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WAYFINDING IN AN EDUCATIONAL FACILITY COMPARING HANDICAPPER AND NON-HANDICAPPER PERCEPTION AND BEHAVIOR: PART II

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ABSTRACT

This report addresses use and meaning in relation to wayfinding in the Chatterjee Communication Arts and Sciences (CAS) building at Michigan State University. An approximately equal number of handicappers with mobility handicaps ($N = 16$) and non-handicappers ($N = 20$) volunteered to follow building scenarios prior to questionnaire completion. Additionally, sixty-one randomly chosen building users were interviewed in a shorter version of the questionnaire to reflect everyday facility usage. The multimethod technique described includes code checklist, scenario instructions and interview questions. No significant differences in wayfinding or building performance based on opinions and behavior of handicappers and non-handicappers were found. Building familiarity was not a critical factor. Using backtrack frequency as the indicator of lostness, 97 percent of all scenario participants became lost at least once. Difficulties in finding specific destinations centered around the adequacy of information provided by building form, directories, signage, and receptionist(s).

INTRODUCTION AND LITERATURE REVIEW

This article is the second report on a research project in post-occupancy evaluation (POE) of Michigan State University's Chatterjee Communication Arts and Sciences (CAS) building. Part I reported on handicapper and non-handicapper preference and meaning associated with building entries, restroom stalls, and drinking fountains with the underlying assumption that concepts of user preference and human dignity are important [1]. Results supported the connotation of stigma associated with the handicapper entryway. Stigma was

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not associated with restroom stalls and drinking fountains. There were no significant differences in preference for restroom stalls. Either there was no preference or people of both groups favored the barrier free drinking fountain.

The focus of Part II is wayfinding within the public areas of this occupied educational facility. Together with Part I, a basic overview of facility performance is presented. The major research question challenged in both parts of the report is, "Does the building perform as and convey an environment more responsive to handicapper needs?"

Lynch defined illegible environments as settings where a coherent pattern of parts is not readily evident [2]. As Weisman discussed, illegible designed environments are familiar to everyone [3]. He found that wayfinding behavior is most strongly related to the "goodness of form" of building plan configurations. He identified five "good form" aspects, of which legibility and simplicity of building configuration play important roles. He believes that a person's adequate mental image of an environment requires both a representation of significant locations and an understanding of the spatial relationships between those places. Weisman, in a university building wayfinding study, tested small groups of four and twelve subjects in ten study settings, with a total of seventy-three participants where wayfinding behavior assessment was based upon self-report data [4]. He maintained that familiarity itself may not be sufficient to explain or resolve wayfinding difficulties, and other factors such as visual and spatial design features should be considered to alleviate disorientation. He found no significant relationships between building familiarity and wayfinding behavior, and views increased familiarity, in some environments, as a way to become lost more often. He defines legibility as "the extent to which it facilitates the process of wayfinding."

In an experimental study by Best which examined entry behavior patterns in a large public building, he defined lostness as "the deviation from the most direct route to that room (*destination*) from one of the main ten entrances" [5]. The main variable affecting lostness was the number of route choices. Over half the errors were attributed to other people being helpful.

Beaumont et al. conducted a focused government building evaluation in New Zealand in order to find major reasons for orientation and wayfinding problems [6]. Forty percent of the comments from eighty-six people concerned orientation and wayfinding. Ten percent of the sample was disabled. Using a multi-instrument approach, they did not find wayfinding to be a problem primarily for the first time user, but found wayfinding problems and orientation to be the same for all people, undiscriminated by age, gender, ethnicity, or disability.

Zimring and Templer conducted a two-part study in which twenty-four and sixteen sight-related handicappers respectively were tested to evaluate material texture in relationship to wayfinding [7]. In study 1, their purpose was to determine paving surface detectability for visually impaired long cane users. In study 2, they tested the cues (countermeasures) identified in study 1 on an outdoor test route. By dividing the sample into two groups who traversed the route with and without countermeasures, they found that familiarity alone did not account for improvement in route negotiation, but was affected by adequacy of environmental cues.

Appleyard considers first time users more dependent on the environment for gaining wayfinding knowledge and states, "It should be possible to adjust attributes of form and visibility to enable each building to achieve the desired level of recognition" [8]. In a study by Evans et al. [9], where the effect of building interior color changes on people's orientation behavior and building knowledge was examined, two groups of seven subjects equally unfamiliar with the university building were randomly selected and given a tour through the building with or without interior color changes, prior to testing. Significant results in wayfinding behavior between color coded and non-color coded groups were obtained, the color coded group making significantly fewer errors in wayfinding, in recognition and goal location, thus substantiating the positive influence of visual access, also tested by Gärling et al. [10]. The authors considered goal seeking errors to be any deviation from the shortest path at any given point. They did not think the findings generalizable to users more familiar with the building and considered the problem of interior building orientation most applicable to low frequency users.

To what degree familiarity facilitates orientation is discussed in Gärling, et al. [10]. Using four groups of six men and ten women each, two groups participated in building tour sessions with familiarity as the variable. Two remaining groups participated with their sight restricted by goggles, thus limiting visual access through windows, across hallways, and in front of them. Only one of the latter two groups was presented with a floor plan prior to building touring. It was found that familiarity facilitated orientation based on improved performance of subjects across building tours. Limited visual access was found to reduce the effects of familiarity on performance, but presentation of floor plan information counteracted negative effects of sight restriction.

Gärling and Lindberg believe that familiarity together with visual access and a floor plan will facilitate spatial orientation in a building [11]. They consider it essential to measure actual performance of users in the building being tested and to do so in actual settings among commonly occurring activities. Passini concurs that tasks should be representative of common wayfinding problems encountered in public spaces [12]. He considers: 1) spatial characteristics of a setting, and 2) wayfinding support systems such as signage and maps as environmental determinants of wayfinding problems. His data showed that all subjects referred to signs, even those who preferred to rely on the understanding of spatial settings for solving wayfinding problems.

Passini defined spatial orientation in two ways: 1) having to do with knowing where one is and having an adequate cognitive map, and 2) knowing what to do in order to go places, including information processing into a cognitive map [13]. Perceptual and cognitive processes, how a person relates to the spatial environment and to destinations, his memory, and learning are all involved in wayfinding.

Gärling, et al. present three factors affecting spatial orientation and wayfinding [14]. They are:

1. degree of differentiation of parts of the environment;
2. degree of visual access to destinations from different vantage points; and
3. complexity of spatial layout.

Context and Conceptual Background for this Evaluation

The general context was described in Part I and will not be repeated here. An expanded description of building configuration is included for clarification purposes.

The CAS basement houses Audiology and Speech Sciences for reasons of sound control. The two story main building block contains classrooms, offices, and radio/television studios. The perimeter of the first two floors and three "U" shaped office floors above wrap around the west, south, and east sides and act as a noise buffer for the radio/television studios, centralized for sound control. Although the facility houses instructional television, broadcast television, and other technologically related student/faculty programs, the focus of this study was on plan configuration of public areas as opposed to building or media technology. A campus map and CAS site plan are shown in Figure 1. Individual floor plans are shown in Figures 2 and 3.

The general belief that the CAS building is barrier free and thus responsive to handicapper needs is cited in Part I. The timing for evaluation was right because the building was relatively new, and the users had an adequate length of time to adapt to their new surroundings. Objectives of the study were:

1. to identify discrepancies and commonalities between the standards and the condition of the existing system; e.g., standards as set forth by ANSI A117.1-1980 [15], and the State of Michigan Barrier Free Design Requirements (MBFD) [16], November, 1979, and Michigan State University's Construction Standards (MSUC) [17], July, 1978; and
2. to evaluate an occupied interior designed environment in terms of human performance; to do so by focusing on wayfinding, plan configuration, and use of interior components.

