

THE ENVIRONMENT FOR AUDITORY RESEARCH

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1. INTRODUCTION

The United States Army Research Laboratory (ARL) recently constructed and made available to their own and other researchers a unique auditory laboratory - the Environment for Auditory Research (EAR). This multi-purpose research facility was designed to conduct signal detection, spatial perception, and communication research in various indoor and outdoor acoustic environments.

The EAR consists of one large integrated Control Room supporting all research functions of the EAR, four indoor listening spaces; Sphere Room, Dome Room, Distance Hall, Listening Laboratory; and outdoor area - the OpenEAR. Indoor listening spaces encompass over 230 m² of configurable laboratory space. Directly adjacent to the indoor facility is the OpenEAR—an outdoor instrumented research space covering more than 4400 m² of natural grassy terrain.

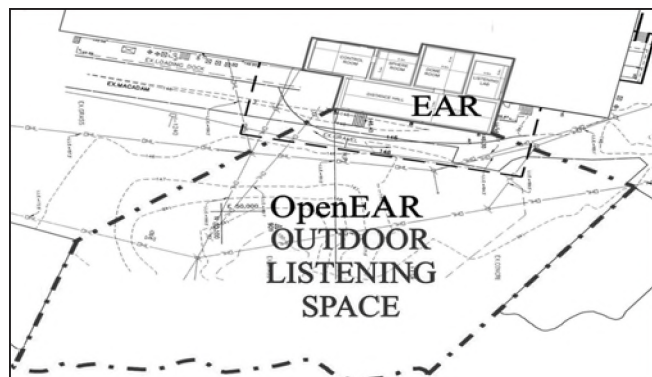


Fig 1. Configuration of the Environment for Auditory Research

2. FACILITY DESCRIPTION

The EAR is an auditory perception and communication research center permitting state-of-the-art spatial perception and communication research in various indoor and outdoor acoustic environments. The EAR, shown schematically in Figure 1, has been designed to address all the needs of auditory spatial research and includes spaces that encompass geometries of most common indoor environments. The four indoor listening spaces (Figure 2) can be used individually or, in some cases, can be combined together to simulate more complex architectural structures. The predominantly anechoic environment of the EAR can be modified, if needed, to represent more realistic environments. The facility is located in the ARL complex at Aberdeen Proving Ground (MD, USA).

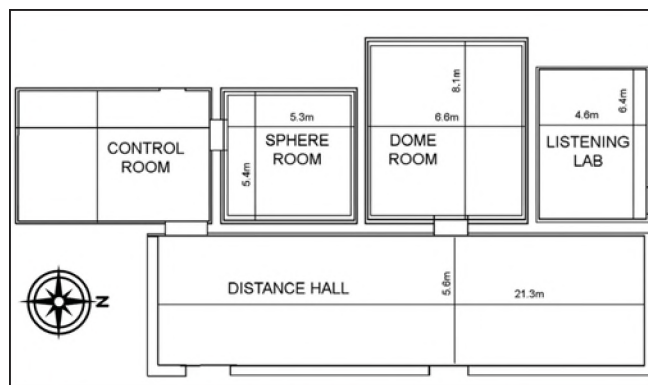


Fig. 2. Schematic configuration of interior spaces.

All indoor listening spaces of the EAR comply with the NC-15 noise criteria resulting in background noise levels close to the threshold of hearing, semi-anechoic listening conditions reducing early acoustic reflections to negligible levels, extensive and flexible means for sound production by 600+ sound sources, and acoustic and electroacoustic means for changing the spatial properties of sound. All listening spaces also have widely adjustable lighting and temperature conditions.

2.1 Control Room

The Control Room (54 m² of floor area) is an integrated control center permitting complete control of instrumentation and research activities in all four indoor spaces and an outdoor listening space. It contains the front-end of all instrumentation and stimuli generation systems. The audio system of the EAR is powered by 4 computers and includes extensive and automatic switching capability. The system is capable of generating up to eight (8) independent audio signals and transmitting them to any or all (approximately 600) loudspeaker and earphone locations throughout the facility.

Functionality of the Control Room enables control and monitoring of as many as four simultaneous experiments conducted in various spaces of the facility from a single location. The networking capabilities of the EAR allow the control functions of the Control Room to be accessed from each of the test spaces allowing a researcher to set up an experiment from within a target space. In addition, audio and video capabilities of the Control Room can be used to provide audio-video demonstrations and instructions for new users, experiment participants, and visitors.



Fig 3. The EAR control center

2.2 Sphere Room

The Sphere Room is a 140 m³ (5.3m × 5.4m × 4.9m) auditory virtual reality space designed to investigate integrity of auditory virtual spaces, realism of complex auditory simulations, effects of Head-Related Transfer Function on auditory perception, and the effect of helmets and other headgear on spatial orientation in a three-dimensional dynamically changing environment (Figure 4 left). The sound reproduction system of the room consists of 57 loudspeakers distributed on a sphere and radially separated by about 25°.

2.3 Dome Room

The Dome Room is a 220 m³ (6.6m × 8.1m × 4.1m) space designed to study the human's ability to localize real or virtual, single or multiple, and stationary or moving sources in a horizontal plane or along two vertical arcs extending from -20° to +40° regarding listener's head position (Figure 4 right). The sound system capabilities support 2° horizontal and 10° vertical spatial resolution.



Fig 4. Sphere Room (left), Dome Room (right).

2.4 Distance Hall

The Distance Hall is a 440 m³ (21.3m × 5.6m × 3.7m) acoustically treated space designed to study auditory distance estimation and the effects of sound source movement toward and away from the listener on sound source detection and identification (Figure 5 left). Acoustic configuration and audio capabilities of the Distance Hall permit extensive investigation of localization and tracking of sound sources moving in a predetermined manner toward and away from the listener, auditory distance and depth

estimation, tracking of sound sources moving above the listener, or detection and recognition of sound sources appearing far away from the listener.

2.5 Listening Laboratory

The Listening Laboratory is a unique multipurpose 140 m³ (4.6m × 6.4m × 3.5m) room for studying the effects of space acoustics (removable acoustic wall treatment) and sound sources configurations on sound perception (Figure 5 right).

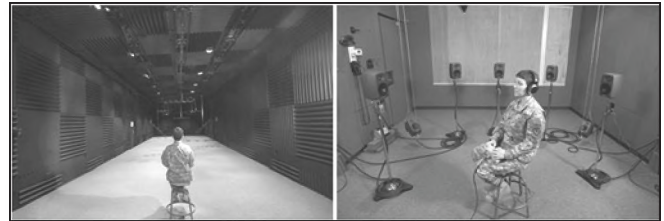


Fig. 5. Distance Hall (left), Listening Laboratory (right)

2.6 OpenEAR

OpenEAR is a 4,459 m² outdoor extension of the EAR complex designed to replicate studies conducted in the laboratory environment in a natural field environment with the same listeners at almost the same time to reduce data uncertainty resulting from laboratory and field studies which are conducted at different times and with different listeners.

3. CONCLUSION

The ARL Environment for Auditory Research is a unique and powerful research tool with indoor and outdoor capabilities that are unmatched at any current military, academic, or industrial facility world-wide. The facility is used by ARL researchers to increase our understanding of Soldier auditory capabilities and challenges on the modern battlefield. However, the EAR is also open to external researchers who are interested in studying spatial orientation, distance and depth estimation, virtual displays design, signature detection and identification, icons and warning signals design, perception of moving sound sources, or similar topics.

REFERENCES

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