Elevator Design Conforming to UNIVERSAL DESIGN

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ABSTRACT

We have been developing elevator designs from this standpoint: "UNIVERSAL DESIGN of elevator products is a design that can be used by as many people as possible regardless of their abilities." In a joint study with a research institute, we conducted a questionnaire survey and a video tape analysis to find out how elevators are actually used by wheelchair users and the visually impaired. Also, we reviewed associated global regional codes, including ADAAG of the USA and EN-81 of Europe. From these studies we propose what the best UNIVERSAL DESIGN for elevator users should be like.

1. INTRODUCTION

The concept of 'universal design' defined by The Center for Universal Design of North Carolina State University is : "The design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design." Following the ongoing active movement of legislation and standardization of ADAAG, EN-81 etc, in the future, more and more elevators will be required to adopt this 'universal design'. This research proposes elevators designs which conform to the UNIVERSAL DESIGN, and are safe, user-friendly and comfortable design for a wide variety of users including the disabled, senior citizens, as well as the physically sound.

2. PROCESS OF DESIGN DEVELOPMENT

This development was made in the following processes :

Step 1 : Review of regional codes with a view to global application of the design.

Step 2 : Field study and interviews to find problems in operation and optimum elevator conditions for users.

Step 3 : Analysis of problems obtained from the study; then, setting concepts for resolving them.

Step 4 : Development of products by creating specific ideas for problem solving.

3. STUDY OF CODE IN GLOBAL REGIONS

The main contents of our study are as follows. (Refer to Table 1.)

(1) Button and Tactile Marking

The Japan Elevator Association Standard (JEAS) for visually impaired requires Braille plates to be placed next to each button. Design Manual Barrier Free Access 1997 enacted by the Hong Kong Government and The Building Regulation 1991 M2 (1999 Edition) enacted by the United Kingdom Government, requires suitable tactile indication to be placed on or next to the buttons. It was concluded that requirements for the visually impaired are Braille and tactile markings. Moreover, the Americans with Disabilities Act Accessibility (ADAAG) requires that all control buttons protrude or be level with the faceplate surface. This allows the disabled to use a joint or any body part other than the finger tips.

(2) Position of buttons

The JEAS for wheelchair users requires the height of button to be about 1000 mm above floor level. This ensures easy access by wheelchair users. European Standard EN-81-70 (draft), the Barrier Free Access 1997 and the Building Regulation 1991 M2 requires button height to be higher than 900 mm and lower than 1200 mm above the floor.

(3) In-car car position indicator

The JEAS for wheelchair users requires an additional car position indicator to be furnished either on the back wall or in the main exclusive car operating board for wheelchair users. It may guard against the wheelchair unable to make a U-turn in the car. Moreover, the Barrier Free Access 1997 requires characters on the indicator to have a minimum height of 50 mm.

(4) Opening width of entrance

The JEAS for wheelchair users and the Building Regulation 1991 M2 requires the minimum opening width to be 800 mm. The ADAAG, however, requires the minimum width to be 915 mm. The ADAAG gives more consideration to the comfort of wheelchair users.

(5) Mirror

The JEAS for wheelchair users requires a mirror to be furnished on the back wall. The mirror is intended for wheelchair users to confirm whether the door is open or not, and other passengers behind their back. The present study indicated that mirrors are not required by codes other than JEAS.

(6) Handrail

The JEAS stipulates the requirement of a handrail at a height of about 800 mm above the floor level to assist the physically disabled which do not use wheelchairs.

(7) Announcement by sound

The JEAS for the visually impaired requires traveling direction to be announced by an audible signal etc, when elevator arrives at the landing. These announcements help the visually impaired confirm the traveling direction. The ADAAG requires that an audible signal sound once for the up direction and twice for the down direction, or verbal annunciators that pronounce "up" or "down" to be provided.

