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ESTABLISHING HABITABILITY FACTORS FOR THE DESIGN OF OFFICE ENVI--ETC(U)
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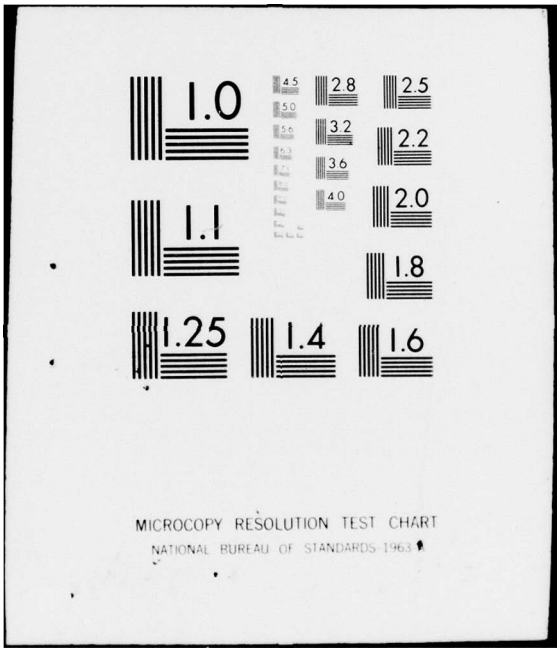
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(6) ESTABLISHING HABITABILITY FACTORS FOR THE DESIGN OF OFFICE ENVIRONMENTS

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Purpose

The purpose of this presentation is to document an overall methodology which incorporates experimental design considerations from the social sciences, specifically environmental psychology, and transfers that technology to planning and design application to improve habitability in office environments. The importance of this application is that the habitability factors which are involved in most office environments do not have a firm basis in basic research, and are not well documented in terms of guidance information for designers. This paper will present a discussion of a means of derivation for habitability factors in a particular context of office environments. However, the same methodology will be shown to be applicable to other types of environments, with the process being beneficial to the generation of new basic research, application of new concepts, and continuing accumulation of new knowledge in the area of habitability factors for any environment.

Background

There are four important considerations which point to the need for a methodology to develop habitability factors for environmental research, design, or application. These four considerations are:

1. For a period of time now there has been no sophisticated, well documented basic research from environmental psychology in the determination of habitability factors which affect individuals, either in their office work stations or any other kinds of living environments. Of course, there have been human factor studies, productivity studies, and general evaluations of management climate.(1) However,

consideration for the physical environment as it affects individual's attitudes, preferences, and feelings has not developed to the point where it can provide design decision guidance, or technology transfer of basic research.

2. This basic technology transfer, information, lacking in the research literature, is precisely the kind designers need to apply to physical environments. In view of the lack of this kind of information, most schools of design operate on an intuitive basis, predominated by the master studio student relationship. Any guidance received is based on intuition and experience and is not verified empirically through research data or documented in a way in which it can be used over and over again.

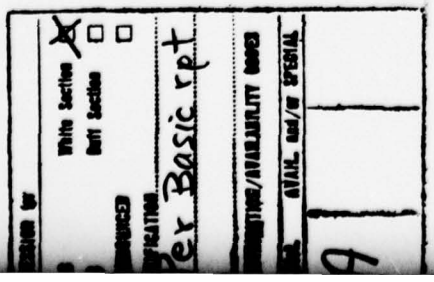
3. It follows logically from the first two considerations that there is a need to improve the overall research information quality used to design physical environments, in this case offices. However, because of the limitations of the first two items, it is impossible to document research knowledge which can accumulate and thereby provide a basis for using each design of a new office as a field test to gain new habitability information. Consequently, there is generally no improvement in the quality or depth of research information available to address the problem of habitability factors as they apply to specific environments.

4. The information from environmental psychology that presently exists in this context, is then mostly academic and does not seriously attempt to make effective technology transfer since it does not provide a means of determining either the return-on-investment payoffs or guidance in the allocation of funds based upon the determination of habitability factors.

Therefore, although there are certain factors such as privacy, professional image, room occupancy, etc. which appear in the general literature on habitability,(2) there is little consideration of a means of transferring this information to application in the field and, thereby, providing a means of technology transfer and return-on-investment. Furthermore, the existing research literature suffers from serious methodological deficits in terms of its application to field situations.