METHOD AND APPROACH

As Zimring and Reizenstein recommend, quasi-experimental research design method and multi-method techniques were utilized to capture various aspects of the social-physical system [18]. It is intended that the results be applicable to

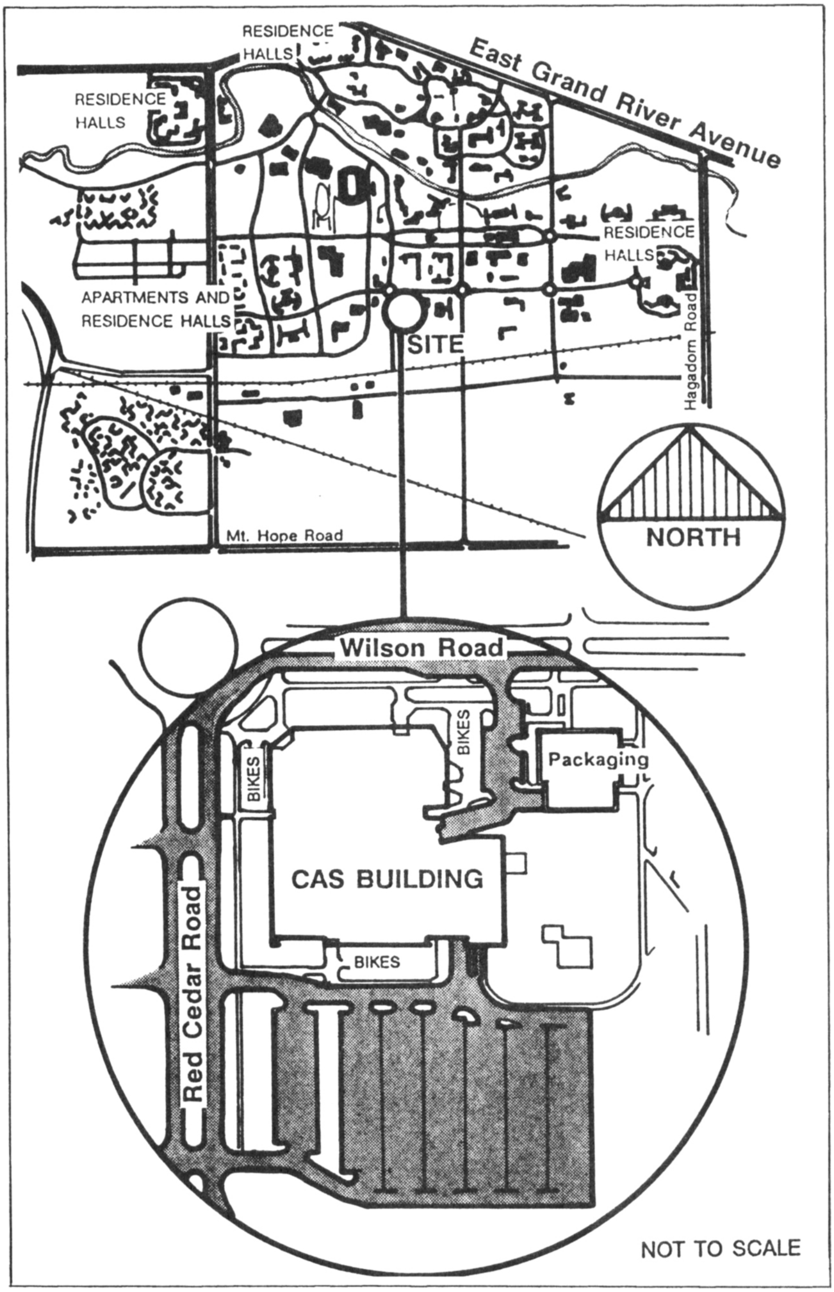


Figure 1. MSU campus map and CAS site plan.

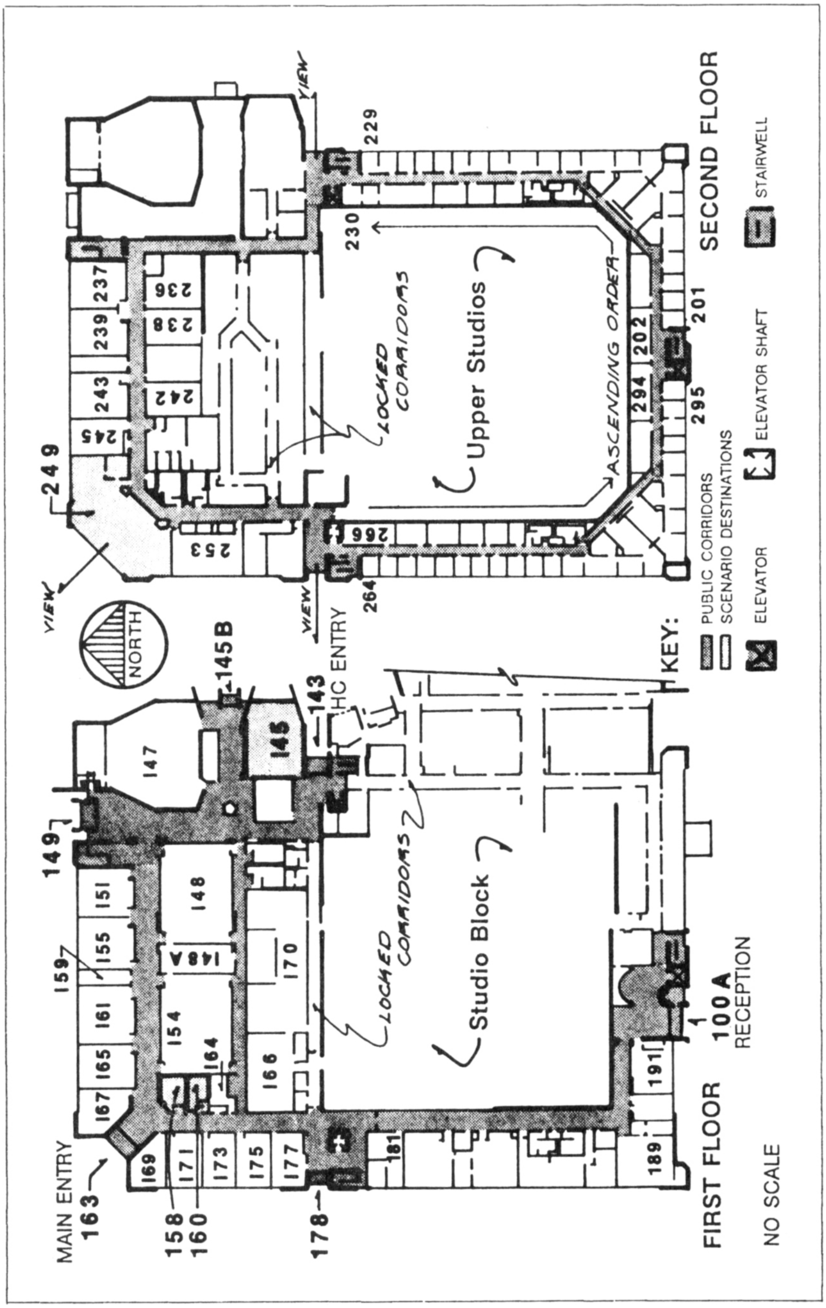


Figure 2. First and second floor plans.

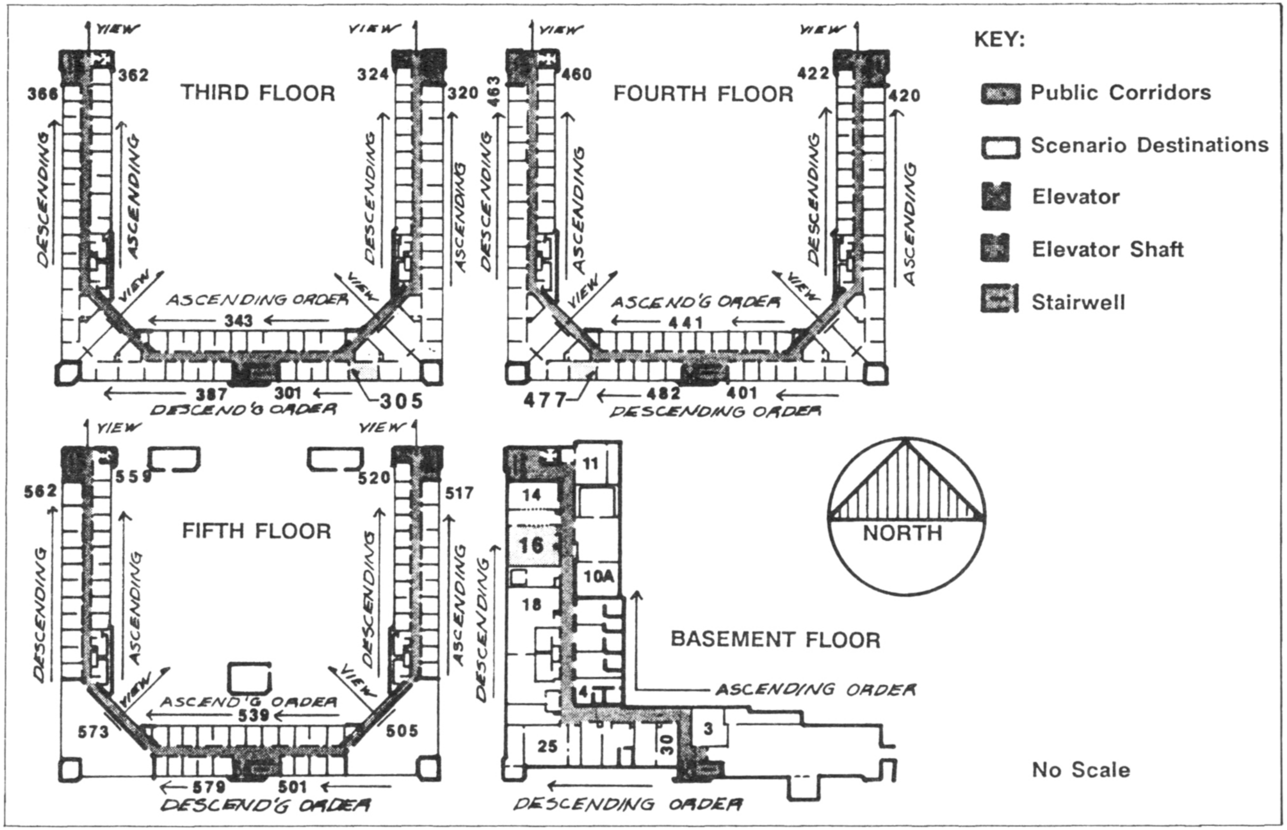


Figure 3. Third, fourth, fifth, and basement floor plans.

this facility and future educational facility design. This POE is setting-focused and descriptive.

