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Research Paper

Field Report: Echolocation and Universal Design

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ABSTRACT:- In Taiwan inclusive accessibility designs and equipment for the visually exceptional (impaired) include both Braille and guidance systems. Guidance systems refer to tactile or broadcast means of affording users' accessibility. Currently though, existing equipment are only able to provide the visually exceptional (impaired) with limited environmental information. Previously, a visually exceptional (impaired) person advised me: "while walking, using echolocation to determine my location has proven to be a useful method for me". We believe it essential that all environmental designers must continue to implement new inclusive and accessible universal design strategies which fundamentally incorporate all manner of design elements.

KEYWORDS:- Echolocation, Universal Design,Visually impaired people, Campus, Way finding,

I. INTRODUCTION

In Taiwan inclusive accessibility designs and equipment for the visually exceptional (impaired) include both Braille and guidance systems. Guidance systems refer to tactile or broadcast means of affording users' accessibility. Currently though, existing equipment are only able to provide the visually exceptional (impaired) with limited environmental information. Previously, a visually exceptional (impaired) person advised me: "while walking, using echolocation to determine my location has proven to be a useful method for me". We believe it essential that all environmental designers must continue to implement new inclusive and accessible universal design strategies which fundamentally incorporate all manner of design elements.

As Bledsoe (1980) argued, “echolocation” technologies are one of the means for implementing inclusive independent mobility for the visually exceptional (impaired)(Bledsoe, 1980). In the past, while I had knowledge of the fact that the visually exceptional (impaired) could make effective use of echolocation while walking through spaces, I remained unaware of exactly how they made use of echolocation to determine and distinguish environmental information. Thus, I conducted an extensive literature review on echolocation, and discovered that the methods of using echolocation to visualize the environment included:

(1) The visually exceptional (impaired) rely on “echolocation” to determine their own location, and help them with parallel movement in relation to wall surfaces(Brabyn & Strelow, 1977; E. Strelow & Brabyn, 1981; E. R. Strelow & Brabyn, 1982), as well as to detect any potential obstacles in their path and estimate their arrival to the end of their path, come to an intersection or corner or open a door.

(2) The visually exceptional (impaired) are able to use “echolocation” to walk parallel to the surface of a wall, because the sound which strikes the wall will create an echo to the side on which they are walking resulting in a sound-wall (Ashmead & Wall, 1999).

(3) They can also use echolocation in regard to items in their environment to determine size, distance, location, shape or other physical characteristics (Au & Martin, 1989; Hausfield, Power, Gorta, & Harris, 1982; Kellog, 1962; Rice, 1967).

(4) In the environment, objects may block transmission of sounds at the source of their interface, through reflection and absorption of the acoustic signal, which results in audible or sound shadows (Gordon & Rosenblum, 2004). When the sound waves of a vehicle are passing by, for example: electric poles, telephone booths and bus stations, signals bounce or are absorbed, and often create a sound shadow (Wiener & Lawson, 1997). These “sound shadows” will cause passersby to pay attention to the unique environmental characteristics the sound shadows create (Gardiner & Perkins, 2005).

In accordance with the aforementioned literature review results, the researcher formulated a visually

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exceptional (impaired) persons interview and field visit observational plan. I plan to make observations of study participants while walking, providing objects which will create echoes, and interviewing them about environmental design elements (such as materials, height and width). For environmental designers, paying heed to visually exceptional (impaired) persons' enhanced competencies in the use of natural sounds to detect obstacles in their paths and maintain their direction represents a new and important concept. This design principle can be used anytime and has many uses in a variety of environmental design plans. The study author hopes that the observations and field research will help inform a robust and inclusive universal design strategy for total accessibility, thus affording visually exceptional (impaired) persons with more efficacious environmental information.

1. Habits in discriminating the environment through echolocation

Initially, the study author compared the echolocation habits of the two study participants in discriminating their environments. Since Worchel, Mauney, & Andrew (1950) noted that the visually exceptional (impaired) use of "echolocation" varies(Worchel, Mauney, & Andrew, 1950). The study author guided the participants in front of a building, and then asked them: "Can you describe your sensation of the echolocation while standing in the front of this building?"

Andy: "As I stand at this location (about 250cm), I can sense that the wall's surface is different from other walls". "Since the echo from the wall is clearly very different". "Usually the echo from the wall can guide me in the right direction when walking". "At the shrubbery or streetlights in front of the wall, I can also hear echoes, though they are faint".

Jack:"I have to stand at this location (about 70cm) before I can sense the wall is a lattice design (because the echo gives me the sense that the wall is penetrated by the sound". "If I stand a little further (about 250cm), I will feel the entire building, but cannot discern that the wall has a lattice structure".