Table 1: Codes in global regions

bold character: unit (mm) , (*): recommended specification

			Japan Elevator Association Standard (JEAS)		Americans with Disabilities Act Accessibility Guidelines (ADAAG)	European Standard EN-81-70 (draft)	Design Manual Barrier Free Access 1997
			for Wheel Chair User (JEAS-B506)	For the Visually Impaired (JEAS-515B)			
Region			Japan		USA	Europe	Hong Kong
Latest edition (First edition)			1996 (1976)	1988	1991	1999	1997 (1984)
Application			Wheelchair User	the Visually Impaired	All people		the Disabled
Car and Hall	Button				Size: min.**19** Buttons shall be raised or flush to the faceplate.	Size: min.**20** Symbols: min.**15** max.**40** (Note.e)	(*) Size: min.**20** Braille and tactile markings (Note.h)
Car	Minimum width of entrance		**800**		**915**		**750** (*) **850**
	Mirror		On the back wall				
	Handrail height above the floor level		**800** (Note.a)				(Note.i)
	Car operating board	Braille and tactile markings		Braille indication plates of each mark adjacent to each button	(Note.c)		
		Button height above the floor level	About **1000**		No higher than **1370** for side approach and **1220** for front approach, no less than **890**	Not less than **900** and not more than **1200**	
		Location	Car operating board on both side panel (Note.b)		Front wall or side wall (Note.d)	The right hand side or the closing side (Note.f)	
	In-car indicator	Location	On back wall or in the main exclusive use car operating board		Above the car operating board or over the door	(Note.g)	
		Height of character			Min. **13**	Between **30** and **60**	Min. **50**
Hall	Hall button height above the floor level		About **1000**		**1065**	not less than **900** and not more than **1100**	

< Notes >

a) To assist the physically disabled other than the wheelchair user.

b) Main car operating board on the right side wall. Sub car operating board on the left side wall.

c) "All control buttons shall be designated by Braille and by raised standard alphabet

characters."

d) "Controls (car operating board) shall be located on a front wall if cars have center opening doors, and at the side wall or at the front wall next to the door if cars have side opening doors."

e) Any symbols for the buttons shall be raised 1 mm.

f) With center opening doors, car operating board shall be on the right hand side when entering the car, and with side opening doors, it shall be on the closing side.

g) "Shall be located with or above the car operating panel. The center line of the indicator be positioned between 1600 mm and 1800 mm from the car floor."

h) Braille and tactile marking shall be placed either on or to the left of the control buttons. Tactile markings shall have a minimum dimension of 15 mm high and be raised 1 mm minimum.

i) "A lift shall have handrails extending to within 150 mm of the corners at the rear and sides of the car, which are suitable for use by persons with a disability."

j) In addition to the codes in Table 1, the Building Regulation 1991 M2 was reviewed but omitted.

4. FIELD STUDY

In order to obtain the design policy for UNIVERSAL DESIGN, the following investigations were made :

4.1 Study of the actual conditions of elevator use by the visually impaired

We conducted a survey on 11 visually impaired persons, for a total of 4 days in December, 1999. We analyzed the actual steps for elevator use and interviewed the 11 subjects regarding the difficulties that the visually impaired may face when using an elevator. The main requests obtained through this survey are shown below .

(1) The hall

- When there is no one else in the hall to provide assistance they worry about whether they can properly operate by themselves after getting on.
- The visually impaired recognize the arrival of an elevator by the sound of door opening. Moreover, they can ask the traveling direction of the arriving elevator only when there is someone nearby. However, it is difficult if they are alone.
- Announcement of the elevator arrival and the traveling direction by sound or voice are desirable. Also, sound-emitting buttons are desirable.
- Most of them commented that they mind the duration in which the door is kept open whenever they get on elevator. Several of them were concerned about level difference between of the hall and car.

(2) In the car

- It is their common procedure to search the right and left side of the door for the car operating board as soon as they enter the car. Therefore, it was understood that the car operating board should be located on the return panel.
- Basically the visually impaired read Braille for the selecting of a destination. When there is no Braille plate or if they cannot read Braille they look for the right button by counting from the end, following to the arrangement of the buttons.

- Since they cannot confirm the registration of a destination floor, most of them requested some kind of feed back by sound, voice, or sense of touch upon registration of the destination floor.
- Announcement by voice are most desirable for recognition of the destination floor. They ask a fellow passenger about the floor level when there no voice guide. When there is no fellow passenger they get off the car and confirm the floor level every time the car stops .

