TYPES OF USER BUILDING EVALUATION(1)

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Abstract

The aim of this paper is to outline an approach to user building evaluation which is grounded in the notion of diversity of user needs rather than a mythical average user. It is suggested that user evaluations may be sorted into types via cluster analysis, and that the members of these different types of evaluation profiles may seize on different features of a building in making their evaluation. Several implications for building design and user evaluation generally emerge from this approach.

Problem

Planning for diversity is much like the weather - everybody talks about it but it is hard to do much about it. Flexible environments which can meet a variety of user needs are as often an ideal as a reality, and depend more on the designer's intuition and imagination than on objective planning strategy. The result tends to be the creation of "average" (or inappropriate) buildings which cater to the needs and interests of a mythical "average" user - the average office worker, the average apartment dweller.

The aim of this paper is to outline a formal approach to user building satisfaction and evaluation; one which is grounded in the notion of diversity or types of users. Rather than treating the totality of users of a building as a group, it is suggested here that it is conceptually possible, indeed preferable, to sort user needs into different types via cluster analysis. Using data from a user evaluation of a university student residence it will be shown that different types seize on different features of a building in making their evaluation.

The results of this approach have serious implications for building design and user evaluation generally.

Case Study

Setting. To illustrate this approach let us turn to an examination of a student evaluation of the Brock University student residence.(2) Brock University is situated in St. Catharines, Ontario, a city of some 110,000 persons. The university has about 2,200 full-time students and the residence houses about 400 of them. The residence is arranged so that eight rooms (four singles, four doubles) form a "floor", sharing lounges, a washroom and a kitchenette. Access to these floors is by a stairwell. Four "floors" stacked one on top of the other constitute a "house". The residence is composed of two groups of five houses, plus supporting dining, administrative, recreational and circulation spaces.

A sample of forty students was drawn and data were collected on attitudes toward eleven varieties of persons and places judged important in a resident's life - attitudes to room, floor, house, residence, university, city, people on floor, people in house, people in residence, people in university and people in city. These attitudinal data were collected on a six point scale which was later collapsed to yield two categories, 1 being average or unfavourable and 2 being favourable.

Method. In numerical taxonomy at least three conceptual problems typically are involved - selection of a domain of characteristics on which objects (residence students here) are to be typed, selection of a suitable index of relatedness and selection of an appropriate algorithm creating groups of homogeneous membership. The domain was outlined above.(3) Because of the possibility of two-state binary characters, Sokal and Michener's similarity coefficient (number of matches divided by number of matches plus number of mismatches) was used.(4) Finally, a hierarchical clustering algorithm was selected.(5)

Results. Figure 1 displays the dendrogram showing how samples - residence students in this case - are merged into successively larger groups until the tenth cycle when all are merged into one group. The sample numbers are the identification numbers assigned to the students and were arbitrarily selected.

Figure 1 also displays the dendrogram in a form showing significant characteristics of a type at a given cycle. "Significant" characteristics means those eleven attitudinal preferences significant at the .05 level or less, using a one sample two-tailed binominal test sequentially on each attitude. For each type a row of numbers is presented from 1 to 11. These numbers stand, respectively, for attitudes to city, people on the floor, people in the house, people in residence, people in the university, people in the city, room, floor, house, residence, university. If the attitude is significantly distributed at the .05 level (two-tailed test) or less, it has a circle around it. If there is a significantly large number of 1's (unfavourable attitude) the character number is circled with an X inside the circle. If there is a significantly large number of 2's (favourable attitude) there is no X. If the character is not significantly distributed it is not circled. Thus in cycle 9 the profile 1 2 3 4 5 6 7 8 9 10 11 indicate that members of this type have the following statistically significant attitudes: unfavourable to city, unfavourable to people in the house, unfavourable to people in the residence, unfavourable to people in the city, unfavourable to the house, and favourable to the university.

Now let us turn to the selection of types. At cycle 9 there are two types - likers and dislikers. Six people like people on the floor, people in the university, their room and the floor. Thirty-four people dislike the city, people in the house, people in the residence, people in the city and the house, but like the university. At cycle 8 this latter group separates into two types. One group of eight students dislikes the people in the house but likes people in the city. The other group dislikes the city, people in the house, people in the residence, people in the city and the house, but likes the university.

