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ABSTRACT

WHY AND HOW ARCHITECTURE AND INTERIOR DESIGN CAN STIMULATE EXPLORATORY LOCOMOTION IS DISCUSSED IN TERMS OF RESEARCH AND TESTING INTO HUMAN RESPONSE. TWO KINDS OF LOCOMOTION ARE DEFINED, EXPLORATORY AND HABITUAL, WITH REGARD TO LOCOMOTION AND BEHAVIOR RESPONSES TO THE ARCHITECTURAL ENVIRONMENT. MEASURING RESPONSES WITH A HODOMETER IS OUTLINED WITH A CASE STUDY EXPERIMENT AND TESTING PROCEDURE. AN EVALUATION IS GIVEN WITH SUGGESTIONS FOR FURTHER RESEARCH. A REFERENCE LIST IS INCLUDED. (TG)

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HUMAN MOVEMENT AND PREFERENCE

ROBERT B. BECHTEL

It has often been stated by architects that no building can be experienced merely by looking at it from the outside. One must move into and around a building before it can be experienced as architecture and not a drawing or piece of sculpture. It was Erno Goldfinger (1941, 1942) who stated that architecture cannot be experienced without movement. Philip Thiel (1961) developed a sequence-experience notation for architectural space. His notation system depicted a blending of movement with the experiences of architecture. Each movement produced a new experience so that the pathway of a person through a building is an almost infinite series of experiences rather than just a perception of a single image.

Architects and psychologists both deal with three dimensional objects that are presented to people as stimuli. The architect is, perhaps, more concerned with the pleasurable experience he can elicit in the person but he, like the psychologist, is also concerned with how the person sees three dimensional objects and is able to move around them. The psychologist James J. Gibson (1958) introduced a theory that all perception is so dependent on movement, or locomotion (as it is called to distinguish it from movement of limbs) that space perception and perception of locomotion possibilities are synonymous. This is a radical statement. According to Gibson, perception of space is the same as saying an area has a walk-into-able quality. Any space that does not look like it could be walked into could have a confusing impression as far as space or distance judgment is concerned. The perception of that space can be changed by walking around in it. Some of Gibson's assertions are partially confirmed by the work of Richard Held at M.I.T. It seems then, that not only the experience of architecture, but the very perception of it is influenced by and dependent upon movement.

Two Kinds of Locomotion

It should be understood that we are discussing a special kind of movement: locomotion. Human locomotion commonly takes place by walking but it can also involve running, and it can even take place while a person is standing still if he moves his head. This is how Gibson defines movement: any motion of the body that causes movement in the field of vision.

But we further must distinguish two kinds of locomotion, and this distinction is a very important one for architects. The kind of locomotion that goes on when a person enters a building for the first time is very different from the locomotion of the worker who has been entering the same building for several years. The two kinds of locomotion are exploratory locomotion and habitual locomotion. Generally, exploratory locomotion predominates in public buildings such as museums and art galleries, while habitual locomotion is most common in private homes and office buildings. Naturally, every person experiences exploratory locomotion the first time he enters a building but he soon begins habitually locomoting if he goes into that building frequently. Table I lists differences between exploratory and habitual locomotion.

Table I

Differences Between Exploratory and Habitual Locomotion

Importance of	Exploratory Locomotion	Habitual Locomotion
1. Architecture	prominent, new and strange	in background, hardly noticed
2. Behavior	looks for directions, explores, hesitates	moves without awareness unless interrupted, does not hesitate
3. Feeling mode	wanting to experience, open and receptive	thinking of goal at end of movement, unreceptive
4. Purpose	moving to experience new things, investigating	moving from one place to another

One can easily see why architecture plays a stimulating and major role in exploratory locomotion, while playing only a guiding or restrictive minor role in habitual locomotion. In exploratory locomotion people are giving ardent attention to the environment, while in habitual locomotion they are giving the least attention possible. For this reason, if one was to study locomotion as a response to architecture, exploratory locomotion would be more fruitful than habitual locomotion.