Previous Research and Its Limitations

General and intuitive descriptions of office work environments exist in the commercial literature. However, there are also some recent studies from environmental psychology which suggest that the office environment is a viable area for empirical research and investigation. These studies can be divided into two general groups: those which provide methodologically tight organization of variables



and assume some scientific generalizability, and those which take behavioral and psychological information and translate it into programming recommendations for design planning. Examples of the former are comparisons of open and closed plan offices by Brooks and Kaplan (3) and Nemecek and Grandjean. (4) Results of these investigations suggest major important habitability variables in office settings. Examples of studies which translate user need research into design and planning recommendations are those described by Deasey, (5) Moleski, (6) and Davis. (7) However, in order to explore some of the more relevant habitability relationships suggested in the earlier discussion, we need to identify specific major environmental issues which may have an impact upon employee performance or productivity. Suggestions for the purposes of examining previous research are professional image, privacy, room occupancy, office partition type, windows and views, and color.

Professional image is both an organizational and a personal variable. If an office work station looks professional, well kept, and neat, some qualitative things about the pride of the employee are suggested. This form of a sense of identity is discussed by Steele (8) as a reflection of what the organization "is." In another discussion of identity, pride, and self-image, Braum (9) suggests that self-image and individual worth may be related to the physical environment and productivity. In general, the image of the environment and its relationship to the person's self-image is not a well-researched area.

Privacy in offices is a very topical issue as many large organizations shift to open-landscaped planning arrangements. Altman (10) suggests that privacy is selective control of access to one's self from the group. In offices, changes in privacy can occur easily since by varying the partition types, one has a great deal of control over access to other persons. Johnson (4) suggests that control over privacy behavior is a means of reducing some forms of stress and also a way of governing a path towards one's work objectives. Implications for office environments are obvious, but the specific question is how is one to manipulate all of the interacting variables in the physical and social environment to achieve this? This is, in particular, where the programming efforts of the designer supplement the statistics of the psychologist.

Room occupancy and partition use in office design is related to concepts of population density and personal territory, both perhaps related to privacy. Density, with research into its effect upon behavior, has been discussed by Calhoun, (12) Sommer, (13) and Rappoport. (14) It is worth noting that this subject is still under considerable controversy. Some researchers would suggest an optimum

density in an office space is a concept relating to the nature of the work which generates some level of noise which is transmitted over some physical distance determinant of density. Partition type, that is, the mode of division of office work spaces, is a little researched area. In a study by Dinnat and Gibbs, (15) comparisons were made between open-plan, bank-screen, and landscaped partition types. Also, human factors studies by Probst (16) in the development of an office product line have provided much useful data about behavior-work station interaction and have been used in designing work station components, such as partitions. Layout of partition type is an ambiguous area of research. In studies comparing office arrangements, Wells (17) noted small office arrangements were more conducive to small group identity and open plans were more conducive to interpersonal contact. Brookes and Kaplan (18) noted that landscaped offices did not function as well as conventional offices, but were aesthetically more pleasing. However, Zeitlin (19) notes that landscaped offices tend to reduce privacy. Partition type then is a determinant of the mode of layout, and in turn can influence attitudes toward habitability factors in the whole office.

Windows and views and color are important to all workers. How important is, however, an unclear area in the research literature. In a summary of research dealing with psychological reaction to environments with and without windows done by National Bureau of Standards, (20) the results were inconclusive. That is, there seemed to be general disagreement on the importance of windows to employee performance throughout most studies. Color in offices and work areas is another important issue in office planning, but still subject to much intuitive decision making. In most office studies, the question of color preference is asked of the employees, but documentation of effects of color is hard to find. A study by Goodfellow and Smith (21) even suggests that color of rooms has no effect upon psychomotor task accomplishment at all.

In summary then, much of the research in this realm of habitability factors and office design is somewhat formative, inconclusive, and exploratory. That is, the relationships between physical parameters and social effects are not clearly defined so that the empirical inspection of relationships can occur for planning purposes. Furthermore, there are serious limitations relating to the generalizability of information which hinder the application of previous studies to the development of well-based habitability factors. These limitations are as follows:

1. Most of the academic studies are one-shot affairs and do not use a standardized questionnaire over and over again in various field tests. Therefore, although the questionnaire may be pretested for

local population, its generalizability is limited. Consequently, the comparison between different field environments in most of the previous literature cannot occur, and generalizability is limited or not possible at all. (22)

2. There is a differentiation of experimental methods in all of the research literature on habitability parameters. There are almost no studies which are replications; and, generally, the literature does not contain enough information on methodology to allow a valid replication. Therefore, generalizability, without experimental bias due to different field methods, is impossible. Since the methodologies and generally the questionnaire instruments are not comparable, there has been no effort to compare data across field studies to verify a general basis for habitability parameters. (23)

3. Therefore, the environmental psychology research literature presently in existence appears fragmented, has many different factors involved, and does not provide a consistent basis for overall generalizability to habitability factors. This situation inhibits the development of guidance and the achievement of technology transfer.