Conceptually, there is good reason to accept three types of attitude preferences one group of "likers" and two groups of dislikers - "mild dislikers" and "strong dislikers." The first group of likers (six people) like many places and people, as with people on the floor, people in the university, their room and the floor. The second group of dislikers (eight people) seem oriented toward the city, disliking people in the house and liking people in the city. The third group of strong dislikers (26 people) dislike many people and places - the city, people in the house, people in the residence, people in the city and the house. However, it is interesting to note that they like the university. At cycle seven these 26 people break down into two groups of five and 21 members. The group of five people cannot be tested at the .05 level because the numbers are not sufficient for a two-tailed binomial test. Perfect agreement among the five people yields a .062 probability. If for the moment we accept this level for the purposes of comparing the 21 and five members of the strong dislikers, the major difference is that the first likes the people on the floor while the second dislikes the people on the floor but likes the floor itself. Findings reported elsewhere(6) indicate that it is the floor which is the meaningful social unit in the residence. This evidence makes it doubtful whether a floor - people on the floor distinction is meaningful since both involve commitment to the floor. In addition, the small numbers of members in types make finer interpretations somewhat unrealistic.(7)

Discussion

Typal Approach to User Building Satisfaction. Through the application of a hierarchical taxonomic algorithm it has been demonstrated that different patterns of attitudinal preferences to people and places exist among students in the Brock University residence. In particular, three conceptually different patterns were suggested - persons tending to like things generally, persons tending to dislike the people in the house but who like the people in the city, and people disliking many things but who like the university and who seem to have a commitment to the floor.

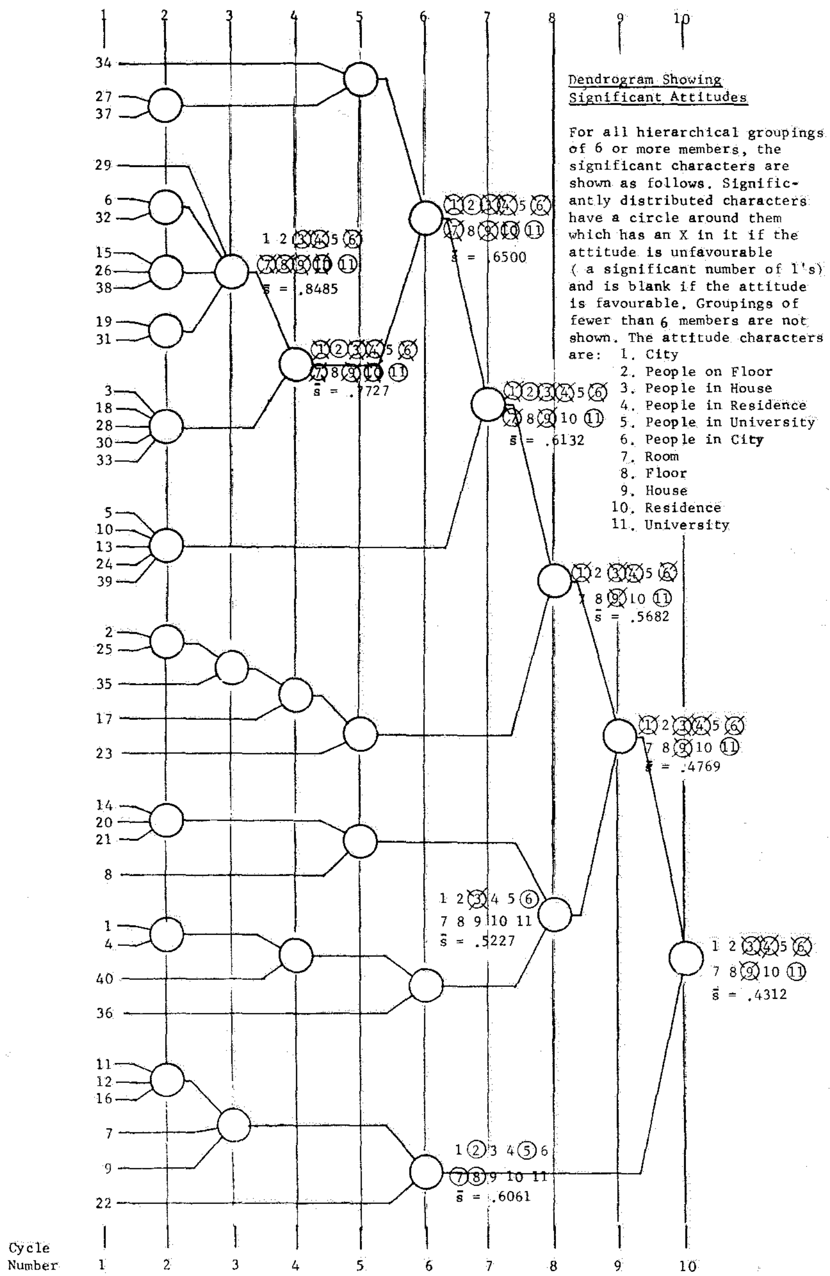
Dendrogram Showing Significant Attitudes
For all hierarchical groupings of 6 or more members, the significant characters are shown as follows. Significantly distributed characters have a circle around them which has an X in it if the attitude is unfavourable (a significant number of 1's) and is blank if the attitude is favourable. Groupings of fewer than 6 members are not shown. The attitude characters are:
1. City
2. People on Floor
3. People in House
4. People in Residence
5. People in University
6. People in City
7. Room
8. Floor
9. House
10. Residence
11. University
s̄ = .8485
s̄ = .7727
s̄ = .6500
s̄ = .6132
s̄ = .5682
s̄ = .4769
s̄ = .5227
s̄ = .4312
s̄ = .6061
Cycle Number