Three methods were used in the study, and they were described in Part I. Briefly, they involved checking for code and standards compliance, on-site observation and recording of user performance, and interviewing users to measure perceptions and opinions. While Part I reported findings based primarily on the third method, Part II is based on findings from all three methods, and represents a portion of the client summary report. Aspects of the methodology specifically involved in Part II are described below.

The Users

A description of the users and breakdown of handicapper characteristics represented in the sample were reported in Part I. Mobility characteristics dominated, some in combination with auditory, visual, and/or dexterity/manipulation characteristics.

Sample Size

Sample selection was presented in Part I. The numbers following are the numbers of subjects used in this study. An approximately equal number of handicappers with mobility associated handicaps ($N = 16$) and non-handicappers ($N = 20$) participated in one of five prescribed building scenarios, and were interviewed subsequently. To reflect everyday building usage, sixty-one additional participants, selected at random, agreed to answer questions in a shortened version of the questionnaire.

The Scenarios

In each scenario, seven or nine participants were directed to enter the building at one of six entryways and to seek a primary destination, e.g., classroom 16, the Applegate Reading Room, the Office of Journalism, or the Office of Handicapper Services. Appropriate sub-tasks to be accomplished within a setting were assigned. Before returning to the original building entry, subjects were directed to find sub-destinations such as a drinking fountain, restroom, and/or public telephone, with appropriate sub-tasks. Each scenario is outlined in Figures 4 and 5.

The Questions

The questionnaire contained 187 questions which covered user preference and opinion, wayfinding, and use of specific classroom settings. Appropriate ones outlined below are being discussed in this report. Following scenario completion and prior to questionnaire administration, three open-ended questions were asked.

By telephone, participant is instructed to meet the investigator at the appropriate building entry location. At the site, instructions are given to the participant and his/her consent is obtained on the consent form. Participant is instructed to:

SCENARIO I

A. Enter the CAS building through (Entry 143) (Entry 145B).
B. Find the Applegate Reading Room, use the card catalog and look up an author named Smith. Record author's full name and title of reading material on card provided. Locate the reading material in the library and read the first 3 pages at a table.
C. Exit the reading room and find a drinking fountain. Get a drink of water.
D. Find and enter restroom 158 or 160, as appropriate; enter and exit a stall, wash hands and comb hair.
E. Exit the restroom and return to original building entry.

SCENARIO II

A. Enter the CAS building through Entry 100A.
B. Find the Office of Handicapper Services, and ask for general information concerning their services. Record the name of the receptionist on the card provided.
C. Exit and find a public telephone. Call 353-8945. Record the name of the department on the card provided.
D. Find and enter Restroom 158 or 160 as appropriate; enter and exit a stall, wash hands and comb hair.
E. Exit the restroom and return to original building entry.

Figure 4. Scenarios I and II.

1. What is the worst aspect of this building and why?
2. What is the best aspect of this building and why?
3. If you had the opportunity to change something in this building what would it be?

Critical wayfinding questions pertained to the degree of ease or difficulty experienced enroute to specified interior destinations and performance of subtasks.

4. Did you find the primary destination easily?
5. Did you find the secondary destination(s) easily?

SCENARIO III

A. Enter the CAS building through (Entry 149) (Entry 163) (Entry 178).
B. Find lecture hall, 145 and find a place to sit.
C. Sit through a class.
D. Find a drinking fountain and get a drink of water.
E. Return to original building entry.

SCENARIO IV

A. Enter the CAS building through (Entry 149) (Entry 163) (Entry 178).
B. Find classroom 16 and find a place to sit.
C. Sit through a class.
D. Exit and find a public telephone. Call 353-8945. Record the name of the department on the card provided.
E. Return to original building entry.

SCENARIO V

A. Enter the CAS building through (Entry 143) (Entry 145B) (Entry 100A).
B. Go to general department Office of Journalism and request a Journalism Planning Check Sheet. If they ask you questions you cannot answer, tell them you are picking up the information for a friend and thank them very much.
C. Exit and find a drinking fountain. Get a drink of water.
D. Find and enter restroom 158 or 160 as appropriate; enter and exit a stall, wash hands and comb hair.
E. Exit the restroom and return to original building entry.

Figure 5. Scenarios III, IV, and V.

6. How would you evaluate the relative ease or difficulty you encountered using building directories/signage?

Findings from these six questions, from behavioral maps, and from comparing participants' responses to code/standards compliance form the basis of this report. Descriptive summary statistics were performed on all questions using a main frame computer and the Statistical Package for the Social Sciences (SPSS). Cross tabulations were performed on the demographics and twenty-five short-form questions. Data were analyzed separately for the thirty-six scenario participants and in combination for the ninety-seven total respondents. The

Chi-square test was used to evaluate differences in: 1) handicapper and non-handicapper responses, 2) first time user and occasional/frequent user responses, and 3) low frequency users and frequent users where appropriate. Means were evaluated using the Student's t-Test. A behavioral map was made during each participant's journey. Map documentation was checked manually against interview responses for congruence. Photographs of easy to find destinations are shown in Figure 6. Those difficult to find are shown in Figures 7 and 8.

RESULTS

It was reported in Part I that the building meets state codes and national standards for the most part. Though not appropriate to include the complete code/standards checklist of 236 items here, all categories covered including the frequency of non-compliance are presented in Table 1. Requirements of three agencies were utilized as stated in the first objective.

Code/Standards Checklist Review

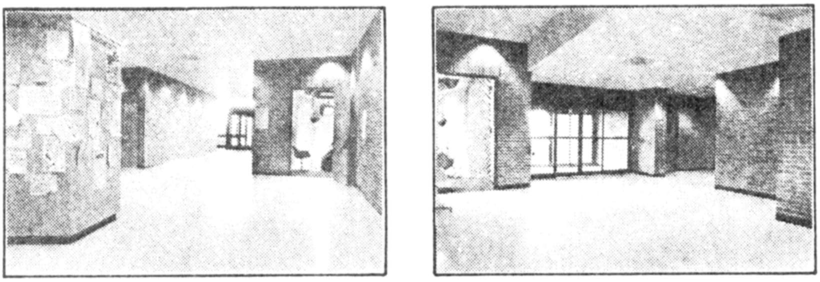
Being in compliance with the requirements of one agency did not always mean being in compliance with another. ANSI parking and exterior circulation standards were met [15], but there were discrepancies on MBFD threshold height requirements [16]. Though MBFD door/doorway requirements were met, ANSI standards concerning heavy doors and operability of door closers were not. Clearance from the lavatory apron to the finished floor did not meet ANSI or MBFD requirements, and MSUC's lavatory mounting height was exceeded in all restrooms [17]. Telephones did not meet either ANSI or MBFD requirements in terms of:

1. appropriate number available;
2. proper identification; and
3. use by handicappers with an auditory impairment.

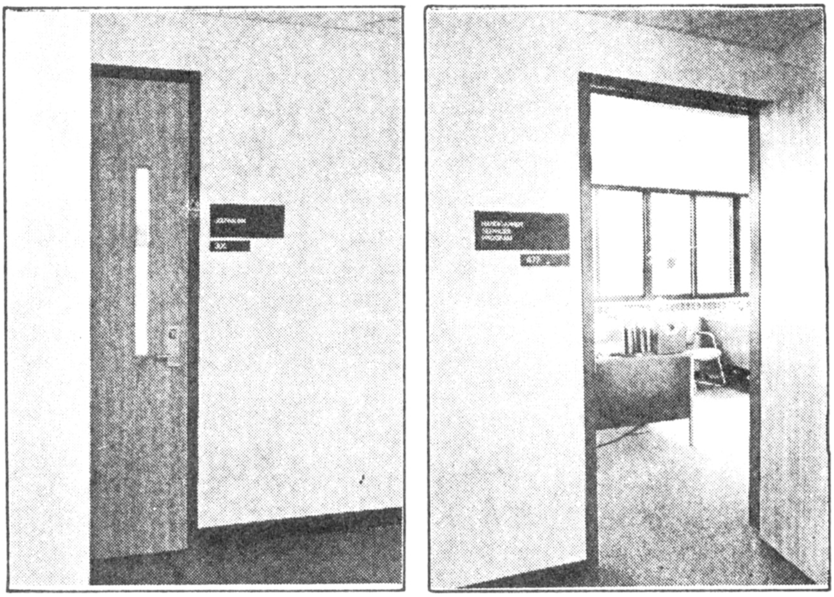
Signage was out of compliance by MBFD requirements in that the international symbol was not used to identify accessible facilities. In all, twenty-seven ANSI standards and thirty MBFD requirements were found to be out of compliance, or 11.4 percent and 12.7 percent, respectively, of the total. Many of the requirements for which the building was out of compliance were duplicated in the two codes.

