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METHODS FOR THE DEVELOPMENT OF SHIP-BOARD HABITABILITY DESIGN CRITERIA

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California University

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13. ABSTRACT

The quality of the shipboard environment has traditionally been given relatively low design priority, due partly to the difficulty of evaluating its effects on personnel, and partly due to low concern for personal comfort. Prospective reliance on an all-volunteer service has focused attention on the potential importance of ship habitability, both as an incentive to personnel retention and as a factor in productivity. This research contributes to the development of human engineering design standards by strengthening the quantitative basis for establishing shipboard habitability criteria. A group of Navy enlisted men have rated a series of shipboard messing areas using a variety of rating scales. In addition, this group and others have rated slides of these messing areas and other non-visited messing areas. Multidimensional scaling techniques have been applied in a preliminary analysis to identify the distinguishable attributes of the environments and to scale the environments on each attribute. The report emphasizes the methodology used in the analysis of the results and the analysis process, with implications for further work. In a parallel study, the responses of the ship's crews have been compared to the responses of visitors. Crew's responses to women aboard ship, as well as women's responses to shipboard conditions have been collected. Slides showing alternate color schemes in a model of a messing area have been evaluated by groups of men. In exploring alternate furniture systems to facilitate multi-purpose usage, mock-ups have been produced and possible layouts generated, which take advantage of the flexibility of the furniture systems. (U)

14 KEY WORDS	LINK A		LINK B		LINK C	
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I. THE PROJECT: OBJECTIVES, STRATEGIES, AND RESULTS

BACKGROUND AND PARTICIPANTS

The initial discussions which led to this task order began in the summer of 1971 when Mr. Joe Castle, of Naval Ship Engineering Center, explored the possibility of conducting research on habitability on the Berkeley campus with a team assembled by Craig McArt, Assistant Professor of Design and comprising, in addition to himself, Hugo Blasdel, Elizabeth Bexton, Harold Bexton, and Sami Hassid.

After several meetings with visiting Naval personnel, the team presented for review an informal project proposal for an 18 month study of messing areas in which four phases of research were described. The first two of these phases were included in an amended 6-month application[1] on basis of which the present task order was issued. After agreed upon extensions, the work was scheduled to run from

May 1, 1972 to December 31, 1972. The remaining portions of the initial proposal were included in an application for renewal of project[2] envisaged to be undertaken from January 1, 1973 to December 31, 1973.

Some of the work completed under the present task order was described in two progress reports[3,4], the main contents of which are also reported here.

Participants in the work covered by this task order have included:
Sami Hassid, Professor of Architecture, Principal Investigator
Craig McArt, Assistant Professor of Design, Co-Investigator
Hugo Blasdel, Acting Assistant Professor of Architecture, Co-Investigator
Elizabeth Bexton, Ph.D. Candidate in Architecture, Researcher
Harold Bexton, Ph.D. Candidate in Architecture, Researcher
Robert Hotten, M. Arch., M.L. Arch., Assistant Specialist
Denise Pourchier, M. Design Candidate, Research Assistant
Henry Yu, M. Arch. Candidate, Research Assistant
Darryl Soon, M. Design Candidate, Research Assistant
P. David Steiner, M. Arch Candidate, Research Assistant
Gary Aufdenspring, Assistant
Patsy Babbitt, Editorial Assistant
Ina Kau, Senior Typist Clerk (to August 1972)
Vianne Ramirez, Senior Typist Clerk (from September 1972)
John Duddy, FHFS, Consultant on ergonomic aspects of furniture development
Phipps Arabie, Ph.D. Candidate in Psychology, Stanford, Consultant on multidimensional scaling
Merg Ross, Consultant on photographing multi-mode furniture mock-ups.

Dr. Martin A. Tolcott, Director, Psychological Sciences Programs, Office of Naval Research, is the Scientific Officer for the project. Mr. Robert Lawson of ONR, Pasadena, was the regional coordinator for visits aboard ship.

Navy personnel at Treasure Island and volunteers from the Naval Training Station at San Diego have participated in the project as respondents to our questionnaires.

The following ships have been visited for slide documentation, and/or the use of their messing areas as settings for the collection of crew reactions:
MEYERCORD (DE), WILTSIE (DD), BRADLEY (DE), AGERHOLM (DD), WADDELL (DDG), BROOKE (DEG), BAUER (DE), FOX (DLG), CRAIG (DD), BAGLEY (DE), GOMPERS (AD), HORNE (DLG), OWENS (DD), DURHAM (LKA), TUSCALOOSA (LST), THOMASTON (LSD), DULUTH (LPD), ROARK (DE), KIRK (DE), McCAIN (DDG), SANCTUARY (AH), HULL (DD), FLINT (AE), HMAS HOBART (DDG).

The commanding officers of these ships, and numerous members of their crews have helped in many ways to make the field work of the research team possible and successful.