Figure 1.

Because types of users exist who have discernibly different evaluation profiles it conceptually does not make sense to visualize a mythical "average" user. Different types exist and must be recognized as such.

The selection of the domain of items on which users are to be typed is all important in yielding useful results. In the residence study outlined above attitudes to people and places were used. Other studies might wish to consider only physical environmental preferences, depending on the problem at hand.

The weighting of items on which people are to be typed may be equally important.(8) In the university residence study all items were treated as being of equal importance to users. It may be useful to weight individual items according to the importance which users attach to them.

Weighting can also enter into the creation of rational as opposed to naturally occurring types.(9) The examples used so far have been naturally occurring types in that they are the outcome only of users' characteristics. Rational types may be created when the analyst wishes to add some criterion external to the subjects. While this might be done for theoretical reasons arising out of a theory of human nature (eg. basic environmental needs), operational reasons arising out of practical necessities are likely to occur more frequently. For example, suppose it is required to type people on office building preferences on the basis of preferred lighting patterns, geographic location and office size. If the purpose is to establish user preference types which can in fact be satisfied, it would only make good sense to weight geographic location as being several times more important in the creation of types than the other two items because one type with different geographic preferences could not practically be satisfied. It might even be preferable to demand that each type created have perfect internal agreement on this item.

If the domain and weighting of items on which types are to be created have been satisfactorily (from the analyst's perspective) selected, there is little reason to be concerned with items in a type for which there is disagreement (i.e. no significant distribution). Cluster analysis can be assumed to have minimized intra-type differences and to have maximized inter-type differences.

There are other questions which bear on the selection of types. Depending on the nature of the research problem, different theoretical or operational concerns may make some similarity indices and some clustering algorithms much more appropriate than others. However, a detailed discussion of these is beyond the scope of this paper.

In all the above areas alternative methodological procedures exist. In deciding which to use one must ask which are most useful in meeting the needs of the particular design or other operational problem at hand.

Social Determinants of Types. A typal approach to user building satisfaction may be visualized in causal terms to discover what it is that "causes" the different types.(10) Presumably a building cannot cause types of people.

Rather than visualizing aspects of the building itself as the determinants, it makes better sense here to look for social determinants - the characteristics of the users themselves.

Let us return to the case study of university residence evaluation types. In order to discover the influence of independent variables the three evaluation profile types mentioned above were related via a two-tailed binomial test to each of a set of socio-economic variables. The aim here was to discover independent variables capable of being viewed as possible "causes" of the types. A .05 significance level was used. The results are displayed in Table 1.(11) The strong dislikers are in first year, do not own cars, and are in Arts courses. The likers are males.