The Place of Locomotion in General Behavior

But before going further into the usefulness of exploratory locomotion in architectural research, two statements about movement must be made as caveats. First, of the two kinds of locomotion, exploratory and habitual, undoubtedly habitual occurs more frequently. This is true not only because the number of buildings where habitual locomotion occurs, homes, offices, factories far outnumber museums and art galleries, but also because the majority of human behavior is itself habitual in nature, not involving much novelty on a day-to-day basis. The opportunities for exploratory locomotion are limited.

Second, if the two types of locomotion together are compared to the rest of the range of human response to architecture, they come out a poor second. Most of the behavior in the architectural environment does not involve locomotion, but such things as sitting, talking, sleeping, etc. Thus, in order to have a proper perspective when considering exploratory locomotion as a response to architecture, one must understand that all locomotion involves only a minority of the behavior in an architectural environment, and that of the two types of locomotion, exploratory is the least experienced in the course of day-to-day events.

The reason for studying exploratory locomotion is that, despite its minor occurrence behaviorally, it is a human response where affects of architectural stimuli could be tested with greatest promise of results.

Unobtrusive Measurement

One objection that could be raised to the use of exploratory locomotion in architectural research is that better results could be obtained by <u>asking</u> people how they respond to architecture or by observing responses. Indeed, how else could exploratory locomotion itself be recorded unless by observation?

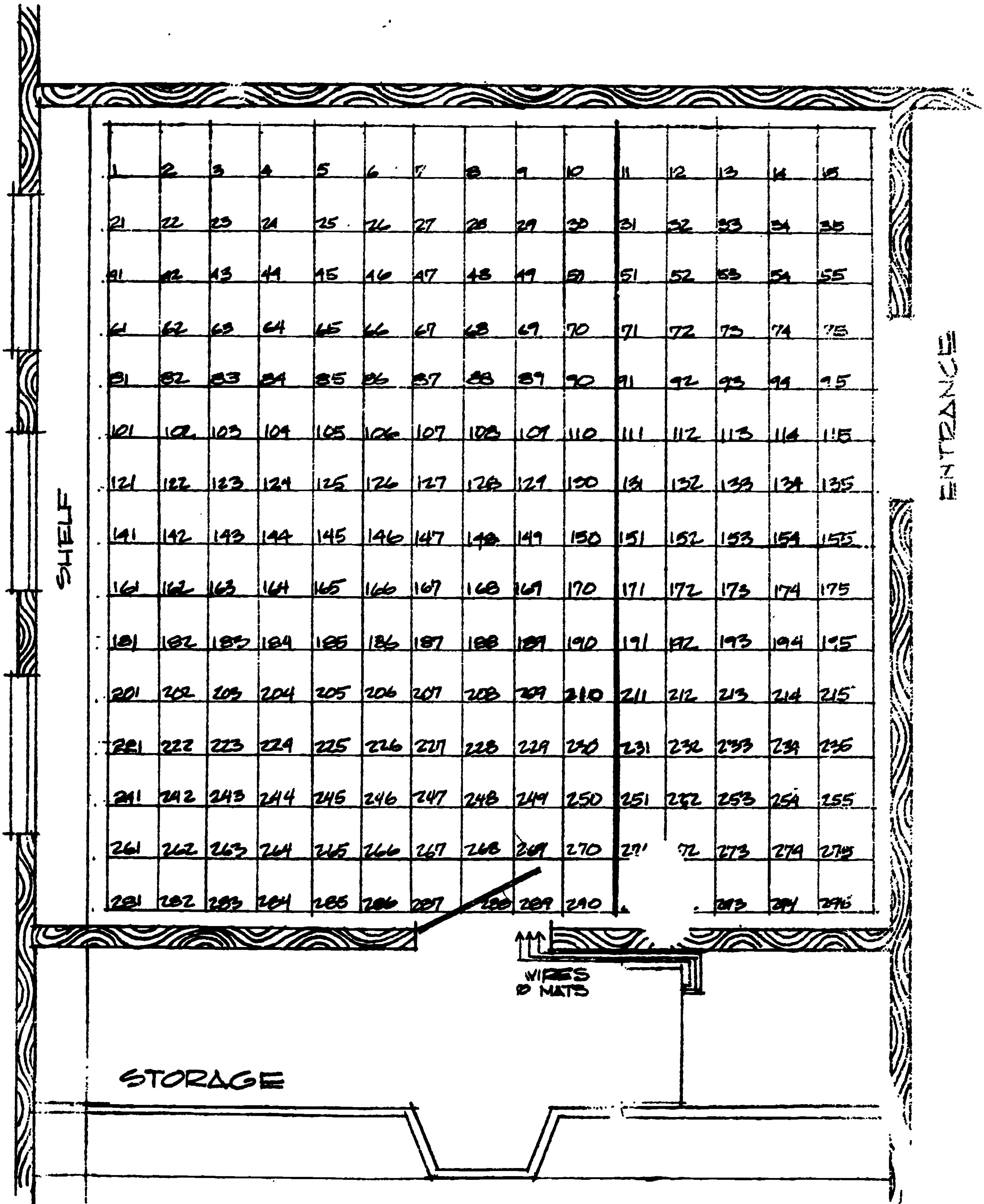
While it is true that many interesting and useful kinds of information can be obtained by asking a person, by interviews, questionnaires, and other kinds of measurement, the last question and perhaps the most important one of all is how the person responds to the architecture naturally without awareness of being observed, or the interference of being measured. All scientists agree that measurement of any kind influences what is being measured. Nowhere is this more true than in the area of human behavior. The psychologist Robert Rosenthal (1963) has made a career of demonstrating how experimenters influence subjects unintentionally to give erroneous results. The case for the use of measurement that does not interfere with natural behavior is made in a recent book Unobtrusive Measures: Non-reactive Research in the Social Sciences by Eugene J. Webb, Donald Campbell, Richard D. Schwartz and Lee Sechrest (196[illegible]). No further comment will be made except to say that the closer one can get to making inferences from human behavior without interfering with that behavior the more confidence he can have of the results. The relevance of this point to the use of exploratory locomotion is that a way has been found to measure it without the awareness of persons being measured. The device for measuring exploratory locomotion unobtrusively is the hodometer.