The distribution of tasks among participants was agreed upon early in the project, and reflects the respective interests of the participants. Most phases of the work were conducted by sub-groups of the team, with one member leading the group in a particular task, and being responsible for reporting the progress of work and the findings to the whole team. Sami Hassid was mainly responsible for overseeing the overall design and administration of the project and for the coordination of the work and findings of the various sub-groups. Craig McArt's main responsibilities related to the phases of work in which simulated environments were constructed and used. Hugo Blasdel's main responsibility included the collection and analysis of data and the design of field experiments. Elizabeth Bexton dealt mainly with the problems related to the inclusion of women on board ship. Harold Bexton studied the social and institutional factors affecting the crew's responses to their environment. Robert Hotten conducted most of the field work, recording measurements in situ, and producing slide views

of ships' messing areas; he also contributed to the bibliographic research. Denise Pourchier assisted in the development of furniture mock-ups and layouts. Henry Yu was mainly responsible for the collection of bibliographic material and assisted in the attempt to develop a computer program as an aid to lighting design. Darryl Soon assisted in the construction of models simulating interior environments, and in the production of slide views of these models. David Steiner assisted in the photography. Patsy Babbitt was responsible for editing and composing the text for the bibliography. Vianne Ramirez was responsible for the day-to-day administrative tasks of the project and for typing the manuscripts including this report.

OBJECTIVES

The main objectives of the study undertaken under the present task order are as follows:

1. To develop methods for assessing crew perceptions with respect to habitability, and
2. On the basis of these assessments and other information, to develop examples of design guide criteria of habitability for ships' messing spaces.

In long range terms, the objective is to determine the cycle of research, development and testing necessary to maintain an adequate environment for human habitation.

Many reasons support the need for this kind of research at the present time. Increasing social awareness in many segments of American life is making strong demands for the recognition of users' needs in the design of man-made environments. This poses a challenge to long-established criteria used by the design professions, criteria which are usually segmented, object oriented, and designed to guarantee minimal physical performance for safety, economy, and comfort. Even within these

areas of minimal performance, the criteria are usually developed under ''laboratory'' test conditions which often do not make adequate provisions for the complexities of ''real'' environments. It is therefore important, within these minimal ranges, to check the performance of the designed environment in actual use and especially as perceived by the users.

Beyond these minimal ranges, designers receive less precise guidance from established norms, and rely heavily on their own judgment. Here the input from users is again very important, since it allows us to verify the congruence of the designer's prescience with the users' perceptions, preferences, and reactions.

Within the Navy, recent developments give a sense of urgency to the kind of research undertaken in this study. The provision of adequate living conditions has always been a major design determinant influencing the crew's performance. More recently, the importance of improved habitability has increased as the Navy has moved from reliance on the draft to a projected all-volunteer force. Problems of attraction of new recruits and of retention of enlisted personnel are intricately linked with the provision of incentives, among which improved habitability should rank high.

Policy changes in personnel composition allowing greater participation of women in roles from which they were heretofore barred, and repercussions of the nation-wide struggle for equal opportunity for minority groups have had and will increasingly have greater impact on habitability standards in which the expressed needs of these groups are considered along with those of all other groups.

We realize, of course, that in ship design, the constraints of budget, of military effectiveness, and of various other systems, will continue to retain primary importance. However, under the emerging conditions

outlined above, habitability should increasingly be incorporated as a highly ranked factor in ship design.

In addition to these pressures, the dynamic nature of the concept of habitability should be stressed. In this respect, we may mention that the concept itself has been defined by various authors in many different ways, reflecting its dynamic nature and particular needs dictated by specific points of view. Parker and Every have given a condensed survey of many of these definitions and have elected in their own work[5] to consider habitability in its broadest sense so that " it covers all issues relating to the living environment which bear upon the comfort, happiness, motivation, and effectiveness of the occupant of the environment."

This panorama of issues pertaining to habitability may be condensed into three distinguishable, though often inter-related areas of concern, namely those related to health and safety, to specific task performance, and to pleasantness of the environment. Issues pertaining to any one of these groups may exist independently of the others, and a reduced or augmented level of performance in one set of issues does not necessarily entail an automatic correspondi change in the level of performance of another. For instance, one can find instances of an unpleasant environment as measured by one's acceptance of such an environment, which may not necessarily result in a health problem, or an environment may be adequate for job performance, but embody undetected long range health hazards.

In this study, we are concentrating on those issues that relate to pleasantness of the environment, and we are relying on user reactions to determine levels of acceptance. In the course of the study, user reactions are sometimes used to check performance with respect to other issues, as these seem to be pertinent to our focus of research. We are therefore studying habitability issues which aim at fulfilling the user's needs and at accomodating his preferences and desires.

These kinds of issues are culturally variable and involve individual judgmental considerations that are difficult to ascertain with much accuracy. Results from research on these issues cannot have the same predictive power and universality of application as results of research in other areas such as engineering, health, and safety. This should not detract from the importance of the issues. An unpleasant environment may adversely affect satisfaction and morale, which in turn might affect human performance or mental health.

Another aspect of the dynamic nature of habitability is that its parameters for satisfaction levels may change in time, and, as the level of habitability expectations rises, an initially satisfactory environment may become less satisfactory. Thus, as the living standards of the civilian population improve, there will be expectations for similar improvements in Navy life which, with the advent of the all volunteer force, will have to find ways to reflect the changing cultural tastes of new recruits.

In this study we attempt to identify the features of the environment which provide the greatest potential for satisfaction, as well as unsatisfactory features. Although some desirable features may represent ephemeral fashion, others may conform to basic needs, and therefore be less subject to change. Where the study is sufficiently comprehensive, it may be possible to identify the underlying variables so that a more general guideline can be created to aid in design and evaluation.