"Worst," "Best," and "Change" Aspects

All but four scenario participants were asked the three open-ended questions outlined above. Their high frequency initial responses ($N = 32$) were identified



Lecture hall 145 showing north (left) and south (right) points of egress.



Typical identification signage for offices.

Figure 6. Easy to find destinations. Lecture hall 145: top. Entry door to the School of Journalism Office 305, bottom left and to Office of Handicapper Services, 477, bottom right. Photo credits: Laura Quackenbush. Office 305 photo credit; Roberta L. Kilty-Padgett.

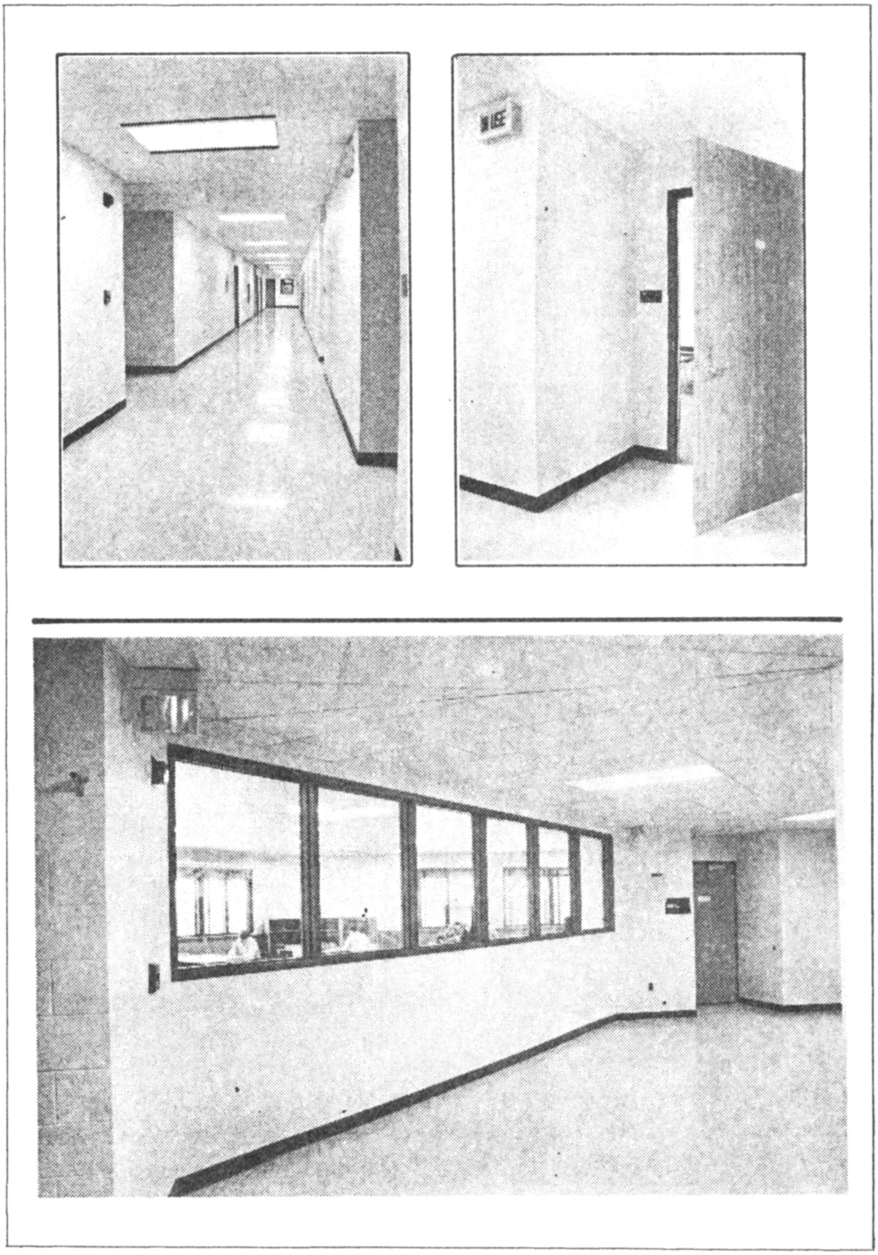


Figure 7. Difficult to find destinations. Classroom 16, top; south approach on left and recessed entry with flush signage on right. Photo credits: Author. Applegate Reading Room 249, bottom. Photo credit: Laura Quackenbush.

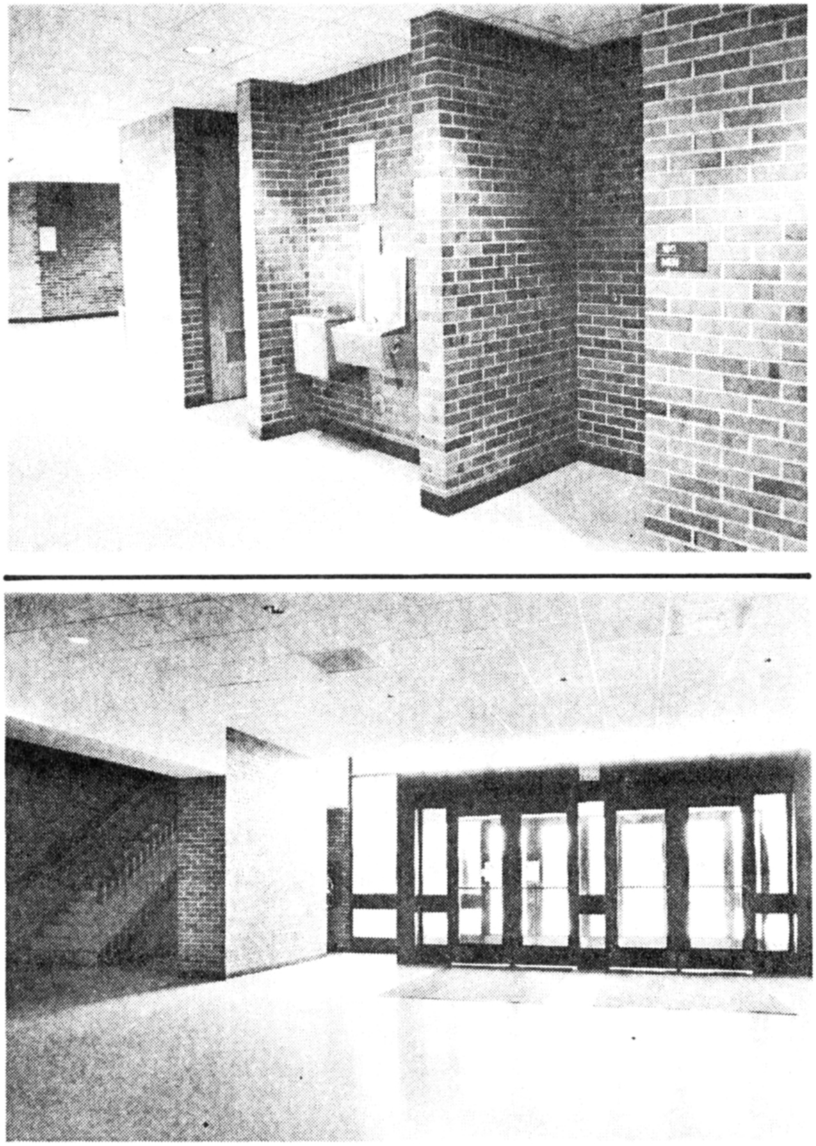


Figure 8. Difficult to find destinations. Restrooms 158/160 with paired drinking fountains, top. Telephone alcove in entry 149, bottom. Photo credits: Laura Quackenbush.

Table 1. Accessibility and Usability Checklist: Frequency of Non-Compliance

Items (N = 236)	*ANSI[a]*	*MBFD[b]*	*MSUC[c]*
Parking: (n = 13)	1	1	
Walkways: (n = 9)	0	0	
Ramps: (n = 16)	0	0	
Building Entries: (n = 14)	0	4	
Interior Circulation:			
Doors/doorways (n = 12)	3	0	
Hallways (n = 5)	0	0	
Stairways (n = 10)	1	1	
Elevators (n = 20)	2	2	
Floors (n = 5)	0	0	
Activity Zones:			
Foyers (n = 4)	1	1	
Classrooms (n = 12)	3	1	
Restrooms (n = 54)	6	11	1
Offices (n = 4)	0	0	
Equipment and Controls:			
Drinking fountains (n = 19)	2	0	0
Public telephone (n = 11)	5	4	
Signage: (n = 7)	1	2	
Safety: (n = 13)	1	2	
Hazards: (n = 7)	1	1	
Column Totals (%):	27 (11.4)	30 (12.7)	1 (0.4)

[a] ANSI A117.1 [15]. Some ANSI and MBFD requirements are identical. Therefore items showing non-compliance may be the same in both columns.
[b] Michigan Barrier Free Design Requirements [16].
[c] Michigan State University Construction Standards only address restrooms and drinking fountains specifically [17].

to partially determine response categories to be used for at random participants ($N = 61$).