The Hodometer

The hodometer is an electrical system for automatically recording number and location of footsteps across a floor space. This device was constructed by The Environmental Research Foundation and installed in a room at the Art Museum of The University of Kansas. The name hodometer comes from the Greek hodos meaning pathways. The hodometer is a cluster of electric switch mats covering an entire floor space with each mat connected to an electric counter (Slide 1). Slide one shows the laying of the first mat starting from the center of the room. The mats are laid from the center toward the sides leaving a space to gather wires at the edge of the room. No fastenings to the floor are necessary. Each mat has two metal plates separated at the sides and center by a resilient material. The entire mat is encased in plasticene. When the plates come together under 4 lbs. per sq. in. pressure, an electrical contact is made. The floor space is covered by the mats as shown in Slide 2 (Slide 2). Each mat has a 60 ft. lead of wire ending in a plug. Each mat and each plug are numbered. There were 225 mats used but the capacity is 300. The wires were gathered, taped down to adjoining mats and led to the edge of the room where they were bound in flat bundles (Slide 3). At this point the cabinet housing the counters was brought in. Slide4 (Slide 4) shows the outside of the cabinet. On each door of the cabinet there are 150 counters. The clock on the face of the cabinet keeps a record of amount of time spent in the room. The clock starts when someone steps on the first mat and stops when everyone leaves the room. Inside the cabinet are the sockets in the back into which the wires from the mats are plugged. All mats and counters were tested, then (Slide 5) the carpet is laid over the mats leaving no trace of any wires or mats. Slide 6 (Slide 6) shows the bundle of wires coming from under the rug. The cabinet is placed in a storage area adjoining the room. Wires are plugged into the sockets in the back of the cabinet (Slide 7).

The Experiments

Seven prints were hung in the room at the museum of art. As far as anyone but the museum staff and the experimenter knew, this was an ordinary exhibit of recent acquisitions. (Fig. 1) (Slide 8) shows how movement data was recorded. At the end of a visit to the room or at the end of a museum day, the totals from each of the counters were placed in the corresponding spaces on the diagram of the room. The sheets of totals could then be added together by days, number of visitors or in any combination we wanted.