STRATEGIES

The objectives outlined in the previous section assume that the case can be made for improved habitability on board ship, and for the desirability of some sort of user input in the process of design and evaluation for habitability. The realization of the said objectives

requires the development of methods by which user reactions can be incorporated into procedures leading to the development of design criteria.

In designing a research effort that would help develop such methods with respect to the habitability of ship messing spaces, numerous questions come to mind relative to scope, kinds of input, and choices open for alternate strategies. Some of these questions follow.

Who are the users? Within the present work force should questions be addressed to crew members only, to commanding officers, to maintenance people? Since design implies future action, should we not anticipate the future composition of crews, the expanding inclusion of women? Should, in fact, the inquiry be restricted to direct users? What about families and relatives of the users, the supporting personnel, the experts and technical people involved in the design and/or operation of the environment?

What environments do we select? Should we necessarily restrict the scope of study to messing spaces, and if so, which ships should be studied? Should we study ships at rest, as well as ships at sea or on missions? Should we broaden the scope beyond those specific real environments, to also include similar environments such as restaurants and cafererias? Can we produce simulated environments and use them in lieu of or in addition to real ones?

What information do we collect? and how? Do we conduct observations, or interviews, or distribute questionnaires? Do we ask open-ended questions, or should questions be pointedly directed at specific aspects of the environment? What aspects do we include? Do we need to select or set up alternatives in order to obtain comparative subjective responses?

How do we analyze the responses? How do we extract from the collected responses and measurement data the attributes of environments that are significant from the point of view of the users? How do we separate extraneous and interfering influences? How good are responses to complex environments? Are available methods of analysis powerful enough to deal with the complexities usually encountered in lived in environments? Is it necessary to break down the complexities into clearly identifiable linear dimensions? If this is possible, how do we allow for the mutual interference of separate dimensions? Should we strive to limit our inquiry to manageable complexities?

Should we incorporate the input of design? Should we limit our study to existing environments? Would this be enough, or should we investigate what could be in addition to what is? What aspects of the environment should be selected for the generation of alternatives? What form should the alternate proposals take? How do we obtain responses to proposals, and how do these compare to responses to real environments? At what points is the input from technicians and experts necessary, and to what extent?

Many of the above questions are inter-related and some are partly overlapping. Even though they cover substantial ground, they are far from exhausting the possibilities for questions that may properly be raised. Numerous team discussions took place from time to time to deal with the above questions, although there was no conscious effort to attack them in any particular order of importance or predetermined sequence. Some of the questions were amenable to logical or at least plausible resolution; many of the decisions taken in response to questions were based on matters of convenience, or dictated by the constraints within which the team was operating; finally, some of the work clearly required for proper resolution of a question was designed to be completed during the renewal period of this project, or suggested for future work. As a result of these discussions, and

within the program outlined in the proposal for this project, certain strategies emerged as being the most appropriate for our purpose. Some of these are recounted in more detail in other chapters of this report, but the main characteristics of the work undertaken are summarized here under the selected strategies.

Bibliography. The research team started the investigations with a thorough bibliographic search which continued all through the period covered by this task order, and is expected to continue during the renewal period. Major likely sources of information were tapped, including the personal bibliographies accumulated by individual members of the team. Relevant items were retrieved, and, as time allowed, abstracts were prepared where deemed useful. Individual entries were produced for the selected items. The first edition of the bibliography including these entries and the completed abstracts has been organized.

Field surveys. One of the early tasks undertaken by the team was a field survey of a ship to gain first hand acquaintance with the problems affecting habitability on board ship. All members of the initial team participated in this visit to a ship moored at Treasure Island, in which ample opportunity was provided to see all parts of the ship and to talk freely and at length with members of the crew. Similar arrangements were made for several members of the team to visit a number of ships in San Diego. After the visits, the team exchanged information on their respective experiences, and this helped set the tone with more accuracy for subsequent portions of the research.

Experiments using slide views of existing ships. The messing spaces of twelve ships moored in San Diego were systematically surveyed to record their physical measurements and furniture layout, and to produce slide views of their main features. Eleven sets of three slide views each were selected as a result. In each set, one of the slides

showed a furniture detail while the other two presented two views of the space. They were projected side by side simultaneously on three equal sized screens to elicit responses from subjects. Questionnaire No. 1 (See Appendix A) was used in this experiment with 34 respondents, comprising Group A. This group included two sub-groups of respondents at Treasure Island who volunteered as subjects, each on a separate day so that the slides could be shown in a different order. The experiments conducted later on provided opportunity for repeating the collection of responses to Questionnaire No. 1 from additional respondents at San Diego (Group B) and at Treasure Island (Group C). Two types of analysis were run on the responses collected from this experiment. In one the differences between environments were computed on the basis of unnormalized data. In the other, each subject's scores on each environment were normalized to the same mean and standard deviation before computing the difference. The intent of the analysis was to find clearly interpretable dimensions, and the relative relevance of rating scales to those dimensions. The data collected in this experiment were also fed into other parts of the study and provided a basis of comparison for results obtained in other experiments.