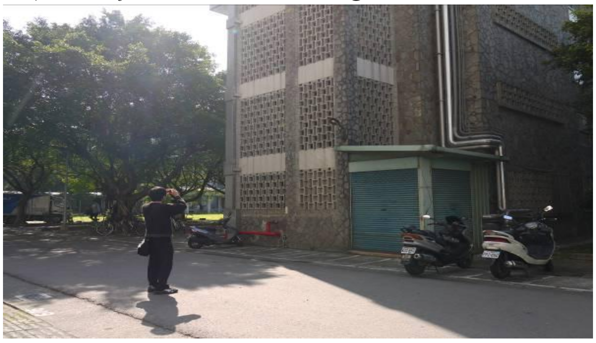


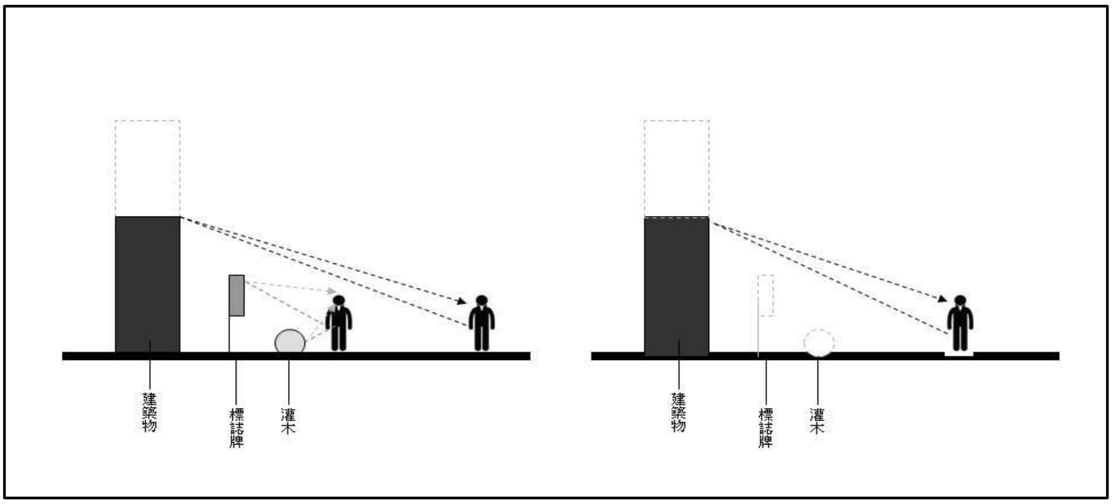
Fig. 1 Andy standing at 250cm can hear the echo of the lattice windows

Fig. 2 Jack standing at 70cm can hear the echo of the lattice windows

According to the descriptions given by Andy and Jack, when Andy stood at a distance of 250cm, he could sense the difference in the echo of the empty and filled space, and discriminate that the combination of empty and filled space indicated the wall was penetrated (Fig 1.). Jack, however, had to stand at 70cm before he could sense the penetration of the wall (Fig. 2). This indicates that when Andy and Jack were using echolocation to determine the physical objects empty and filled spaces, there were differences in the environmental information they perceived (Fig. 3).

When Andy (at left) and Jack (at right) stood at 250cm from the wall, Andy could discriminate the empty and filled spaces, obtaining more detailed spatial information. Jack could sense the entire wall as a physical object, thus perceiving somatosensory information.

Fig. 3 Simulation of Andy and Jack discriminating the building



Left image: When Andy stands at a relative distance he can use echolocation to discriminate the building. When Andy stands closer he can use echolocation to discriminate the existence of signage and shrubbery. Right image: When Andy is walking he mostly pays attention to the echo from the building itself.

Fig. 4 Simulation of Andy using echolocation of the distance of the building, shrubbery and signage

Andy is accustomed to using a long cane to strike the ground and generate sound for use in environmental echolocation; Jack is used to snapping his fingers, using the tip of his tongue or long cane to strike the ground and create sound for use in environmental echolocation. Andy and Jack rely on the reflected sound and its relative weakness to determine the height of a building. According to Andy's narrative, as for plantings or signage in the environment, as long as one is close enough, their faint echo can be perceived, and thus they are often disregarded (Fig. 4). Jack, on the other hand, can only sense the echo of the overall building, and cannot distinguish and discriminate those smaller elements of the environment which are narrow, short or small.