SCALE 3/8" = 1'-0"

FLOOR PLAN OF MUSEUM DISPLAY ROOM
(SHOWING 12" X 12" MAT LAYOUT ON FLOOR)

The first investigation was to determine whether people stood more in front of the prints they liked or more in front of those they disliked. First, a movement pattern of 1200 museum visitors was recorded. Using this pattern as a basis, the preferences of persons for each of the prints was predicted in a rank order. In other words, since there were more footsteps recorded in front of the JFK print than any other, it was ranked first, and so on until the one ranked seventh. Then 161 subjects were sent through the room and asked to write down their preferences. The average preferences of these subjects for the prints corresponded to what was predicted by the movement patterns by a correlation of .93. Chances of this being an error were less than one in a hundred.

This process was repeated for an architecture exhibit. The names of the architects will not be repeated to save some possible embarrassment. Three walls of the room contained exhibits of drawings and photographs from the work of each architect. Movement patterns were recorded for 1085 visitors and a prediction of the order of preference for each architect's exhibit was made. 58 architecture students who had seen the exhibit then gave their preferences for each of the exhibit. The prediction from the movement pattern corresponded 100% with the preferences of the students.

The second study was really not separate from the first except that it involved different ways of looking at the movement data. (Table II) (Slide 9) shows six conditions under which subjects were sent into the room. These were the same subjects who recorded their preferences for the prints. Please note in Table II on the left hand side that there are five ways of looking at the data. <u>Area</u> is the number of square feet the person used as he moved

TABLE II

Mean Responses for Museum Visitors And Experimental Subjects

	Group I N=40	Group II N=41	Group III N=40	Group IV N=40	Group V N=40	Group VI N=40
Instructions	Asked to rank prints without awareness of observance.	Asked to wait in room with no further instructions. Without awareness of observance.	Natural visitors to museum without awareness of observance. Did not rank prints.	Asked to rank prints. Told they were recorded and watched.	Asked to rank prints. No awareness of observance. Order of prints changed.	Asked to rank prints. No awareness of observance. Content of 2 prints changed.
Measures: Area (no. of spaces)	M = 76.100	M = 74 146	** M = 34.950	** M = 58.255	M = 78.500	M = 76.750
Elevation** (no. of movements)	* M = 158-275	* M = 160.756	** M = 47.675	** M = 110.850	M = 166.150	M = 179.350
Times* (no. of seconds)	M = 313.700	300 sec. for all subjects	** M = 71.150	** M = 220.475	M = 327.900	M = 343.975
Pace (elevation/time)	M = 2.080	M = 2.116	M = 1.460**	M = 2.152	M = 1.973	M = 2.096
Standard deviations for each subject**	M = 1.368	M = 1.535	** M = .542	** M = 1.116	M = 1.485	M = 1.552
*only measure that showed no sex difference. All other measures showed sex differences at P<.01	*Differs from V and VI P <.01	*Differs from VI P <.01	**Different from all other means P <.01	**Different from all other means P <.01		
** Interactions between sex and groups P < .01						

Note: Analysis of variance was used to test main effects and interactions between groups and sex. Newman-Keuls method was used to test differences between individual groups.

about the room. Since each mat is one square foot, a measure of area is simply the number of mats stepped on regardless of the number of times it was stepped on. Elevation is the total number of footsteps recorded during the time a person was in the room. Time is the number of seconds a person spent in the room. Pace is elevation divided by time or the number of footsteps per second. Standard Deviation is a matter of how evenly the person distributes his footsteps among the mats. A good way to imagine this is to consider two possible extreme patterns, one where a person steps on only one mat 100 times, and the other where a person steps on 100 mats one time each. In the first case the standard deviation is 6.7 and in the second case it is .5. The smaller the standard deviation, the more evenly are footsteps distributed among the mats.

At the top of Table II are the different instructions given to each of the six groups of subjects. Group I was asked to rank the prints in the room. Group II first was asked to wait and then was asked to rank the prints five minutes later. Group III were natural unaccompanied visitors to the room. They had no idea an experiment was going on. Group IV were asked to rank the prints and were told that they were being watched through a convex mirror and recorded by an electric device. Group V saw a new arrangement of pictures, and Group VI saw two new pictures substituted for two older ones.