The above results indicated that the points for consideration for the visually impaired are voice, sound, and sense of touch.

4.2 Study on the actual elevator use by the physically disabled

We investigated 30 physically disabled people over a total of nine days in February, March, and December, 2000. Of the 30 people investigated, 29 were wheelchair users.

4.2.1 Study method

(1) Interview Survey (Only in February and March)
60 minutes interviews were conducted on each subject regarding procedures for operating elevator.
(2) Simulation using a mock-up car operating board (Refer to Figure 1.)
We experimented user-friendliness of the switches on the operation panel in the car and at the landing using different shapes, positions, and installation heights of the switches. Furthermore, we verified the best size and position of the display character of the indicator. Also, we conducted a video tape analysis to find out how elevators are actually operated by the physically disabled.

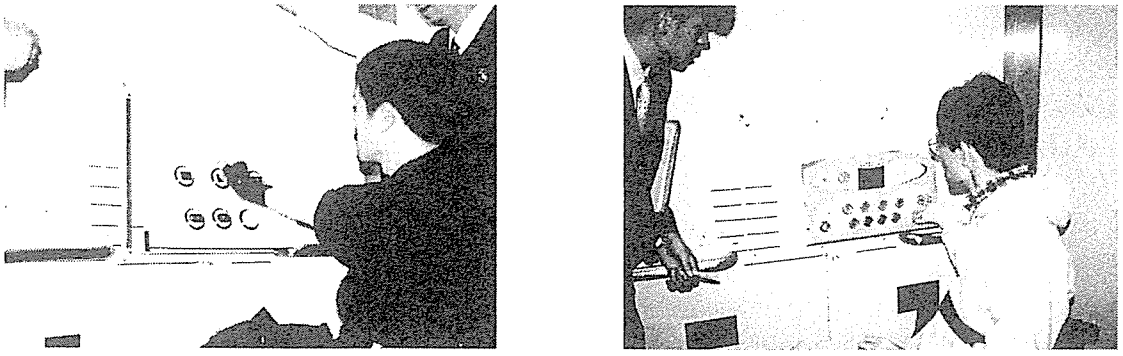


Figure 1: Simulation Experiment using mock-up car operating board

4.2.2 Study results

(1) The main requests obtained through the interview survey are shown below.

- The height of the operating board should be lowered for easy operation.
- The button should protrude from the faceplate of the operating board.
- The mirror which allows the wheelchair user to confirm safety just behind the rear wheels should be extended down to the floor level.
- The door opening time should be lengthened, to allow wheelchair users to safely board and exit the elevator.
- The door should be more slowly closed.
- The opening width of entrance should be extended for easy access.
- The inner car area should be large enough for the wheelchair user to rotate easily.
- The running clearance between the car sill and the landing sill should be minimized to

prevent the wheel from falling in between.

- Elevators which can be operated by speech recognition.

The points for considerations in design were found to be the installation height and shape of buttons, the opening width of entrance and the inner car area.

(2) The results of the simulation experiment using a mock-up car operating board are summarized as follows :

- The horizontal arrangement of buttons on the car operating board is easy to operate because less vertical movement of the arm is required.
- We reconfirmed that the buttons need to protrude from the faceplate of the operating board for those who operate using the joints of the elbow or the hand.
- More than half of the subjects are able to operate the buttons without trouble if they are located 400 mm from the corner of the car.
- For wheelchair users, the maximum height of the button that can be operated is up to about 1250 mm.
- More than half of the wheelchair users commented that the appropriate position of car position indicator is in the transom (upper part of the door), because upon pressing a button they need to make a U-turn to face the door to find the timing to exit.
- Several subjects commented that the car position indicator with the 19 segment display method (now under development) is easier to see than the conventional 5×7 dot display indicator of our company.

4.3 Study in Fujitec Japan headquarters elevators

On March, 2000 we investigated 24 physically sound Fujitec employees in elevators at the headquarters building. The study results are as follows.

(1) When the car is relatively less crowded 18 (75%) out of 24 found it easier to use the operating board on the side wall.

(2) When the car is crowded, most of the people found it easier to use the operating board on the return panel.