In Table 2, a comparison of negative and positive aspects is depicted. The only markedly negative aspect of the building was wayfinding with which 58 percent of the respondents reported difficulty, whereas only 4.3 percent considered it to be easy. Twenty-five percent of the respondents felt the building was alienating, but this was countered by 60 percent of the respondents believing the building to be appealing. Both handicapped and non-handicapped respondents considered building access to be good. For all other building aspects

Table 2. Comparison of Negative and Positive Aspects[a]

Negative Aspects	*Frequency*	*(%)*	*(%)*	*Frequency*	*Positive Aspects*
A. Inadequate parking	8	(8.6)	(5.4)	5	Adequate parking A.
B. Alienating building	23	(24.7)	(60.2)	56	Appealing building B.
C. Restricted building access	0	(0.0)	(14.0)	13	Easy building access C.
D. Difficult wayfinding	54	(58.0)	(4.3)	4	Easy wayfinding D.
E. Heavy, difficult doors	7	(7.5)	(8.6)	8	Automatic, easy doors E.
F. Barrier free restrooms	6	(6.5)	(6.5)	6	Barrier free restrooms F.
G. Lighting	3	(3.2)	(1.1)	1	Lighting G.
H. Other	22	(23.7)	(38.7)	36	Other H.

[a] Multiple responses possible (N = 93).

the response was approximately balanced. These included parking, doors, barrier free restrooms, lighting, and other miscellaneous items.

Responses to the question, "If you had the opportunity to change something in the building, what would it be," show in Table 3 that elevators and building directories/signage were chosen for change by 35 percent or more of the respondents. Corridor seating, although selected for change by 25 percent of the respondents, was primarily selected by non-handicapped, at random participants. All other categories elicited a response for change by less than 20 percent of the participants. Table 3 shows a large difference in the responses of the handicapped scenario participants compared to non-handicappers regarding changes in elevators, directories/signage, doors, and restrooms.

Easy To Find Destinations

Scenario participants considered classroom 145, the Office of Journalism 305, and the Office of Handicapper Services 477 to be easy to find as shown in Table 4, and they were in fact. The Chi-square test (alpha .05, n = 21, df = 1) showed no significant differences in opinions between handicappers and non-handicappers, between first time users and users familiar with the building, or between frequent users and low frequency users. Drinking fountains, as shown in Table 5, were considered easy to find by both scenario and at-random participants with similar results from the Chi-square test (alpha .05, n = 51, df = 2).

When the frequency of backtracks (BT), of times people asked for information (ASK), and of times they referred to directories and/or signage (REF) was analyzed through behavioral mapping of scenario participants, results coincided with expressed user opinion as can be seen in the differences between actual

Table 3. Change Aspects in Rank Order

Aspects	Scenario Respondents[a] (N = 32) (4 Missing) Hc[d] Frequency (%)	N-Hc[e] Frequency (%)	At Random[b] Respondents (N = 61) Frequency (%)	All[c] Respondents (N = 93) Row Total (%)
A. Elevators	8 (25.0)	2 (6.3)	31 (50.8)	41 (44.1)
B. Directories/Signage	14 (43.8)	8 (25.0)	13 (21.3)	35 (37.6)
C. Corridor seating	1 (3.1)	0 (0.0)	24 (39.3)	25 (26.9)
D. Corridor lighting levels	3 (9.4)	2 (6.2)	14 (22.9)	19 (20.4)
E. Telephones	4 (12.5)	2 (6.3)	7 (11.5)	13 (14.0)
F. Doors	10 (31.2)	1 (3.1)	---- (-------)	11 (11.8)
G. Restrooms	6 (18.7)	0 (0.0)	---- (-------)	6 (6.5)
H. Connect NE and SW hall layout	2 (6.2)	3 (9.4)	---- (-------)	5 (5.4)
I. Other	9 (28.1)	6 (18.7)	7 (11.5)	22 X 1 (1.1)

[a] Scenario participants who were asked this question were free to give multiple responses.
[b] At random participants could choose a maximum of two responses.
[c] Multiple responses possible.
[d] Handicappers
[e] Non-Handicappers.

Table 4. Found Primary Destination Easily: Classroom 145, Office of Journalism, 305, and Office of Handicapper Services, 477

Responses	Hc[a] FTU[c]	Hc[a] OU[d]	Hc[a] FrU[e]	N-Hc[b] FTU[c]	N-Hc[b] OU[d]	N-Hc[b] FrU[e]	All FTU[c]	All OU[d]	All FrU[e]	Row Totals Frequency (%)
	Scenarios II, III, and V									
Easy to find way	4	2	1	3	3	4	7	5	5	17 (80.9)
Not easy to find way	0	0	2	0	1	0	0	1	2	3 (14.3)
Ambivalent	0	0	0	0	1	0	0	1	0	1 (4.8)
Column Totals	4	2	3	3	5	4	7	7	7	21 (100.0)

[a] Handicapper
[b] Non-Handicapper
[c] First Time User
[d] Occasional User
[e] Frequent User

Table 5. Found Drinking Fountain Easily

	Scenarios (N = 23) and At Randoms (N = 28)						
	Scenarios I, III, and V			*At Randoms*[a]			*Row Totals Frequency (%)*
Responses	*FTU*[b]	*OU*[c]	*FrU*[d]	*FTU*[b]	*OU*[c]	*FrU*[d]	
Easy to find way	3	8	7	1	13	12	44 (86.3)
Not easy to find way	1	0	1	1	0	0	3 (5.9)
Ambivalent	1	0	0	0	1	0	2 (3.9)
Blank	0	0	0	2	0	0	2 (3.9)
Column Totals	5	8	8	4	14	12	51 (100.0)

[a] Directed to answer question only if subject used drinking fountain that day.
[b] First Time User
[c] Occasional User
[d] Frequent User

frequencies in Tables 6 and 12, and between mean scores in Tables 7 and 13, 8 and 14. While BT frequencies for easy destinations ranged from 0 to 5 (Table 6) with a mean of .75 for handicappers (Hc), .48 for non-handicappers (N-Hc) (Table 7), .45 for first time users (FTU) and .64 for users familiar with the building (FAM) (Table 8), those for difficult destinations ranged from 1 to 12 (Table 7) with a mean of 1.96 for Hc, 1.56 for N-Hc (Table 13), 2.13 for FTU, and 1.81 for FAM (Table 14). ASK frequencies for easy destinations ranged from 0 to 3 (Table 6), with a mean of .31, .26, .27, and .29 for HC, N-Hc, FTU, and FAM, respectively (Tables 7 and 8). But those of difficult destinations ranged from 0 to 7 (Table 12) with a mean of 1.13 for Hc, .79 for N-Hc, 1.2 for FTU, and .84 for FAM (Tables 13 and 14). While REF frequencies for easy destinations ranged from 0 to 10 (Table 6) with a mean of .50, .65, .36, and .68 for Hc, N-Hc, FTU, and FAM, respectively (Tables 7 and 8), those of difficult destinations ranged from 0 to 8 (Table 12) with a mean of .91 for Hc, .50 for N-Hc, .93 for FTU, and .59 for FAM (Tables 13 and 14). In finding difficult destinations, handicapped and first time building users utilized all three strategies (BT, ASK, and REF) more often than other groups.

The Chi-square test (alpha .05, $n = 57$ where n represents frequency of occurrence) (Table 6) showed no significant differences in performance for easy destinations between Hc and N-Hc or between FTU and FAM. The Students' t-Test comparing means for these groups yielded similar results as shown in Tables 7 and 8.

Returning to the original entryway from all last destinations was very easy for almost all scenario participants based on observation alone.

Table 6. Frequencies for Easy Destinations Comparing Handicappers (Hc) and Non-Handicappers (N-Hc) by Familiarity

	Frequency of Occurrence													
	Hc						*N-Hc*						
Destinations	*FTU*[a]			*FAM*[b]			*FTU*[a]			*FAM*[b]			*Row Totals*
	BT[c]	*ASK*[d]	*REF*[e]	*BT*[c]	*ASK*[d]	*REF*[e]	*BT*[c]	*ASK*[d]	*REF*[e]	*BT*[c]	*ASK*[d]	*REF*[e]	
477	1	0	1	1	1	0	0	1	0	1	2	1	9
145	—	—	—	1	0	4	1	0	2	5	0	10	23
305	2	2	1	2	1	2	0	0	0	3	3	2	18
Drinking fountain	1	0	0	4	1	0	0	0	0	1	0	0	7
Column Totals	4	2	2	8	3	6	1	1	2	10	5	13	57

Note: (HC FTU[a]: N = 6, N-Hc FTU[a]: N = 5)
(HC FAM[b]: N = 10, N-Hc FAM[b]: N = 18)

[a] First Time User
[b] Familiar with Building
[c] Backtracked
[d] Asked for Information
[e] Referred to Signage/Directory

Table 7. Means and *t*-Test Results for Easy Destinations Comparing Handicappers (Hc) and Non-Handicappers (N-Hc)

		Mean		*Standard Deviation*		
	n	*Hc*	*N-Hc*			*t**
Backtracked	16	.75		.86		
	23		.48		.73	1.07
Asked for Information	16	.31		.60		
	23		.26		.54	.28
Referred to Signage/Directory	16	.50		1.10		
	23		.65		1.37	-.37

* Critical Value = -1.64 with an alpha level of .05. All *t* values are greater than the critical value, so each null hypothesis is accepted: $\overline{x}_{Hc} = \overline{x}_{N\text{-}Hc}$.