Notice particularly the Figures for Groups III and IV. The double asterisks indicate that every measure in Group III was different from all other groups. This means that being in the experiment made subjects behave radically different from natural visitors. The differences in Group IV indicate that knowledge of being watched and measured made persons behave differently. The chief difference seems to be that it inhibits the level of their responses. The evidence from these two groups alone indicates that being in an experiment and knowledge of being observed has very noticeable effects on movement patterns. So, researchers beware if you intend to observe people without concealing your own observation.

There are many other interesting findings in Table II. For example, males and females differed significantly on all measures except time. (End of slides.) But to dwell any longer on these results would detract from the main purpose of introducing the hodometer as a device for use in architectural research. The fact that it can predict what people like from how long they stand in front of it, and the fact that this can be measured without any interference in natural behavior is sufficient.

Future Research with the Hodometer

...ier part of this paper, a distinction was made between exploratory and habitual locomotion. Now that it has been demonstrated that the hodometer can measure exploratory locomotion in a museum and obtain useful results, the study of habitual locomotion promises an even wider field. Just as it would be useful for a museum architect or director to know about preferences for kinds of exhibits, and movement patterns around them, so it would also be useful to know how architecture influences habitual movement. Is it true that the architecture only helps to set the habitual pattern or are there more subtle influences over time? Can one tell whether architecture produces movement patterns that show strain, or relaxed qualities? The questions to be investigated are endless.

In addition to further investigations in exploratory locomotion and the study of habitual locomotion, there are four areas of possible research of interest to architects.

The first is social distance. The work of Edward T. Hall, (1966), the anthropologist, points to the fact that social distance can be measured in inches. People from different cultures use varying distances to converse with one another. Latin Americans stand uncomfortably close for North Americans. A hodometer with smaller switch mats could easily measure these social distances under natural conditions and among groups as well as between two persons. A group with larger social distances would have a less dense movement pattern than one with smaller social distances. Further, the empirical relationship between social distance and space could be worked out. This is the kind of information architects need for building in different cultures and ethnic groups and for considering the appropriate spaces necessary for social activities.

The second area of needed research is color. Some color experts maintain that warm colors tend to increase the level of activity while cool colors depress activity. The hodometer is a useful instrument in testing for these differences without the awareness of the subject. It has been found that even when a person appears to be standing still he will make slight shifts in weight which are picked up by the sensitive (4 lbs. per sq. in.) mats. Thus an empirical test of this hypothesis in a museum or art gallery is immediately possible.

The third area of research is in the use of space. Do windows really increase the amount of useable space or does it just look that way? Does a light room really appear larger than a dark room of the same size? These are questions of immediate practical importance to the architect and they can now be easily tested by a combination of hodometer records with visual estimates of subjects.

At the present time, Rajendra Srivastava and Thomas Peel of The Environmental Research Foundation have completed a study of space use in a museum room that tested changes from a light to a dark color. Results are not yet available but hodometer records were used with subjects' estimates of room size.

The fourth area of research is that of personality variables. This is a field of special interest to the architect who builds for the individual person. It has been shown that persons who have a low tolerance for ambiguity in ideas do not like complexity as much as those with high tolerance of ambiguity. Since tolerance of ambiguity is a personality variable that can be independently measured by psychological tests, it would be interesting to determine if such persons would respond similarly to ambiguity in architectural design. Since it has already been shown that the hodometer measures preferences for art objects, it would be equally feasible to measure preferences of persons who differ in personality characteristics. The possibilities of combining personality measures and architectural variables are almost limitless. They open up a new dimension for the creative architect. Will the day come when the architect will give personality tests to his client to help in the selection of spaces and colors?

Conclusion

The hodometer is not a device that will immediately tell the architect all he wants to know about building museums, art galleries, or public buildings.

It has shown itself to be a useful tool, among many kinds of tools needed in a long program of careful scientific research. In areas dealing with social distances, color, space and personality variables as well as exploratory and habitual locomotion, the hodometer may prove extremely practical in the information it can provide. The kinds of research proposed will help the architect to plan his buildings around human needs and behavior, and it will help the psychologist to understand more about the behavioral response to architecture.

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