Experiments utilizing real environments in actual use. Thirteen ships at San Diego provided the settings for these on-site experiments utilizing the real environments of messing spaces. Thirty-eight volunteers (comprising Group B, including four Waves) from the Naval Training Station were divided into four sub-groups of approximately ten persons each who rotated around the 13 ships in 13 days, for a total of 52 visits. Each visit included the evening meal for the members of the group in the messing area to be evaluated, followed by an evaluation of the space on a questionnaire provided for that purpose (See Appendix A, Questionnaire No. 2). Although the groups started with ten participants in each, this number varied in subsequent days due to the failure of some of the subjects to attend.

Physical measurements of the ships were recorded and slide views of the interiors were produced where this had not already been done in previous visits. On the fourteenth day, all the participants of Group B responded to Questionnaire No. 1 with respect to slides of the visited environments and of other messing spaces. They also responded to slide views of models of ship messing areas depicting various color schemes as explained in the following section.

Data from all responses to Questionnaire No. 2 were analyzed, the intent being to discover the main dimensions in the evaluation of real environments of ship messing spaces from the point of view of Navy personnel actually utilizing the spaces.

Experiments using slide views of models. It was realized early in the project that the limited number of real environments available for experiments, in this case the messing spaces of ships which could be scheduled for needed visits by groups of respondents, would not, in spite of their variety, be sufficient for the purposes of the project. Ways were also needed by which some control could be exercised over the changes in the space complexity while specific variables were introduced. The introduction of these variations in real environments was difficult because of the problems of timing and cost involved. The strategy adopted called for models of messing spaces to be constructed in a way allowing variety to be introduced, and for slide views to be taken of each stage of variation. These, in turn, would be used to elicit responses from subjects. Part of the research intent would be to find out to what extent the results obtained with this method of utilizing slide views of models would be comparable to those obtained from direct viewing of real environments or of slide views thereof.

A three-dimensional, demountable scaled model of a typical messing space of a Destroyer type ship was constructed and furnished with scaled replicas of tables and chairs. Color was selected as the

first variable to be studied. The removable decks and bulkheads allowed the illustration of interior finish colors used in different patterns and combinations. The overhead simulated the light distribution of recessed luminaires. Slide views taken of the model appeared convincingly realistic when projected.

Three experiments were designed using different sets of slides for different purposes. In Experiment I, the subjective feeling of spaciousness was tested utilizing seven sets of three slides showing different brightness arrangements of achromatic colors. In Experiment II, eleven sets of three slides were used; each showed different arrangements of color and pattern, with each set illustrating variations of the dominant color scheme. They were used to find the degree to which these variations were liked or disliked by respondents. In Experiment III, sixteen selected slides were used to elicit ratings in four categories of judgment.

Experiments using the input of design for multi-purpose use of space. Early results of the team's research in this project unveiled a subject of recurring criticism that seemed clearly amenable to improvement through design. This related to the fact that, not only did many of the surveyed messing areas lack comfort and aesthetic appeal for the main purpose of serving meals, but that they also were unsuitable for other needed purposes in-between meal times. The problem was most acutely felt on destroyer-type ships where space was at a premium.

Preliminary investigations uncovered several alternate off-time uses for the space that crewmen felt were highly desirable, among which cinema viewing was mentioned most often. Accordingly, this alternate use was selected to illustrate the strategy of design input into the process of developing design criteria. The intent of the strategy was to demonstrate how user reactions may lead to the discovery of unfulfilled needs which may be satisfied through a process of design;

and how the results of design development would be assessed by acceptable technical methods of evaluation which would also incorporate user satisfaction among the used criteria.

Analysis of the problem situation revealed that the development of multi-mode furniture would greatly facilitate the multi-purpose use of the space. Six concepts of multi-mode furniture were developed in mock-up form to allow preliminary operational assessments to be made. A two dimensional scale model of a typical messing area plan was used to illustrate furniture arrangement for alternate purposes, using magnetized components for easy re-arrangement of the pieces in different layouts.

Investigations assessing the impact of the composition of respondent samples and of their attitudes. One of the strategies agreed upon in this project called for the examination of the impact of social factors that may influence the responses of the crew and of other samples of respondents, or create demands on the designed environment. A full-scale investigation along these lines was not intended, since this would have required the expenditure of effort beyond that contemplated in the project design.

Two aspects were selected because of their apparent importance, namely the differences in rating of ships between crew members and other categories of respondents, and the projected expansion by the inclusion of women on board ship.

The investigation of comparative ratings among respondents participating in the project's experiments was conducted by means of informal conversations with crew members and by the use of questionnaires administered to crewmen on board some of the ships visited in San Diego and to volunteers from the Naval Training Station in San Diego who visited the same ships.

The problems to be faced as a result of women's inclusion on board ship were examined by means of questions inserted in Questionnaire No. 1 which elicited responses from Group A, by informal conversations with male and female members of the crews, and by a number of interviews on board a hospital ship with a substantial number of women in its crew.

Selecting the appropriate methods of analysis. The process of converting the rating response into matrices for multidimensional scaling can be performed in a variety ways. The data from each subject can be standardized either to the same overall mean and standard deviation, or standardized to the same mean within each rating scale, or within each environment. The various forms of standardization yield potentially different kinds of information. The approach followed in this project has been to see whether the results do show information which is of value and consistant with the other results.