Table 8. Means and *t*-Test Results for Easy Destinations Comparing First Time Users (FTU) and Users Familiar with the Building (FAM)

	n	*Mean*		*Standard Deviation*	*t**
		Hc	*N-Hc*		
Backtracked	11	.45		.52	
	28		.64	.87	-.67
Asked for Information	11	.27		.65	
	28		.29	.53	-.10
Referred to Signage/Directory	11	.36		.67	
	28		.68	1.42	-.73

* Critical Value = −1.64 with an alpha level of .05. All *t* values are greater than the critical value, so each null hypothesis is accepted: $\bar{x}_{FTU} = \bar{x}_{FAM}$.

Table 9. Found Primary Destination with Difficulty: Classroom 16 (Aural Rehabilitation) and Applegate Reading Room 249

	Scenarios I and IV									
	Hc[a]			*N-Hc*[b]			*All*			*Row Totals Frequency (%)*
Responses	*FTU*[c]	*OU*[d]	*FrU*[e]	*FTU*[c]	*OU*[d]	*FrU*[e]	*FTU*[c]	*OU*[d]	*FrU*[e]	
Easy to find way	0	0	1	0	0	1	0	0	2	2 (12.50)
Not easy to find way	3	2	1	2	3	1	5	5	2	12 (75.00)
Ambivalent	1	0	0	0	0	0	1	0	0	1 (6.25)
Blank	0	0	0	1	0	0	1	0	0	1 (6.25)
Column Totals	4	2	2	3	3	2	7	5	4	16 (100.00)

[a] Handicapper
[b] Non-Handicapper
[c] First Time User
[d] Occasional User
[e] Frequent User

Difficult to Find Destinations

Classroom 16 (Aural Rehabilitation) and Applegate Reading Room 249 were considered difficult to find as shown in Table 9. The Chi-square test (alpha .05, $n = 16$, $df = 3$) showed no significant differences in opinions between Hc and N-Hc, between FTU and FAM, or between frequent user opinions and those of low frequency users.

Table 10. Found Restroom 158/160 with Some Difficulty

	Scenarios II, III, and V									
	Hc[a]			N-Hc[b]			All			Row Totals Frequency (%)
Responses	FTU[c]	OU[d]	FrU[e]	FTU[c]	OU[d]	FrU[e]	FTU[c]	OU[d]	FrU[e]	
Easy to find way	1	2	1	3	3	1	4	5	2	11 (47.8)
Not easy to find way	3	1	2	0	2	1	3	3	3	9 (39.1)
Ambivalent	0	1	0	0	0	2	0	1	2	3 (13.0)
Column Totals	4	4	3	3	5	4	7	9	7	23 (100.0)

[a] Handicapper
[b] Non-Handicapper
[c] First Time User
[d] Occasional User
[e] Frequent User

Table 11. Found Public Telephone with Difficulty

	Scenarios (N = 13) and At Randoms (N = 13)							
	Scenarios II and IV				At Randoms[a]			
Responses	FTU[b]	OU[c]	FrU[d]	Row Totals Frequency (%)	FTU[b]	OU[c]	FrU[d]	Row Totals Frequency (%)
Easy to find way	1	0	1	2 (15.4)	0	2	4	6 (46.2)
Not easy to find way	5	4	1	10 (76.9)	0	0	6	6 (46.2)
Ambivalent	0	0	1	1 (7.7)	0	0	1	1 (7.7)
Column Totals	6	4	3	13 (100.0)	0	2	11	13 (100.0)

[a] Directed to answer question only if subject used telephone that day.
[b] First Time User
[c] Occasional User
[d] Frequent User

Finding specified restrooms 158/160 presented difficulty for 39 percent of the people as shown in Table 10. The Chi-square test (alpha .05, n = 23, df = 2) showed no significant differences in opinions between Hc and N-Hc, between FTU and FAM, or between frequent users and low frequency users.

The public telephone presented wayfinding difficulty to 77 percent of the scenario participants and 46 percent of at random participants as shown in Table 11. The Chi-square test (alpha .05, n = 13, df = 2) showed no significant differences between group opinions whether Hc, FTU, or frequent user.

Table 12 shows how often participants of different user groups utilized each of three wayfinding strategies when seeking difficult to find destinations. The

Table 12. Frequencies for Difficult Destinations Comparing Handicappers (Hc) and Non-Handicappers (N-Hc) by Familiarity

	Frequency of Occurrence												
	Hc						N-Hc						
Desti-	FTU[a]			FAM[b]			FTU[a]			FAM[b]			Row
nations	BT[c]	ASK[d]	REF[e]	BT[c]	ASK[d]	REF[e]	BT[c]	ASK[d]	REF[e]	BT[c]	ASK[d]	REF[e]	Totals
249	2	1	2	12	7	8	2	0	2	5	4	5	50
16	8	6	0	–	–	–	3	3	1	9	5	2	37
Restroom	3	3	2	9	1	4	1	0	0	6	3	3	35
Telephone	7	6	0	10	5	0	5	1	0	11	6	0	51
Column Totals	20	16	4	31	13	12	11	4	3	31	18	10	173

Note: (HC FTU[a]: N = 10, N-Hc FTU[a]: N = 6)
(HC FAM[b]: N = 13, N-Hc FAM[b]: N = 19)

[a] First Time User
[b] Familiar with Building
[c] Backtracked
[d] Asked for Information
[e] Referred to Signage/Directory

Table 13. Means and t-Test Results for Difficult Destinations Comparing Handicappers (Hc) and Non-Handicappers (N-Hc)

		Mean		Standard		
	n	Hc	N-Hc	Deviation		t*
Backtracked	23	1.96		1.97		
	25		1.56		1.58	.80
Asked for Information	23	1.13		1.32		
	24		.79		1.10	1.00
Referred to Signage/Directory	23	.91		1.31		
	24		.50		.72	1.39

* Critical value = –1.64 with an alpha level of .05. All t values are greater than the critical value, so each null hypothesis is accepted: $\overline{x}_{Hc} = \overline{x}_{N\text{-}Hc}$.

Chi-square test (alpha .05, n = 173 where n represents the frequency of occurrence, df = 2) showed no significant differences in performance between groups. The Student's t-Test comparing means for these groups yielded similar results as shown in Tables 13 and 14. Though not statistically significant, the

Table 14. Means and t-Test Results for Difficult Destinations Comparing First Time Users (FTU) and Users Familiar with the Building (FAM)

		Mean		*Standard*		
	n	*FTU*	*FAM*	*Deviation*		t^*
Backtracked	16	2.13		1.59		
	32		1.81		2.01	.55
Asked for Information	15	1.20		1.26		
	32		.84		1.19	.94
Referred to Signage/Directory	15	.93		1.39		
	32		.59		.87	1.00

* Critical value = −1.64 with an alpha level of .05. All t values are greater than the critical value, so each null hypothesis is accepted: $\bar{x}_{FTU} = \bar{x}_{FAM}$.

Table 15. Relative Ease or Difficulty Using Building Directories and Signage

	Scenario Respondents (N = 36)		*At Random Respondents (N = 59)*	*All Respondents*
Rating Scale	*Hc*[a] *Frequency*	*N-Hc*[b] *Frequency*	*(2 Missing) Frequency*	*Row Total (%)*
Difficult/Very Difficult	10	12	25	47 (49.5)
Neutral	3	5	17	25 (26.3)
Easy/Very Easy	3	3	17	23 (24.2)
Column Totals (%)	16 (16.8)	20 (21.1)	59 (62.1)	95 (100.0)

[a] Handicappers
[b] Non-Handicappers

range of mean values is higher for handicappers than non-handicappers for both easy and difficult destinations, the single exception being that of signage/ directory referral for easy destinations shown in Table 7.

In Table 15, responses ranking the relative ease or difficulty in using building directories and signage show that forty-seven or 49.5 percent of all respondents agreed that they were difficult to very difficult. Twenty-three or 24.2 percent considered them easy to very easy, and twenty-five or 26.3 percent remained neutral. Figure 9 shows a typical building directory.