4. Finally, there is little emphasis on the allocation of funds in a rational, acceptable way to determine returns on design investments related to habitability factors. Since this data does not exist, most of the dollar allocations in any new building or renovation of an office tend to still be done intuitively, and consequently there is no possibility of doing an estimate of a return-on-investment.

In summary then, there is the lack of a consistent experimental method which will provide a long-term basis for deriving generalizable habitability factors. In view of these deficits in the research literature, a process has been developed and documented herein to rectify this situation. This process enables both the designer and the researcher to work together to build a cumulative process of deriving habitability factors from various office settings, each one regarded as an individual field study contributing to both theory building and technology transfer.

Field Studies to Create a Data Base

The purpose of conducting field studies is to provide an experimental basis for determining habitability factors. In administrative facilities such as offices, data from users can be used to establish factors of habitability, such as privacy, space, view, noise, or image. Evaluation of these environmental factors can then be applied to interior design solutions in order to improve the habitability for all office occupants. The methodology of this type of field research is to: 1) analyze results from a before- and after-renovation study, and 2) generate design criteria for layout and workstations of offices.

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The approach to determining habitability factors for office occupants consists of the design of a before-after experiment in which certain parameters of the environment (such as floor space, distance to next person, and degree of enclosure of the work-station) can be measured. For example, an existing office building of 130 persons participated over a one year period in an evaluation. The initial comprehensive survey of occupant attitudes and behaviors indicated certain environmental conditions related to the habitability for the office occupants. New office layouts and workstation arrangements were designed and installed. The workstation components were designed in such a way that a within-groups experimental design for some parameters (high vs. low partitions, floor area variations, etc.) was possible.

After an occupancy period of six months in the new office environment, the users were again surveyed. Data analysis consisted of before-after comparisons, satisfaction with privacy, space, image, noise, etc. and with individual aspects of the workstation such as floor area, storage, work surface, etc. Factors of habitability (such as workstation image, privacy, and furniture satisfaction) were further analyzed with regressions to indicate shifts in user's cognitive awareness of the environment in the before and after office conditions.

The data from this office study is then incorporated into a data base using Statistical Package for Social Sciences programs (SPSS) (24). Other office contexts can then be added to this original study in the data base to provide a basis for comparison. These various contexts have included the Army Research Office, the Construction Engineering Research Laboratory, the National Aviation Facilities Experimental Center, Foreign Science and Technology Building, etc. for a total of over 700 individual subjects.

To provide for a basis for generalizability in a habitability data base for offices, there must be three common elements across all office research contexts. They are as follows:

1. Most of the office environments in the before condition are similar in character, arrangement, floor area, lighting levels, etc. Since most of these office environments are from Government technical installations, the overall organizational character of the sponsoring organization is somewhat the same also.

2. A second commonality amongst the environments studied is the demographics of the subjects. Most individuals in these offices were of three groups: (1) managers, (2) research/technical-oriented investigators, or (3) support personnel such as secretaries, etc.

3. The same commonality across groups exists in terms of their tasks; that is, subjects are either involved in research generation and investigation, support of that research endeavor, or management of that research or technical endeavor.

Therefore, it is reasonable to assume that there is some degree of comparability across the office environments in the data base. The demographics, the tasks, the environments, and the settings are similar. The experimental prerequisites are sufficient for the creation of a comparative data base. In summary, then, the information from the before and after evaluations of the field studies are structured into an SPSS data base, and the data base used to investigate habitability factors, such as privacy, within the office context being evaluated, and comparatively over other office contexts. A simple matrix representation of the data base is shown in Fig. 1.