(3) Regarding the position of the car operating board suitable for the Universal Design, 16 (67%) out of 24 are said that the board should be located on the side wall and return panel. Eight (33%) out of 24 comment that one side wall is sufficient.

5. Search for references and information

According to a 1996 survey by the Japanese Ministry of Health and Welfare, the Braille literacy of the visually impaired, that is, the percentage of the visually impaired who can read Braille is 9.2 percent. Therefore, incorporating Braille plates in the elevator design is not always sufficient for assisting the visually impaired.

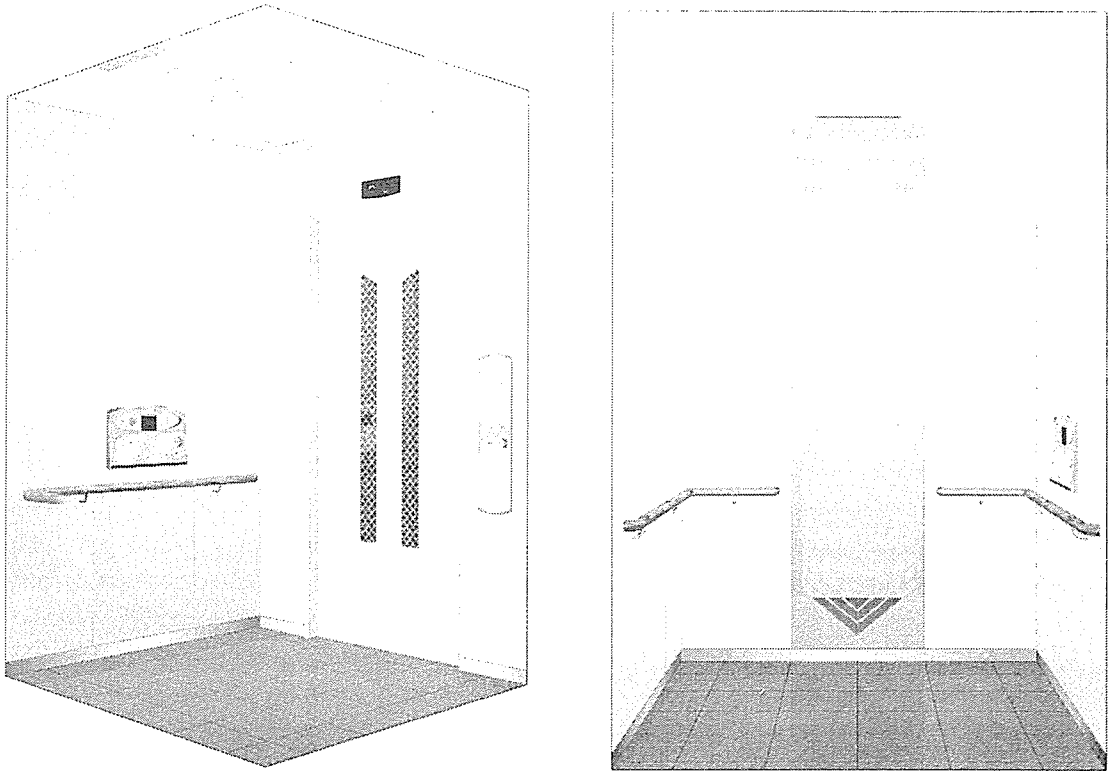
6. Concept

We have been developing elevator designs from the standpoint that "UNIVERSAL DESIGN of elevator products is such a design that can be used by as many people as possible regardless of their abilities." We consider 'universal design' of elevators should aim at being user-friendly and can be shared by the physically sound and the disabled, not limited to the disabled and senior citizens. Moreover, we consider it necessary to prepare two or more design options that can be selected by the users.

7. Commercialization

7.1 Car interior

Figure 2 shows the car interior.



(a) Diagonal View to the entrance *(b) View from the entrance*

Figure 2: Car interior

7.1.1 Mirror (for wheelchair users)

The large-size mirror, which enables the wheelchair users to check for safety when going out is placed on the center of the back wall. The mirror extends close to the floor level to allow wheelchair users to confirm safety just behind the rear wheels and clearance between the car sill and the landing sill.

7.1.2 Handrail

Consideration has been given for senior citizens, and the handrail is extended from the side wall to the back wall, including the corners.