TABLE 1

		Course Type 1 = Arts, 2 = Science	Car Owner 1 = no, 2 = yes	Father's Occupation 1 = blue collar or deceased, 2 = white collar or professional	Sex 1 = male, 2 = female	Year 1 = 1st year, 2 = 2, 3 or 4	Age 1 = 20 or less, 2 = more than 20	Room Type 1 = double, 2 = single
Type	Strong Dislikers (n=26)	(21)	(23)	13	18	(19)	16	16
	Mild Dislikers (n=8)	5	7	2	4	3	5	3
	Likers (n=6)	5	4	3	(6)	3	2	5
	All Students (n=40)	(31)	(34)	18	(28)	25	23	24

The table shows frequencies of 1's.
Frequencies significant at the .05 level are circled (two-tailed test).

The variables associated with the strong dislikers seem to be reasonably consistent with the type. The type members are first year Arts students restricted to the residence by lack of easy transportation, who are enthusiastic about life on the floor and the university, but otherwise critical of their surroundings. The other types are less "reasonably explained" by the independent variables significantly related to them. The small numbers involved in these types may have masked relationships with year, age, sex, father's occupation, room type, <u>et cetera</u>. In particular, it is hypothesized that a larger sample size would show that the likers or mild dislikers were upper year students who had returned to the residence even though they had made friends in the university during the previous year or years.

Practical Implications. There are clear planning implications for building design and user evaluation generally which arise from the finding that 1) user evaluations may be sorted out into different types, and 2) the members of these different types may seize on different features of a building and life inside it in making their evaluation.

Diverse patterns of user evaluation will be the norm rather than the exception, and it cannot be hoped reasonably to satisfy everybody unless these variations are taken into account.

The approach to user evaluation outlined here will be especially applicable in cases where it is deemed useful to plan to accommodate sub-groups of a population of users. If it is possible to specify in advance with reasonable accuracy who the population of users of a building (a university residence, an office building) will be, the following planning algorithm might be adopted. 1) Establish via cluster analysis types of relevant user building needs from a sample of representative users (or the population if possible). 2) Design building environments based on the satisfaction of these user profile patterns. These can be used to create environments which closely match specific types of users, or to enhance the fit in more flexible design solutions, or both where appropriate. 3) Wherever feasible, make it possible for users to be located in environments consistent with their profile patterns. This might also be achieved on the basis of user scores on independent "causal" variables where these have been adequately specified and if, for whatever reason, it is not appropriate to use profile type scores.

A fourth step might be added to this algorithm. Once users are located in environments via the above procedures, it would be helpful to re-evaluate the fit between users and environments. This would serve the purpose of validating the environments created and, if done over time, would point to any changing user need patterns.

A typal approach to user building needs has several advantages. It can provide a fit between users and their environments which, on the basis of probability, has a good chance of proving satisfactory. It can be used either in the design of new buildings or in the redesign of existing building environments. In either of these cases, however, it must be recognized that "environment" includes not only physical structures but also norms and regulations governing user behaviour which may yield design solutions which do not utilize physical structures.

From Preference to Use. While the examples given in this paper have been ones of attitude or preference, there is no reason why the algorithm can not be extended to include use. Measures of use are concerned with what people actually do as opposed to stated preference. However, it cannot be said that types created out of use characteristics are better or worse than those of preference. The choice between the two should be made on the basis of which is conceptually most likely to yield results which meet the needs of the particular design problem at hand. In practice, types constructed out of both use and preference characteristics are likely to be relevant to a wide range of design problems.

Planning for diversity is a complex business. While the algorithm suggested above is not the only means of coping with the problem of diversity, and the study of cluster analysis as a statistical technique is only in its infancy,(11) the perspective outlined in this paper appears to be one which should not be ignored.

Notes

1. This paper is a shared collaborative one and the authors are therefore listed in alphabetical order.

2. The ideas and data presented in this paper emerged out of a larger study of the Brock University residence reported in Brock University Planning Department and Trevor Denton. An exploratory study of the Brock University residence. Volume 1. Social life in the residence. St. Catharines: Brock University Planning Department, 1972.