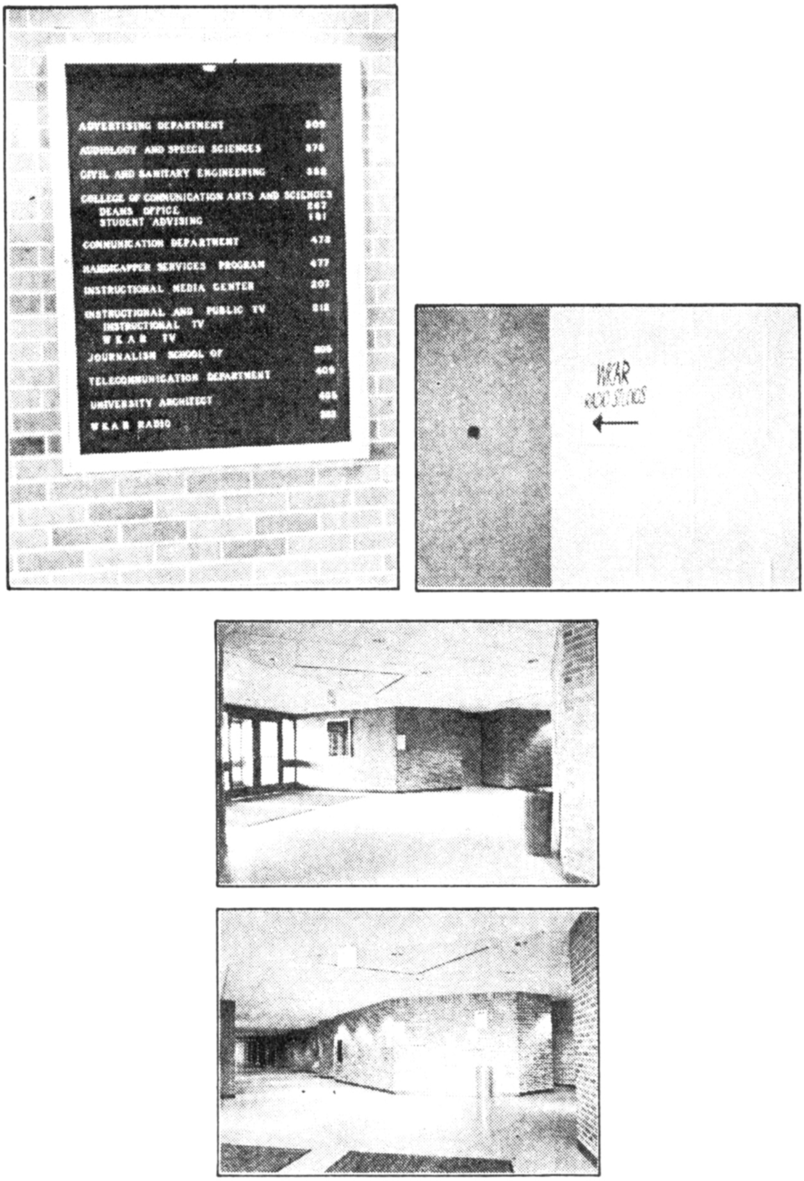


Figure 9. Building directories and signage. Typical directory, upper left. User applied supplemental signage, upper right. Photo credits: Author. Entry 163 showing building directory location, middle. Entry 163 as choice point, bottom. Photo credits: Laura Quackenbush.

DISCUSSION

The results reported in this part of the study were substantiated for scenario participants by questionnaire responses and documentation of scenario route behavior. The scenarios allowed the researcher to document wayfinding problems and compare these observations with user opinion, yielding more reliable data.

Responses of random participants were compiled in

1. open-ended question analysis (Tables 2 and 3); and
2. drinking fountain, telephone, and building directory/signage analysis (Tables 5, 11, and 15, respectively);

yielding data which further substantiated opinions concerning wayfinding. Their destinations were self-determined and more widely varied than those assigned to scenario participants, making it difficult to make performance comparisons.

The code checklist served as a guide to check correspondence between physical features of building components and reported ease or difficulty of use found by other methods. For example, three of the building entry discrepancies in Table 1 (MBFD) related to threshold heights and one to level entries inside and out. Handicapper study participants did not find these discrepancies to cause problems and felt that having every entrance at building grade level was a good aspect.

Overall dimensions for width in hallways met all requirements (Table 1) and elicited positive responses from handicappers and non-handicappers alike, who described the building as new, modern, clean, and spacious with specific comments on the "nice wide hallways" and "state of the art" studios. Hard and soft flooring meeting ANSI requirements were easily negotiated and praised by study participants.

Fifty-eight percent of all respondents identified wayfinding as a major problem in the CAS building, whether handicapped or not, familiar with the building or not (Table 2). Participants explained, "When you enter, you're lost. There aren't any indications of where the elevators and stairs are. And the locked doors: A person who hasn't used the building would wonder why they're all locked." They indicated that the building is confusing because of:

1. layout;
2. similar appearing entryways; and
3. lack of information provided by directories, signage, receptionist(s), and other building users.

No entryway proved to be without difficulty in terms of wayfinding, all lacking some essential information. Both handicappers and non-handicappers wanted to make the route between the east and south sides of the building more direct (Table 3). To make wayfinding information more readily available, they suggested educating the receptionist(s) and relocating the information desk to the north side of the building.

Stairway landings and handrails were found to be out of compliance in the checklist (Table 1), but they were not specifically noted as problems by study participants either through expressed opinion or behavior. Handicappers relied on the elevators rather than the stairwells. Non-compliant elevator aspects possibly affecting wayfinding included the mounting height of elevator hall call buttons [15] and of metal tactile numbers [16] and the existence of an audible gong limited to the first floor landing only [17]. The cab's interior dimensions met minimum square footage requirements, but not ANSI's minimum width (sixty-eight inches) dimension. However, this did not appear to cause difficulty for anyone based on questionnaire responses and behavioral map information. What participants did consider difficult was the fact that only one of two elevators currently available accessed the basement.

The top ranking change aspect reported in Table 3 was the elevator system by 44 percent of all participants. Typical comments focused on adding one or two elevators in various locations, accessing the basement with more than one, improving maintenance, making them more prominent, and improving call button panel information and usability.

Directories and signage, though ranked second in priority for change by all respondents (Table 3), was the first ranking item for handicappers. Absence of the international symbol was not a problem (MBFD, Table 1), yet adequacy of building information as a whole was.

Tables 4 through 15 specifically address the issue of wayfinding. If one applies the three factors affecting spatial orientation and wayfinding presented by Gärling et al. [14], in addition to CAS user opinion and behavior, reasons for ease and difficulty in CAS wayfinding become readily apparent. For all destinations, architectural differentiation, visual access, and complexity of layout played roles to varying degrees. Comparisons of CAS visual access capability for easy and difficult destinations support views and findings of Weisman [3], Gärling et al. [10], and Evans et al. [9], that wayfinding is positively enhanced by the degree of perceptual access provided by the environment.

Easy Destinations

Since destinations 145, 305, 477 (Table 4 and Figure 6) and the drinking fountain (Table 5 and Figure 8) were considered easy to find by more than 80 percent of scenario and all respondents respectively, and since there was no difference in user group opinions (Tables 4 and 5) using the Chi-square test or in performance (Tables 6, 7, and 8) using the Student's t-Test in any of the cases, the environmental features distinguishing these destinations are important for both specific and general university building design application. The following analysis is intended for this purpose.

Classroom 145, flanked by two ground floor building entries as shown in Figures 2 and 6, is distinguished further by proximity of a free standing bulletin board where students gather. The room is visible from three building entries predominantly receiving student use. One can follow the room numbering sequence fairly easily even though 145 is not identified on any building directory. The corridors are at right angles to one another with a short travel distance from each of these three entries.

Flush doors to offices 305 and 477 shown in Figures 3 and 6 are both located in a chamfered corridor. The entry doors themselves (not room identification) are visible from elevator landings, from the east and south third floor corridors and west and south fourth floor corridors, respectively. Though not visible from any building entry, they are consistently identified by name and room number on every building directory (Figure 9). Both elevators access the third and fourth floors, with corridor layout at right angles. Some difficulty presents itself for the 149 stairwell user who must develop new route tactics once he realizes that these stairs end on the second floor. Quantity and availability of drinking fountains make up for what limited visibility may exist for some units.

Difficult Destinations

Classroom 16 (Aural Rehabilitation) and Applegate Reading Room 249 were considered difficult to find for 75 percent of the participants (Table 9). There was no significant difference in opinion or performance among Hc and N-Hc, FTU and FAM based on the Chi-square Test (Tables 9 and 12). The Student's t-Test (Tables 13 and 14), yielded no significant differences among user groups, though the range of mean values for handicappers is greater than that of non-handicappers for both easy and difficult destinations with the exception of one parameter (Table 7).

Classroom 16, in the difficult to find category, looks the same as other rooms in the basement as shown in Figure 8. The room numbering sequence ascends on the right side of the hall and descends on the left side (Figure 3). With only one main basement corridor, reaching room 16 was not difficult (Figure 3) once participants found the basement. Difficulty occurred because:

1. the existence of a basement was not generally known;
2. basement room numbers did not appear on any building directory; and
3. limited elevator access to the basement increased
   a. the travel distance to room 16, and
   b. the number of wayfinding decisions from the north side of the building.