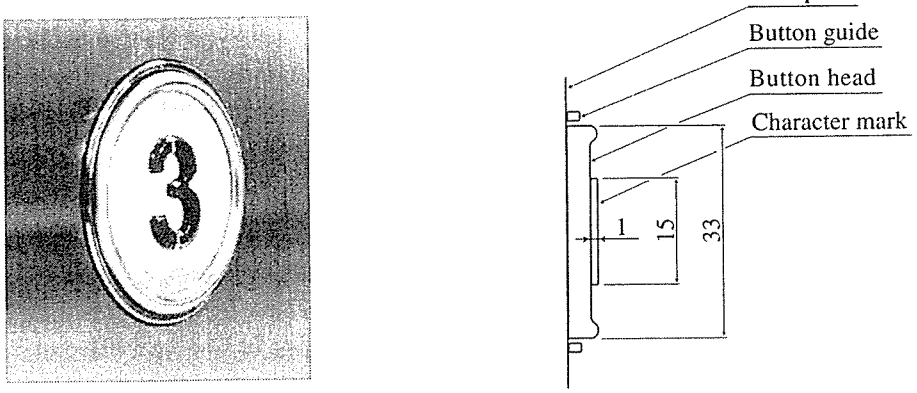
7.1.3 Door

Wide entrance (opening width: 900 mm) and large windows on the door have been adopted for easy access by everyone including wheelchair users. Through the large windows, users can easily confirm the car interior and the hall before safely going in and out the car.

7.2 Operating fixtures

7.2.1 Tactile buttons

Based on the study results, we developed tactile buttons with the following features that are user-friendly and accessible by everyone. (Refer to Figure 3.)



(a) Front View *(b) Side View*

Figure 3: Tactile button

(1) 33 mm in diameter, and a character or mark that is raised 1 mm above the surrounding button surface. The height of such characters or marks is 15 mm which conforms with the guidelines of the codes we investigated in Japan, USA, Europe and Hong Kong. The raised character or mark allows Braille-illiterate people to recognize the mark or character.
(2) To help the visually impaired to easily identify the position of the button, the button rim is raised.
(3) Longer button stroke of 1.5 mm with an operation feel.
(4) The visibility of a telltale lamp has been improved to clarify the response by the use of different colors. When the lamp is ON (LED: orange color) and OFF (resin color : blue).
(5) High intensity LED lamp that easily identifies the response of the telltale even outdoors.

7.2.2 Hall button

We developed tactile hall buttons. Positioning of hall buttons at a height of 1000 mm may be relatively high for the wheelchair users. However, we set this height considering the maximum height which the physically disabled can operate as well as the physically sound. Moreover, the operating button is provided with a sound-emitting function to help the visually impaired to confirm that registration is complete.

7.2.3 Car operating board

According to the study results, we decided to provide car operating boards in two places : the side panel and the return panel.

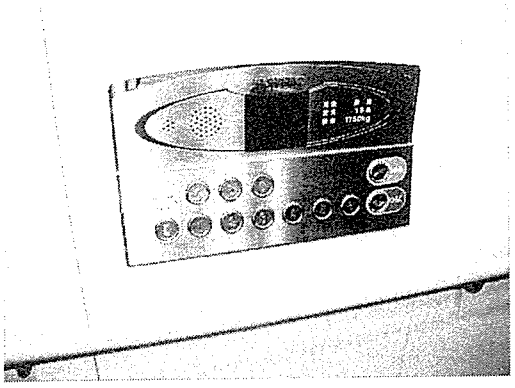


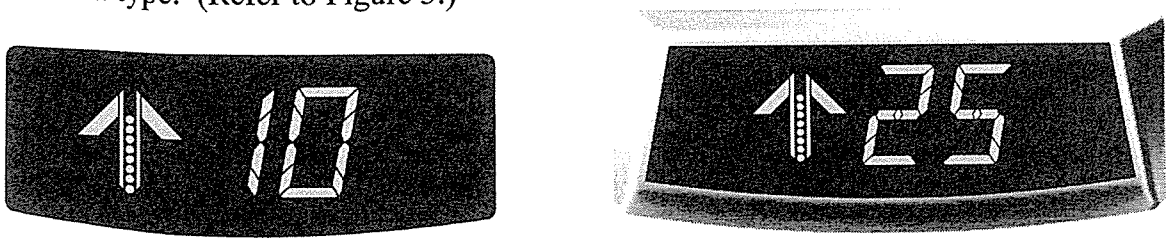
Figure 4: Main Car Operating Board at the side panel