II. ECHOLOCATION OF OBJECTS AND ENVIRONMENTAL DESIGN STRATEGIES

Through the initial interviews with Andy and Jack, the study author realized that Andy liked to use his digital camera for photography (he relied on sounds from others or objects or echoes to determine the direction of the lens), so I invited Andy to use his camera to record the items from which they received echoes.The path of the field research visit began at Andy and Jack's major department buildings and traversed to their dormitories. The path had a road width of 480cm and a length of 11,100cm. The surface medium was asphalt concrete, with the entire road free of any pedestrian walkway, and there were no separate lanes for pedestrians and vehicular traffic.

Andy used his camera to record 15 items which provided echoes. These 15 items included 11 which relayed details about the buildings, another 2 items were shrubbery, and 2 other were signs (see Table 1, A1-A15). Through field observations I discovered that Andy and Jack could perceive items at a distance greater than they could touch with their White Cane. Their echo-based information enjoyed the advantage of providing both greater environmental information about distance and immediacy then did tactile information (such as: the medium of the ground's surface). So I began to enquire of Andy and Jack about each of the 15 items as to any particular characteristics they could discriminate through echo-engagement. These characteristics all represent part of the design elements, such as: medium, height, width, spatial shapes and measurements or object shape, which are developed into the Universal Design strategy (see Table 4-1 "yellow column").

III. CONCLUDING REMARKS

In the natural environment, echoes provide a robust and nuanced multi-dimensional source of environmental information for the visually exceptional (impaired). In the future, environmental designers can advance their analysis and strengthen the use of empowering design elements emphasizing diverse physical echo-producing characteristics, and strategically locating such elements throughout the pathways of a campus. This will help visually exceptional (impaired) persons such as Andy and Jack enjoy an inclusive and accessible learning community in which to apply their heightened skills for echolocation, and to optimize the cognitive spatio-mental model of their environment.

Table 1 Echo located objects and Universal Design strategy

	Object providing echoes	Design element characteristics							Universal Design strategy
		Surface media	Height	Width	Vertical media	Spatial shape	Spatial dimensions	Object shape	
Building Entry, Exit and doors	 A3  A2  A7  A10	✓	✓	✓	✓	✓	✓		Andy and Jack identified four readily identifiable entrances/exits, and could determine the spatial measurements and spatial shapes of the entrances using echolocation skills. Among the design elements which aided their echolocation performance were the surface medium, height and width. In future entrances, application of Universal Design strategy should mean emphasizing distinguishing these three design elements for maximum variety.
Building outer walls	 A15  A9  A1		✓	✓	✓			✓	Andy and Jack identified two readily identifiable outer walls of buildings. They could use echolocation to determine the overall size and wall media of these buildings. Among the design elements which can aid their echolocation performance are the medium of the outer wall, height and width. In future entrances, application of Universal Design strategy should mean emphasizing distinguishing these three design elements for maximum variety.
Columns and rain shelter walkways	 A14  A13		✓	✓	✓	✓	✓		Andy and Jack used echolocation to identify the distance between building columns. They could also use echolocation to distinguish the rain shelter walkways, medium, spatial shapes and spatial dimensions. Among the design elements which can aid their echolocation performance are the height of the rain shelter walkway, the width of the building columns, medium and distances between the columns. In future design of rain shelter walkways, application of Universal Design strategy should mean emphasizing distinguishing these four design elements for maximum variety.
Landscape design (plantings and trees)	 A4  A5		✓	✓	✓			✓	Andy could use echolocation to identify the distance between plants and their overall size. Among the design elements which can aid their echolocation performance are the fragrance of the plants, as well as height, width and distance between plantings. In future landscape design, application of Universal Design strategy should mean emphasizing distinguishing these four design elements for maximum variety.
Signage	 A6  A11			✓	✓			✓	Andy could use echolocation to identify the overall size of signage. Among the design elements which can aid their echolocation performance are vertical medium and width. In future signage, application of Universal Design strategy should mean emphasizing distinguishing these two design elements for maximum variety.
Building's partially covered outdoor walkway	 A8		✓	✓	✓	✓	✓		Andy could use echolocation to identify two readily identifiable a building's partially covered outdoor walkway. Among the design elements which can aid their echolocation performance were the wall medium of the outdoor partially exposed walkway, height and width. In future outdoor partially exposed walkways, application of Universal Design strategy should mean emphasizing distinguishing these three design elements for maximum variety.
	Object providing echoes	Design element characteristics							Universal Design strategy
		Surface media	Height	Width	Vertical media	Spatial shape	Spatial dimensions	Object shape	
Building eaves	 A12		✓	✓				✓	Andy identified one readily identifiable building eaves. He used echolocation to determine the overall size of the eaves, and height of the building. Among the design elements which can aid his echolocation performance are the building eaves' height and width. In future building eaves, application of Universal Design strategy should mean emphasizing distinguishing among different floors' design elements for maximum variety.

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Biographical Note

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