Methodology for Empirical Habitability Factors

By careful statistical manipulation of the data base, the experimenter can isolate the individual effects of separate, independent variables operating simultaneously on a single dependent variable. By doing this comparatively across a number of individual settings, the researcher can develop a basis for theory building to establish habitability factors in offices. A major goal of theory building is to make use of the deductive types of arguments which can go beyond common sense but still can be empirically verified. Therefore, it is necessary for the experimenter to be cognizant of the limitations of his experimental design and still be perceptive of inferences which may be made by comparing individual designs. In most experimental designs referenced in this paper, Campbell and Stanley's definition of the pre-test/post-test control group design is most applicable. (25) In some instances, in determining the effect of complex research variables on one another, a Solomon four-group design is used. In conditions where it was impossible to do a post-test, a pre-test or static group comparison was used.

In order to generate habitability information in the form of non-generalizable guidance, standard statistical analyses are used, which would result in a statement of guidance as shown in Fig. 2. This could be used for the particular office design, but would not have generalizable validity until comparatively checked with other office evaluation results in the data base. To make the information more generalizable, the researcher determines a habitability factor and develops statistical comparisons as shown in Fig. 3.

By constructing a data base of this nature dealing with over 1200 (before and after conditions) individual subjects at five different office sites with similar demographics, environments, tasks, and

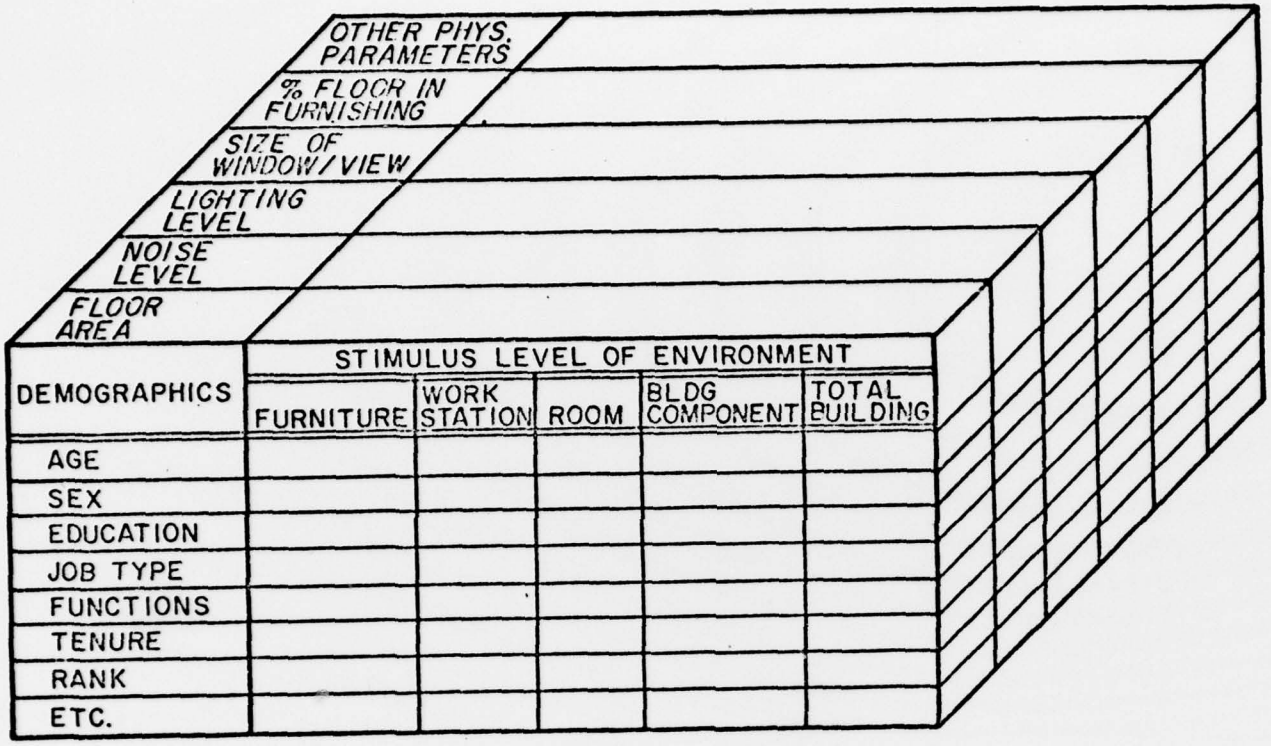


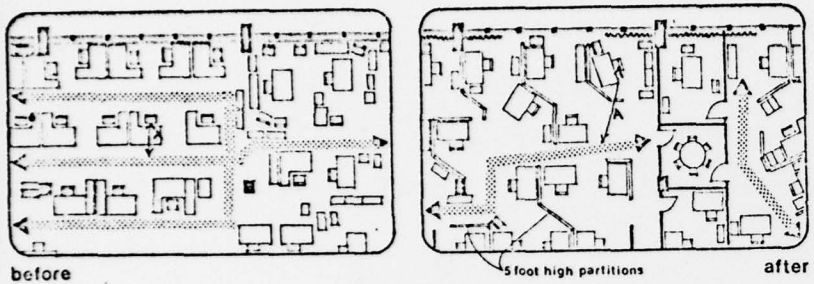
Fig. 1: Matrix Representation of Office Facility Data Base

This diagram shows generic data collected and structured for each office study. Data can be analyzed for individual offices or for all offices combined.