The door opening and closing buttons and the intercom button were made easier to distinguish by color coding, to prevent pressing a wrong button. The operating button is provided with a sound-emitting function in the same way as the hall button. The main car operating board to be shared by physically sound and disabled is located at the center of the side wall as the most easily operated position. Buttons are designed in horizontal arrangement for easy use by the wheelchair user. (Refer to Figure 4.)
Moreover, consideration has been given to place the door open button and the intercom button, in a position lower than the hall buttons (950 mm above the floor level), so as to avoid entrapment even when a small child presses the hall button and gets in the car by mistake. Also, a slight tilt is applied to the board so that the physically sound may operate easily. The auxiliary car operating board is installed on the return panel considering the operation by the visually impaired and when the car is crowded. (Refer to Figure 2.)

7.3 Indication Fixtures

7.3.1 (In-car or hall) Car position indicators

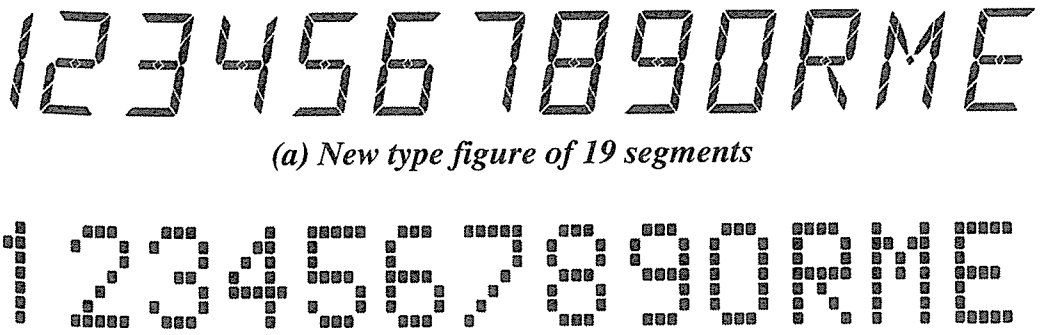
We have developed two types of indicator for landing and car. One is flush type and the other is wall-mount type. (Refer to Figure 5.)



(a) Flush type *(b) Wall-mount type*

Figure 5: Indicator adopting 19 segments-character

Conventional display of 5×7 dots characters tended to be hard to recognize when enlarged. Thus, we adopted 19 segment-character display, which ensure d good visibility in the field study, and adopted it in our standard indicator. (Refer to Figure 6.)



(a) New type figure of 19 segments

(b) Conventional figure of 5×7 dots

Figure 6: Comparison with display character of Fujitec's original 19 segment and Conventional 5×7 dots

We emphasized the visibility of the frequently-used numerical characters ("0", "1" to "9"), examined the segment shape, and developed large-sized characters (Height : 51 mm) which conforms with the guidelines of the codes we investigated.

8. CONCLUSIONS

The goal of applying universal design to elevators is to adopt equipment requested by the users as the manufacturer's standard specification. To do so, it is necessary to promote the cost reduction. Moreover, we learned that packaging of the visual display and the voice guide is especially important for everyone including the visually and hearing-impaired, and senior citizens. It is necessary to offer specialized products designed to assist the needs of severally disabled users.

Through product development, we felt the strong need to study what the users are dissatisfied or troubled with. In addition, we should study 'universal design' for ourselves since every one of us will go through the aging process. And soon or later we ourselves will be able to get benefit through the development of universal design products. It is our mission to develop elevators that are user-friendly and comfortable for everyone.

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BIOGRAPHICAL DETAILS

Masakazu Kawahira, graduated from Kyusyu Institute of Design in 1982 and joined Fujitec Co., Ltd. in the same year, currently belongs to Engineering Headquarters.