3. The domain here includes references to both places and people in the residence because both were felt to be important aspects of users' overall evaluation of the building. Other studies utilizing the evaluation approach outlined in this paper might find it preferable to use only parts of the building in question. The domain of characteristics is important and will be discussed again later in the paper.

4. Sokal, R.R., and Sneath, P.H.A., Principles of numerical taxonomy. San Francisco: Freeman, 1963, 133.

5. Here is the algorithm. It draws on the hierarchical algorithms of R.R. Sokal and P.H.A. Sneath (Principles of numerical taxonomy. San Francisco: Freeman, 1963), on the write-up for computer programme CSD 113 from the University of Guelph, and on the writers' own contribution. In Sokal and Sneath's terminology the algorithm is a "weighted" technique. Initially, a matrix of similarity coefficients is computed for all pairs of samples (persons). Samples are progressively linked into groups at successively lower and lower levels of similarity. The procedure is iterative, with new values of similarity being calculated between groups and ungrouped samples at each cycle. At every iteration those samples (or groups of samples) whose coefficients are highest in both row and column of the matrix are linked together. In this way several linkages can take place at a single iteration. At each cycle new values of similarity are calculated from the latest array of similarity co-efficients, not from the original array. Cluster cycles are continued until all samples and groups of samples have been linked together into a single large group.

As stated so far, in the case of ties in similarity coefficients, the order of pair formation would presumably depend on the order in which data were stored in the array. The algorithm was therefore altered to permit merging of reciprocal strings - i.e. sets of types in which each member reciprocates with at least one other member in the set.

Obviously, this is not the only algorithm which could be used. Many others are available but this one was chosen because it allows the analyst flexibility in the selection of final types.

6. Brock University Planning Department and Denton, Trevor. An exploratory study of the Brock University residence. Vol. 1. Social life in the residence. St. Catharines: Brock University Planning Department, 1972.

7. At this point it is appropriate to comment here on the selection of types in the dendrogram. It is possible to set out some criteria which can be optimized as a means of deciding on final types from among the many available in the dendrogram:

- internal consistency of types (designated by $\bar{s}$ in Figure 1)
- conceptual sense
- numbers of persons per type
- number of types

Generally speaking, the higher up the dendrogram the more members per type, the fewer the number of types and the less the internal consistency or homogeneity of type members. Conceptual sense should always be a criterion; here, it and number of members per type were the only ones used. Nevertheless, the number of optimizing principles used, and the relative importance given each, may vary as the context of the individual research project and the use to which it is to be put (infra).

8. For a discussion of different techniques of weighting items on which people or objects are to be typed, see R.R. Sokal and P.H.A. Sneath. Principles of numerical taxonomy. San Francisco: Freeman, 1963, Chapter Six.

9. The rational versus naturally occurring type distinction follows the terminology of R.C. Tryon and D.E. Bailey. Cluster Analysis. New York: McGraw-Hill, 1970.

10. This approach obviously differs from building evaluation studies such as Mary C. Avery, Gerald Davis and Ronald Roizen. Architectural determinants of student satisfaction in college residence halls. San Diego: TEAG - The Environmental Analysis Group, University of California, San Diego, 1970, which have attempted to create a model of user building satisfaction in which all users are treated as a single group.

11. Admittedly, the causal argument outlined here is tentative because the small numbers of subjects did not permit controlled multivariate causal modelling. The number of subjects was set at 40 because of considerations in-

volved in other aspects of the research project from which the data came. Nevertheless the variables cited here as "independent" are plausible ones and the analysis may be viewed as illustrative rather than definitive. Further work in this area should make more use of predictions based on theoretical formulations rather than simply the demographic variables used here.

Although three variables in Table 1 (sex, car ownership and course type) are significantly distributed for the entire 40 students, this is not seen as influencing the distributions of independent variables for the three types. From the perspective of this paper, the population is an artificial entity which is simply the summation of all type members.

12. Borgen, F.H., and Weiss, D.J. Cluster analysis and counseling research. Journal of Counseling Psychology, 1971, 18, 590.