In assembling the standardized data for scaling, it is possible to do six different forms of analysis. Some of these may be rejected as making unwarranted assumptions about the comparability of data obtained from different subjects. More reasonable assumptions are made in evaluating dimensions of differences between environments for each rating scale and this has been the main approach to the analysis. Where complete data is available for each environment for an individual, it is possible to compare his responses to the responses of other such individuals to evaluate differences in response to the environments and differences in the use of rating scales. This data may be of use in identifying the range of individual priorities, and in developing better evaluation techniques.

RESULTS

Definitive results of the study will be included in a number of projected technical reports. The following sections of this report show

some of these results where they have been reached, as well as tentative conclusions derived from the work completed thus far. Highlights of these conclusions and interim results are summarized here.

Bibliography. The bibliographic research conducted so far has resulted in substantial sections under a number of headings. A technical report scheduled to appear soon will include the completed sections in a first edition of a bibliography on habitability. This may prove to be a useful instrument for quick reference to sources of information on some aspects of the subject. The information collected thus far has helped our research team avoid the duplication of past efforts, and, in some cases, provided the background needed for our own work. A future edition of the bibiliography will add new sections when completed, and revise previous sections where warranted by substantial additions.

Scaling. The multidimensional scaling process using rating scale data in evaluating a wide range of perceptual features of the environment is being used here for the first time. The emphasis in this early report has been on the description of the methodology and exploration of the process of analysis and interpretation. Issues need to be resolved with respect to the choice of subjects, stimuli, and rating scales, as well as the process by which the evaluation is done. The ratings may not be as useful in raw form when they are standardized to equalize the impact of each evaluator on the results. Finally, it is necessary to select the rating scales to be used in any one of the series of analyses and to identify resulting dimensions for interpretation. The process of sorting rating scales into ''compatible sets'' and finding the appropriate number of dimensions to request for each set, is, to some extent, a process of trial and error with the initial results providing an indication of the relations between rating scales and stimuli which will hopefully emerge later in clearer form.

The question of how many dimensions to request involves both issues of interpretability, and issues relating to statistical significance. The types of analysis usually used with the data does not provide a better fit with an increasing number of subjects. An additional dimension may not provide a significantly better fit to the data, yet may allow a more straightforward interpretation of the relation between the rating scales and physical differences in the environments. Because of these issues, further exploration of the statistical significance of dimensions is required for a satisfactory interpretation of the data collected.

Slide views of models. The three experiments relating to color, in which slide views of models were used, have yielded some interesting results:

a. Although some ambiguity may be removed by projected changes in the design of the experiment isolating the brightness attributes, results collected so far indicate that the brightness of deck surfaces is related to the perception of spaciousness; the brighter decks positively influence the feeling of spaciousness.

b. There is a consistent and predominant preference for schemes composed of relatively high chroma, hue contrast, brightness contrast, and pattern, which may provide a basis from which principles of color selection and application can be derived.

c. A ''stimulating'' environment is thought of as being both desirable and appropriate for messing spaces, provided the environment be also appropriate for dining by avoiding extreme application of supergraphics including high chroma and contrast.

d. Color slide views of models offer adequate substitutes for real environments allowing controlled changes to be more efficiently introduced in systematic perceptual studies of environmental attributes.

Studies along these lines projected for the renewal period aim at further validation of this substitution adequacy by matching the

color schemes of real environments in simulations, and subjecting both to reactions of crews and other subjects. A technical report is projected in which this series of experiments and their results will be reported.

The input of design. Early analysis revealed the need to provide for multi-use of the messing space, with cinema viewing rating high on the list of desirable alternate uses. It also showed that development of multi-mode furniture would greatly enhance the multi-use capability of the space. The six concepts for multi-mode furniture, developed at this stage, were designed with this purpose in mind.

Performance criteria were formulated to evaluate the developed concepts under the headings of accomodation, operation, appearance, structure, mechanisms, materials, maintainability, cleaning, hazards, and safety. The intent was to conduct a technical appraisal of the designs with regard to these criteria, and to follow this with an evaluation in which crew responses would be recorded.

So far, only the technical evaluation has been conducted. When the crew responses are collected, the combined results may lead to the selection of one or more concepts for further development.

Impact of crew composition and attributes. When responses to environmental differences by crew members are compared with those exercised by visitors who are not members of the crew, the most striking result is that the crew, with few exceptions, rate the environment considerably lower than the visitors. The range of responses of the crew tends to be much narrower than the range for responses by visitors. But the rank ordering of preferences is, with few exceptions, the same for crew and visitors alike. The crew's reactions are influenced by their life on board, as well as critical failures of

performance in situations of severe use, while visitors tend to react to perceived characteristics of the environments and to visible evidence of poor performance. It seems, therefore, that responses from a visitor group similar in composition to the crew, but not actually working on a ship, would provide a more reliable input for the study of environmental characteristics, except in cases where functional performance is involved. In these cases, the experience of the crew with the environment in actual use would provide more reliable input.

The inclusion of women on board ship. Initial sampling of men and women regarding their attitudes toward the inclusion of women on board has yielded some tentative results which will be further scrutinized in the light of additional input contemplated for the renewal period.