This supports the need for improving the existing directory and signage system.

Applegate Reading Room 249 is architecturally differentiated by its location in the northwest building chamfer (Figures 2 and 7) with interior corridor windows and view windows to the campus. Figure 2 shows that visual access to

249 is possible from the northeast corner of the second floor where the 149 stairwell ends, but not from elevator landings. Although corridors are at right angles to room 249 and should facilitate wayfinding, the second floor layout differs from the first floor in that perimeter corridors are all open to the public. The room numbering sequence on the first and second floors is consistent in that the numbers alternate sides of the hall (Figure 2). However, on the first floor, numbers are intermingled in areas not available to the public, causing a loss of sequence and thus direction for wayfinding. Ascending and descending order was not indicated at any elevator or stairwell landing. The room is not identified on building directories (Figure 9), nor is it generally known as "Applegate." Room numbering in the basement and on floors 3 through 5 (Figure 3) breaks with the pattern of floors 1 and 2 by numbering in ascending order on one side of the hallway and descending order on the opposite side. Such inconsistencies obviously do not help wayfinding.

Restrooms 158/160 were difficult to find, with no differences in user group opinions based on the Chi-square test (Table 10) or in user group performance based on the Student's *t*-Test (Tables 12 through 14). The difficulty was highlighted in participants' comments on the logic behind the room numbering sequence. It would seem that numbers 158/160 should be opposite 159/161 if other sequences hold. Instead the rooms are around the corner causing confusion on the part of participants coming from the northeast direction. Figure 2 shows the room numbering scheme for the north, first floor corridor and the cut-through corridor. Re-ordering this particular sequence would be a simple and economical thing to do, or the alternative would be to add supplemental signage at each end of the north hallway. Locations of restrooms were not identified on any building directory (Figure 9). Finding restrooms by room number on upper floors would present similar difficulties since the pattern of room numbering changed, and there was a lack of wayfinding information at elevator/stairwell landings.

Finding the only public telephone in the building was difficult for 77 percent of the scenerio participants (Table 11) and 46 percent of the at random participants, and again there was no difference between opinions and performance among user groups. The telephone is differentiated by being recessed as shown in Figure 8, but visual access is possible only from the east side of entry 149, and no identifying signage is present. Both ANSI and MBFD call for an appropriate number and proper identification of public telephones. Incorporation of auditory enhancement features would comply with ANSI and MBFD requirements and make the telephones usable for those with auditory impairments. This would seem especially important since the aural rehabilitation laboratory is located in this facility and attracts the hearing impaired. Study participants requested additional public and campus telephones be installed and identified.

Building Familiarity

Although the utilization of the three wayfinding strategies was greater for Hc and FTU, these were not significantly different statistically. CAS data is in agreement with Weisman [3], Zimring and Templer [7], and Gärling and Lindberg [11] who found no significant relationships between building familiarity alone and wayfinding behavior and Beaumont et al. [6] who found no evidence for group differences in wayfinding problems, whether Hc or N-Hc, FTU, or FAM. Data in this study differ from that of Appleyard [8] and Evans et al. [9], who believe that orientation problems in interiors is most applicable to new or low-frequency users.

Building Complexity

The CAS building is a complex structure which on the first floor roughly follows the figure 8 configuration described by Weisman [3]. This configuration is considered to be neither easy nor difficult in finding one's way. Since the CAS building plan is a modified figure eight with the entire center closed off from public access and one-half of the south perimeter corridor restricted as well, the CAS plan follows most closely Weisman's plan 24. This type of configuration received low ratings in Weisman's study from the simplicity and legibility standpoints [3]. Since 97 percent of all scenario participants (Tables 6 and 12) became lost according to Evans' et al. [9] and Best's [5] definition of lostness, CAS configuration also rates a low score in this study. Since a segment of the first floor is missing from public view, it is difficult to relate first floor configuration to that of the other floors. Someone linking the exterior building shape to the interior layout may intuit some understanding prior to building use.

Building Directories and Signage

There is a building directory as shown in Figure 9, identical and consistent in appearance and content, for five of the six building entries, west entry 178 being the exception. There are no directories on floors other than first. Visual access is problematic in three entryways. The building directory shared by entries 143 and 145B is hidden from immediate view from both entries and is dimly lit. In the main entry, 163, a person is apt to find himself well into the space with the directory behind him before he starts looking for information. Figure 9 shows the symmetrical entryway with corridors leading both right and left, forcing an immediate route choice without adequate information. Since visual access to the wall facing the doors is direct and immediate, it seems logical that building information should be contained upon it, as evidenced by user activity.

The existing directories are legible through lettering choice and high contrast, though tactility features are absent. The structuring of the information is currently alphabetical as shown in Figure 9. Information pertaining to services and the number of floors is missing. It would seem appropriate to restructure this information alphabetically, floor by floor, and to indicate the receptionist's location and that of elevators and stairs. Reassurance signs following Passini's guidelines should be strategically placed at "choice" points such as elevator/stair landings [19]. Choice points were defined by Best [5] as those where a user seeks further information to make a wayfinding decision, or where a user often makes an incorrect decision. One does not have to remember where a corridor leads if its destination is indicated [3]. Figure 9 shows a user's idea for a reassurance sign on the second floor. Study of decision points through behavioral mapping indicate the following locations as appropriate choice points for improved directories and supplemental signage:

1. all entries (improve directories–add one to entry 178);
2. all elevator landings (add improved directories on floors 1, 2, and 3–add supplemental signage to all floors);
3. north and west first floor corridors (add supplemental signage);
4. stairwell landing at entry 149 (add supplemental signage);
5. east and west ends of the first floor cut-through corridor open to the public (add supplemental signage);
6. area outside the Applegate Reading Room 249 (add supplemental signage);
7. east and west corridors, third and fourth floors (add supplemental signage);
8. locked doors on first and second floors (add supplemental signage); and
9. public telephone on first floor (add required supplemental signage).

Room signage lettering was consistently in relief, making it readable by those sighted and visually impaired in accord with the ANSI standard. Existing lettering style, size, and color were consistent, enhancing signage readability. However, recessed classroom and restroom entries and room signs flush with the walls (Figures 7 and 8) cannot be read from a distance. If restroom, telephone, elevator, and important room locations could be identified with supplemental signage at the ends of corridors, finding one's way to these services and settings would be improved.

It is important to point out that all CAS building users do not need to know the whole building. Identifying first and second floor restricted areas as such (Figure 2), in a positive way, would alleviate feelings of alienation. This and restructuring the building directories to inform people of services and destinations is an economical procedure. Orienting them to public corridors and destinations through routing information, thus alleviating unnecessary feelings of panic or discomfort for all people, is highly desirable.

Gärling and Lindberg point out that visual access and a floor plan along with familiarity facilitate spatial orientation in a building [11]. Some study participants expressed a need for maps and "you are here" indicators. Passini recommends that orientation maps be located where decision making occurs and that they correspond to the real spatial arrangement of the facility with sufficient reference points [19]. It should be easily seen and read by Hc and N-Hc alike, with tactility features incorporated. The two appropriate choice points for display of such a map are the east elevator lobby at entry 143 and entryway 163 identified as the handicapper and main building entries, respectively, in Part I.

Limitations and Contributions of the CAS Study

Situation sampling, as discussed in Weisman [3], means that a range of similar settings are chosen for the study. In Weisman's case, this meant sampling ten university buildings. While all CAS beginnings, routings, and destination doorways discussed here had similar characteristics, the functions of the various destinations differed, as did their interior layouts. The discussion of these specific interiors has not been a part of this report. The fact that the destinations selected represent a geographical sample of the building has permitted a more comprehensive overview of building performance than would limiting these destinations to a single floor. Wayfinding was measured in different parts of the building as recommended by Gärling et al. [10], including the ability to return to the original building entry with a 90 percent success rate. This study is limited to one building, but it is a large structure in an institutional setting with qualities common to other educational facilities. In those terms the data would appear to be generalizable to other settings and users.

Combining the study of 1) wayfinding behavior in interiors and that of 2) user preference and opinion is not a common approach. People's knowledge of building interiors, the consequences of interior illegibility, and individual differences in perception and use are all areas needing further study. Evans asked [20], "Does greater knowledge of a place make a difference in self esteem, competence, or the likelihood that one will explore a setting?"

CONCLUSIONS

1. Although the building did not conform to all ANSI or MBFD requirements, it performed well in terms of accessibility for handicappers and non-handicappers alike based on opinion and behavior.
2. Relatively inexpensive alterations of current building directories and the addition of supplemental signage at a limited number of choice points would apparently alleviate most wayfinding difficulties and the feeling of lostness expressed by many of the participants.
3. In this study, the perceptions and behavior of handicappers and non-handicappers, first time users, occasional, and frequent users did not differ in regard to finding both easy and difficult destinations.
4. More attention to details such as auditory enhanced telephones and automatic closers on fire doors would have further improved building performance for impaired persons.

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