Problem Statement: Many distractions occur in open offices because of the passage of persons near a workstation. These distractions can be modified by the extent and location of circulation paths.

Requirements: Office workers have a requirement for privacy from circulation paths in open office areas.

Criteria: No specific criteria exist dealing with the relationships between circulation and lack of privacy (as distractions from noise and movement).



Research Commentary: In the before condition, the major circulation paths were directly through the open work areas of exposed workstations. This was changed in the after condition so that most circulation was in the hallways anad the workstations were "enclosed" with 5-foot high partitions. The distance from a circulation path was used as a design variable, thus respondents were divided into four groups: (1) those three feet away from the circulation path, (2) those four to six feet, (3) seven to nine feet, and (4) ten or more feet as measured on the plans. Their responses to items dealing with (1) conversations as a disturbance, (2) people coming into their areas, (3) visual distractions, (4) control of privacy, and (5) perception of adequate privacy were analyzed.

The results presented in the tables below indicate "general" improvement across all variables in the after (partitioned) condition. However, the distance of 10+ feet away is consistently the category of major improvement. It would appear the 10 feet distance is a threshold where the visual and acoustical attenuation components (of the after condition) accomplish their design purpose.

Q. 88: Conversations in room disturb my ability to concentrate.

distance from circulation path	% agreeing		
	before renovation	after renovation	improvement
3 ft.	90	75	+15
4–6 ft.	57	83	−26
7–9 ft.	92	76	+16
10+ ft.	86	52	+34

Q. 90: People keep coming into my room and disturbing me.

distance from circulation path	% agreeing		
	before renovation	after renovation	improvement
3 ft.	91	62	+29
4–6 ft.	57	71	−14
7–9 ft.	69	46	+23
10+ ft	77	24	+53

Q. 92: I have a high degree of control over my privacy in my room.

distance from circulation path	% agreeing			
		before	after	improvement
3 ft.	%	0	13	+13
4–6 ft.	%	0	0	0
7–9 ft.	%	15	23	+8
10+ ft.	%	7	32	+25

Q. 93: I have many visual distractions in my office which are disturbing.

distance from circulation path	% agreeing			
		before	after	improvement
3 ft.	%	48	25	+23
4–6 ft.	%	43	28	+15
7–9 ft.	%	17	29	−12
10+ ft.	%	57	18	+39

Q. 21: The privacy I now have is adequate for my tasks.

distance from circulation path	% agreeing			
		before	after	improvement
3 ft.	%	10	31	+21
4–6 ft.	%	7	17	+10
7–9 ft.	%	23	35	+12
10+ ft.	%	7	45	+38

Guidance: It has always been good design practice to keep circulation paths away from work areas. In open office planning, this is a difficult since almost any path between two workstations is a reasonable path for circulation. Since privacy is impacted by the proximity to circulation paths, the circulation paths should be short dead-ends that are screened from the actual workstations, with any major circulation at least 10 feet away.

Fig. 2: Development of Guidance for Habitability Factor
Chart shows result of analysis of a single parameter for one office context.

	Satisfaction with Furnishing	=	Constant	+ b_1 comfortable furniture	+ b_2 modern furniture	+ b_3 sturdy furniture	+ b_4 high quality furniture
Office A Movable Partitions	(n = 23)	=	-.628	.278	.670	.273	-.021
Office B Open Office Area	(N = 91)	=	.308	.435	.175	-.013	.360
Office B High Partitions	(N = 23)	=	.426	.492	-.129	.346	.246
Office C Bank Screen Partitions	(N = 23)	=	1.28	.409	-.230	.255	.585
Office D Private Offices	(N = 59)	=	.623	.186	.314	-.108	.440
Office D Open Office Area	(N = 339)	=	.506	.255	.300	.065	.372

Fig. 3: Comparative Regressions on Satisfaction with Furnishings
Results from comparison of a single habitability parameter over office A, B, C, and D. Inspection of shifts in coefficients indicate different attitude responses to office conditions. Most stable factors are comfortable furniture and high quality furniture.

settings, the earlier criticisms of the lack of an empirical basis for developing habitability factor research are negated. By using the data base, it is possible to determine, recognizing some inherent methodological biases, generalizability across various factors and groups. An example of this process follows.