The majority of men are favorable or ambivalent toward the possibility, with some suggesting the presence of women be restricted in some areas of the ship. Chivalry, concern for the women's safety, and/or the need for men to maintain some male preserve are among the motivating forces for men's attitudes. Women expressed needs such as private access to sanitary spaces from berthing areas, reduced crowding in berthing areas, maintenance of modesty, and increased locker and storage spaces.

It seems that with the inclusion of women on board ship, the heterosexual environment may help in the retention of personnel, although some areas of the ship may have to be designed for relaxation and the exclusive use of each sex.

[1]SYSTEM DEVELOPMENT FOR HABITABILITY DESIGN GUIDE CRITERIA. Application to Office of Naval Research, Psychological Sciences Division, by The Regents of the University of California, Berkeley, Department of Architecture; Principal Investigator: Sami Hassid, Professor of Architecture; Co-Investigators: Craig McArt, Assistant Professor of Design and Hugo Blasdel, Acting Assistant Professor of Architecture; Duration of Activity: May 1, 1972 to October 31, 1972.

[2]SYSTEM DEVELOPMENT FOR HABITABILITY DESIGN CRITERIA. Application for renewal of project, submitted to Office of Naval Research, Psychological Sciences Division, by The Regents of the University of California, Berkeley, Department of Architecture; Principal Investigator: Sami Hassid, Professor of Architecture; Co-Investigators: Craig McArt, Assistant Professor of Design and Hugo Blasdel, Acting Assistant Professor of Architecture; Duration of Activity: January 1, 1973 to December 31, 1973.

[3]PROGRESS REPORT No. 1 for period May 1, 1972 to August 1, 1972, dated August 7, 1972.

[4]PROGRESS REPORT No. 2 for period August 1, 1972 to November 1, 1972, dated November 10, 1972.

[5]James F. Parker and Martin G. Every, HABITABILITY ISSUES IN LONG DURATION UNDERSEA AND SPACE MISSIONS. Prepared for Engineering Psychology Programs, Office of Naval Research, Arlington, Virginia; Contract No. N00014-71-6-0397 Work Unit No. NR 196-113, July 1972.

II. MULTIDIMENSIONAL SCALING EVALUATION OF HABITABILITY

Multidimensional scaling has been developed as a means for analyzing human responses to stimuli where there are multiple stimulus attributes and where these attributes may have no simply related physical correlates. This section illustrates the applicability of multidimensional scaling to the assessment of habitability; it demonstrates modifications to current multidimensional scaling procedures which are more appropriate to scaling stimuli as complex as human environments. Habitability can, in part, be specified as a set of physical measures (temperature, sound level, light quantity, physical dimensions), but there are many other features of design which are not as easily specified and may be as important in providing conditions which will be perceived as habitable.

The research is primarily focused on an exploration of methodology and its implications. As a part of this exploration, some initial habitability evaluations have been made of shipboard conditions in messing areas (13 destroyer and amphibious types) and of slides of

these and other ships by various groups of enlisted personnel. The analysis of these evaluations is primarily used to provide examples of the applicability and limitations of the methodology.

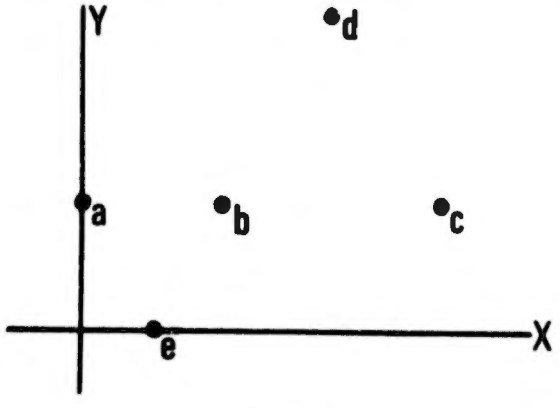
The range of environmental features relevant to the issue of habitability is partially determined by the responses of the occupants. These responses are limited by the perceptions of the occupants, and the means they have to convey their responses. One of the simplest survey techniques is to use a questionnaire to elicit an evaluation of the environment by an occupant. Unfortunately, the responses may reflect a variety of features not related to the physical environment; also, the subjects generally do not have a feeling for the range of alternatives which are possible. They may be unable to appreciate the success or failure of features in their own environment. In evaluating several environments, there is the advantage of providing a context for evaluation, but the difficulty of separating an overall response from more specific criticism and praise remains, since it may be assumed that each evaluative response is partly affected by the overall impression. An additional problem is the implicit dependence on the scales meaning what they ''appear'' to mean. A single scale may be interpreted in different ways, yet this interpretation will not be found by a comparison of average ratings. A given environment may be quite good in one sense, and poor in another, yet receive a moderate rating as the average. The ''overall evaluation'' may be seen as an alternative interpretation to each evaluative scale.

