: It's me.
BERENGER: Who's me?
DUDARD: Me, Dudard.
BERENGER: Ah, it's you, come in!
DUDARD: I hope I'm not disturbing you. [He tries to open the door.] The door's locked.
BERENGER: Just a moment. Oh dear, dear! [He opens the door.]
DUDARD enters.

DUDARD: Hello Beringer.
BERENGER: Hello Dudard, what time is it?
DUDARD: So, you're still barricaded in your room! Feeling any better, old man?
BERENGER: Forgive me, I didn't recognize your voice. [Begins to open the window.] Yes, yes, I think I'm a bit better.
DUDARD: My voice hasn't changed. I recognized yours easily enough.
BERENGER: I'm sorry, I thought that... you're right, your voice is quite normal. Mine hasn't changed either, has it?
DUDARD: Why should it have changed?
BERENGER: I'm not a bit... a bit hoarse, am I?
DUDARD: Not that I notice.
BERENGER: That's good, that's very reassuring.
DUDARD: Why, what's the matter with you?
BERENGER: I don't know—does one ever know? Voices can suddenly change—they do change, alas!
DUDARD: Have you caught cold, as well?
BERENGER: I hope not... I sincerely hope not. But do sit down,
Dudard, take a seat. Sit in the armchair.
BERENGER: Oh yes, I've still got a headache. But there's no bump.
I haven't knocked myself... have I? [He lifts the bandage, shows his forehead to Dudard.]
DUDARD: No, there's no bump as far as I can see.
BERENGER: I hope there never will be. Never.
DUDARD: If you don't knock yourself, why should there be?
BERENGER: If you really don't want to knock yourself, you don't.
DUDARD: Of course. One just has to take care. But what's the matter with you? You're all nervous and agitated. It must be your migraine. You just stay quiet and you'll feel better.
BERENGER: Migraine! Don't talk to me about migraines! Don't talk about them!
DUDARD: It's understandable that you've got a migraine after all that excitement.
BERENGER: I can't seem to get over it!
DUDARD: Then it's not surprising you've got a headache.
BERENGER: [driving to the mirror, lifting the bandage] Nothing there... You know, it can all start from something like that.
DUDARD: What can all start?
BERENGER: I'm frightened of becoming someone else.
DUDARD: Calm yourself, now, and sit down. Pushing up and down the room like that can only make you more nervous.
Bérenger: No... no... he proved the contrary—that the
African ones were Attic and the Attic ones... I know
what I mean. That's not what I wanted to say. But you'll see
on very well with him. He's your sort of person, a very good
man, a very subtle mind, brilliant.

[Increasing noises from the rhinoceroses. The words of the two men
are drowned by the animals passing under the windows; for a few
moments the lips of Dudard and Bérenger are seen to move
without any words being heard.]

There they go again! Will they never stop? [He runs to the
up-stage window.] Stop it! Stop it! You devils!

[Dudard stands in the entrance to the left. Bérenger shakes his fist at him.]

Dudard: [seared] I'd be happy to meet your Logician. If he can
elevitate me on these obscure and delicate points, I'd be only
too delighted.

Bérenger: [as he runs to the down-stage window] Yes, I'll bring him
along, he'll talk to you. He's a very distinguished person, you'll
see. [To the rhinoceroses, from the window] You devils! [Shakes
his fist at them.]

Dudard: Let them alone. And be more polite. You shouldn't
talk to people like that...

Bérenger: [still at the window] There they go again!

[At the same time a rhinoceros horn enters from the orchestra
pit under the window and passes swiftly from left to right.]

There's a beast impaled on a rhinoceros horn. Oh, it's the
Logician's hat! It's the Logician's! That's the bloody limit!
The Logician's turned into a rhinoceros!

Dudard: That's no reason to be coarse!

Bérenger: Dear Lord, who can you turn to—who? I ask you!
The Logician a rhinoceros!

Dudard: [going to the window] Where is he?

Bérenger: [pointing] There, that one there, you see!

Dudard: He's the only rhinoceros in a bustée! That makes you
think. You're sure it's your Logician?

Bérenger: The Logician... a rhinoceros!!!

Dudard: He's still retained a vestige of his old individuality.
BERENGÉ: I don’t trust the ex-Legionary and the other rhinoceroses who have moved away! I’ll never join up with you! I’ll never join up with you! I’ll never join up with you!

DUDDARD: [setting into the armchair.] Yes, that certainly makes you think.

BERENGÉ: [shouting after the ex-Legionary and the other rhinoceroses who have moved away.] I’ll never join up with you! I’ll never join up with you! I’ll never join up with you!

DUDDARD: [side, in his armchair.] They’re going round and round the house. They’re playing! Just big babies!

BERENGÉ: [at the window, and shouts.] No, I’ll never join up with you! I’ll never join up with you! I’ll never join up with you!

DUDDARD: [side, in his armchair.] They’re going round and round the house. They’re playing! Just big babies!

DUDDARD: There’s somebody at the door, Berenger!

BERENGÉ: [He takes BERENGÉ, who is still at the window, by the sleeve.] No, I’ll never join up with you! I’ll never join up with you! I’ll never join up with you!

BERENGÉ: [shouting after the rhinoceroses.] It’s a disgrace, masquerading like this, a disgrace!

DUDDARD: There’s somebody knocking, Berenger, can’t you hear?

BERENGÉ: Open, then, if you want to! [He continues to watch the rhinoceroses whose noise is fading away.]

DUDDARD: You’re a good friend, Miss Daisy.

DAISY: That’s just what I am, a good friend.
CUE SHEET

RHINOCEROS

DAISY: I saw him do it.
BERENGER: Then he must have been lying; he was just pretending.
DAISY: He seemed very sincere; sincerity itself.
BERENGER: Did he give any reasons?
DAISY: What he said was: we must move with the times! Those were his last human words.
DUDARD: [to DAISY] I was almost certain I'd meet you here, Miss Daisy.
BERENGER: ... Move with the times! What a mentality! [He makes a wide gesture.]
DUDARD: [to DAISY] Impossible to find you anywhere else, since the office closed.
BERENGER: [continuing, aside] What childishness! [He repeats the same gesture.]
DAISY: [to DUDARD] If you wanted to see me, you only had to telephone.
DUDARD: [to DAISY] Oh you know me, Miss Daisy, I'm discretion itself.
BERENGER: But now I come to think it over, Berard's behaviour doesn't surprise me. His firmness was only a pose. Which doesn't stop him from being a good man, of course. Good men make good rhinoceroses, unfortunately. It's because they are so good that they get taken in.
DAISY: Do you mind if I put this basket on the table? [She does so.]
BERENGER: But he was a good man with a lot of resentment...
DUDARD: [to DAISY, and hesitating to help her with the basket] Excuse me, excuse us both, we should have given you a hand before.
BERENGER: [continues] ... He was riddled with hatred for his superiors, and he'd got an inferiority complex...
DUDARD: [to BERENGER] Your argument doesn't hold water, because the example he followed was the Chief's, the very instrument of the people who exploited him, as he used to say. No, it seems to me that with him it was a case of community spirit triumphing over his anarchic impulses.
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