Establishing Habitability Factors

One basis for determining habitability factors is to start with the evaluation of the validity of certain hypotheses about the interaction of man, his attitudes, and the environment in the office. These hypotheses are generally built out of the research data which exists in the literature. For instance, the hypothesis that there is a relationship between the distance from workstation to the circulation paths and ratings of overall privacy in an office is documented in a number of publications. Using the data base, these hypotheses can be tested for single office studies and comparatively over other studies. An example of this type of analysis is presented in Fig. 2. Here, simple statistical analysis is used to indicate trends. This is adequate for a single office context, but has little generalizability. By comparing results over different office studies, the researcher can feel more confidence in his interpretation of data.

Taking as an example, a simple regression analysis to determine the major components of satisfaction with furnishings, the results are seen in Fig. 3. These results are for five office environments and would be generalizable to other office environments. The major factors which contribute most to the variance of the dependent variable are shown underlined in this table. Although this is not a complete analysis, it does give the reader an indication of how a designer and a researcher would collaborate using the data base to determine major habitability factors and taking that information to determine priorities for renovation scheduling or priorities for the allocation of dollars to a renovation. In this way the application of the data base to existing problems would accomplish a number of specific improvements over previous literature. Therefore, the researcher could use the data base to create a number of regression analyses for comparison across different physical office conditions to determine the amount of variance accounted for, and the designer would use these equations as a guide to the allocation of funds to improve habitability in office environments. This would enable the designer to make an evaluation for an existing environment and that evaluation could be generalizable to a new building design.

In summary then, a methodology is presented for establishing overall habitability factors with some degree of generalizability. This is done by creating a standardized methodology which addresses the limitations of a pre-tested questionnaire, the comparability of data,

and the comparison of research environmental contexts. By using the data from different contexts in a comparative data base, the researcher and the designer are able to collaborate in the establishment and the application of information. Furthermore, each application of the information in a new context represents a step forward in another experimental design as it is added to the existing data base. This new application can then be used to replicate previous studies, to validate previous information and hypotheses, or to develop new empirical or intuitive insights into other habitability factors.

The point of this then is that the designer no longer lacks basic habitability research information, but now has a step by step method to improve the overall quality of his design decision making along with the researcher improving the overall quality of his basic research in real field contexts.

Developing Guidance for Technology Transfer

This method for determining habitability factors provides a basis for developing guidance to apply research information from the data base to new field situations. In simple terms, this is regarded as technology transfer. By using this approach, that is, standardizing the method across environments and comparing from a data base, one is able to develop three specific technology transfer impacts at different levels of application. All of these contribute to the development, support, and application of habitability factors in office environments, or may be used appropriately to other environments. These are:

1. Information developed from the application of the data base can be translated into "design guides" which are similar to catalogs specifying types of components to go in a new office environment. The specific difference between these and ordinary catalogs is that the elements of the design guide are selected on the basis of the information derived from an analysis of variables within the office data base. As an example, one might select three different manufacturers of desk types as being acceptable to improving overall satisfaction in office environments based upon a comparative analysis of satisfaction with different furniture types.

2. Information derived from the data base can be used for small problem field consulting. This is a case in which a client is in need of some level of decision making and does not require a major research effort, his variables may be related to those already in the data base. By manipulating the data base, one can determine some level of predictability in order to suggest actions for implementation. An example may be a client who wishes to know the impact of energy conservation measures in a particular type of office environment. One can partition

the group of subjects in the data base with low lighting levels and determine the minimal lighting level which will conserve energy and yet provide adequate satisfaction for office occupants.

3. Finally, one of the benefits of the construction of a field-oriented methodological data base dealing in habitability factors is that it provides the basis for project-to-project comparison, validation, reliability testing, and generation of new hypotheses which serve to build the basis for a theory of habitability in office environments. This same methodology for field application and comparability can also be used for housing, hospitals, residences, etc. The application of this procedure could be of great benefit to the entire field of habitability research and provide a systematic approach to defining, verifying, and validating habitability factors where one presently does not exist.

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