Multidimensional Scaling

A partial solution to the problem of the evaluative scales is found in the use of traditional multidimensional scaling. In such scaling, instead of requesting a rating of each stimulus, the judgment requested is to estimate how different two stimuli are from each other. Once all pairs of dissimilarities are found, then the analysis models

these responses as distances along one or more axes. The more different two stimuli appear to be, the further apart they will be on one or more axes. If the estimates of dissimilarity are assumed to have the same properties as distances, then the analysis process described by Torgerson (1958) may be used. Where the estimates are assumed only to be ordered roughly according to size, then a more complex analysis process developed by Shepard (1962a,b) and improved by others (Kruskal, 1964) is used. The results of both processes have the same form (locating stimuli on axes). In practice, the results of analyzing the same data using both methods have been similar.

A representation of the analysis process is shown in Figure 1, where the first table or matrix shows the dissimilarities. These dissimilarities may be treated as distances and graphed as shown in the Figure. After analysis, this matrix of dissimilarities may be represented as locations on two axes or dimensions. One of the possible numerical and graphical equivalents of the axes is shown as X and Y. The axes may be arbitrarily placed and still adequately represent the matrix of distances. Convention places the mid-point of the axes at the centroid of the points, but this placement is not necessarily related to the magnitude of the underlying attribute which evoked the distinctions shown as the spread of points. The axes are generally placed so that each contains the most remaining variance, but this placement is not necessarily related to the attributes.



	a	b	c	d	e
a	0	2.0	5.0	4.4	2.0
b	2.0	0	3.0	3.0	2.0
c	5.0	3.0	0	3.0	4.4
d	4.4	3.0	3.0	0	5.0
e	2.0	2.0	4.4	5.0	0

Dissimilarities Matrix

X	0.0	2.0	4.4	5.0	1.0
Y	1.7	1.7	1.7	4.3	0.0

Dimensions in the Matrix

Figure 1

Where a few attributes are of interest, the problem of placing the axes may be solved by orienting the axes to correspond to physical variables or features of the stimuli. Where there are many attributes, it is far more difficult to match features and axes; whatever matching is done remains a matter of judgment. If there are specific attributes which contribute to the perception of differences between stimuli, then it is desirable to use a means of analysis which recovers those attributes without intervening judgment.

A second limitation of multidimensional scaling, as it has been applied, involves the information which may be recovered from dissimilarity judgments. One review of research suggests that summary judgments may be adequately represented as a linear combination of only a few of the many possible variables (Shepard, 1962c). Nonetheless, subjects felt that they were accounting for more than the one or two aspects which were significantly related to their judgments. A scaling process which depends on such summary judgments is unlikely to accomodate the diversity which can be perceived in human environment. The scaling process itself creates some technical difficulties, in that pairs of stimuli have to be considered and even a few stimuli can require repetitious revisiting of environments when they are considered in pairs.

New Approaches to Scaling

A general technique for identifying unique and relevant axes has been developed by Carroll and Chang (1970). Rather than using one matrix of dissimilarity judgments, multiple matrices are analyzed simultaneously into a single set of axes which is fitted to all of the matrices. As originally proposed, each matrix is the result of a single individual's data and it may be assumed that all individuals do not give any specific axis the same weight in their judgments of dissimilarity. For example, Wish (1970) demonstrated that "hawks"

tended to see *political alignment* as more important in dissimilarities than did ''doves'', who emphasized *economic development* in judging dissimilarity. To a ''dove'' the USA and USSR were more similar than the USA and Mexico, but to a ''hawk'' the USA was more similar to Mexico. Both groups used both dimensions, but they weighted them differently.

Wish (1970) provides an alternative to single judgments of dissimilarity by using a series of rating scales to evaluate each stimulus. He compares these results with those from similarity judgments and similarity sortings. Osgood, Suci, and Tannenbaum (1958) also have done some multidimensional scaling of semantic differential ratings with results comparable to factor analysis. In developing dissimilarities from the ratings, each rating scale is treated as an independent axis in multidimensional space. The distances are computed between stimuli as root of the summed squared rating differences on all of the scale axes. The data structure of environments, rating scales, and individuals is shown in Figure 2 along with the notation necessary to express the computations. It can be seen that the analysis used by Wish collapses the ''data solid'' along the rating scale mode, producing one matrix of environmental dissimilarities for each individual. Equation 1 shows how these dissimilarities are generated from differences in ratings. Horan (1969) has shown that where different perceived attributes are judged at a level approaching a ratio scale, it is appropriate to combine these structures using this root-sum-square approach.

$$s^{i}_{hk} = \sqrt{\sum_{q=1}^{q=s} (y^{i}_{hq} - y^{i}_{kq})^2} \qquad (1)$$

t *dimensions* r
n *subjects* i,j
m *stimuli* h,k
g *scales* q,p
ratings y_{ikp}
coordinates x_{kt}
weights w_{qt}
distances d_{hk}
dissimilarities s_{hk}

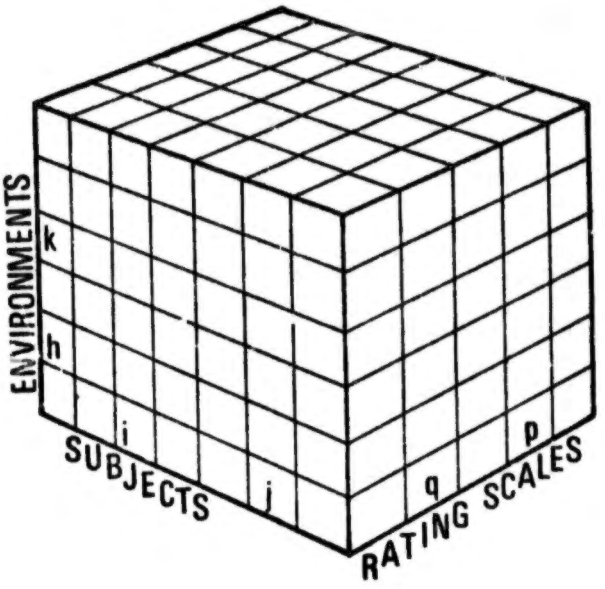


Figure 2: Terminology and data configuration

Using the rating scales, it is possible to obtain a wide range of assessments of each stimulus, to rate each stimulus in turn (rather than work with pairs), and to correlate the resulting dimensions with original ratings so as to more positively identify the nature of dimensions resulting from the analysis. Wish, using judgments with nations as stimuli in comparing the different approaches, found that the first two dimensions of each of the approaches were similar. These dealt with political alignment and economic development. The similarity ratings and sorting provided third and fourth dimensions which described ethnic and geographic separation. The rating scale data yielded a different third dimension relating to internal satisfaction and no fourth dimension.

The Carroll/Chang model changes dissimilarities into distances by assuming a linear transformation (L) shown in Equation 2. There has been a growing awareness that, while it is desirable to maintain the ordinal data properties in developing non-metric scaling (Shepard, 1962a,b), the results of assuming a simple linear transformation are often equivalent (Young and Cliff, 1972). The model of stimulus coordinates and weights necessary to reproduce the distances is shown in Equation 3. The weights w_{it} effectively expand or contract the differences $(x_{ht} - x_{kt})$ along the axes but are expressed as terms

already squared so that they are always presumed positive. The option of changing the sign of the difference would have no meaning, nor would the sign be determinable from the matrix of dissimilarities. Even though the axes are identified with respect to the orientation of the axis, it is still necessary to identify the nature of the extremes on the axis, since the mirror image of the axis would as adequately fit the model.

$$e^{i}_{hk} = L(d^{i}_{hk}) \tag{2}$$

$$d^{i}_{hk} = \sqrt{\sum_{t=1}^{t=r} w_{it}(x_{ht} - x_{kt})^2} \tag{3}$$

Where Wish (1970) used the differences in rating along one mode (rating scales) to compute the dissimilarities between elements of a second mode (stimuli) in order to produce one matrix for each member of the third mode (individuals), it can be seen that it is computationally possible to collapse the data solid in any one of six different ways (ordered pairs of three elements). There is perhaps less sense in subtracting the ratings of one individual from the ratings of another, so it would be difficult to justify computing the dissimilarities between individuals producing one matrix for each of the rating scales or for each of the stimuli. The matrices of dissimilarities between rating scales can be computed for either the individuals or the environments, but the resulting information is perhaps more of semantic interest than of use in distinguishing environments. Of greater interest in evaluating environments is the possibility of computing the dissimilarities between environments for each person or for each rating scale. By using only one rating scale to generate dissimilarites, the problem of different rating scales having different numerical properties is avoided. Each of

the dissimilarities matrices contains the information resulting from different individuals using the same scale. If different interpretations are made of the rating scale, then different ratings will be given and different dimensions will result from the same matrix.

It is likely that similar information will emerge from an analysis of inter-environmental dissimilarities whether the data are accumulated for each individual or for each rating scale. The rating scale approach does identify which scales contributed to a given dimension. Where there are many possible dimensions, it is desirable to take related subgroups of rating scales to be analyzed together. The approach requires only one step, rather than having to correlate ratings to the resulting dimensions as a second step after the multidimensional scaling required by the use of dissimilarity matrices for each individual as proposed by Wish.

In terms of Carroll and Chang's model, the equation for generating the inter-environment dissimilarities for each rating scale becomes:

$$d_{hk}^{q} = \sqrt{\sum_{i=1}^{i=n} (y_{hi}^{q} - y_{ki}^{q})^2} \qquad (4)$$

and following the monotone transformation, the model for reproducing the dissimilarities:

$$d_{hk}^{q} = \sqrt{\sum_{t=1}^{t=r} w_{qt}(x_{ht} - x_{kt})^2} \qquad (5)$$

where now the w_{qt} term relates each rating scale to each dimension. Since the rating scales are likely to be more independent than the

individuals, there are likely to be only a few matrices which contain a given dimension and develop a w_{qt} term of significant magnitude. Results being now accumulated across many individuals, some noise reduction will have taken place in comparison to dealing with individual data. It is still possible for individuals to use the rating scales with different interpretations, producing several dimensions for a given rating scale. It is also possible for two rating scales to combine, providing the opportunity to express a response not appropriately described by either scale alone. In the sense of handling verbal distinctions, the analysis technique is comparable to factor analysis of semantic differential ratings. However, it appears to be more sensitive to environmental distinctions and will find more dimensions than will a factor analysis of the matrix of correlations between rating scales (Blasdel, 1972). It is not necessary to have redundant scales in order to develop a correlation. In comparison to the use of dissimilarity judgments, there is the potential for more dimensions, since each rating scale matrix may represent a different judgment, which may itself contain several dimensions.

DATA SOURCES

The main source of raw data was initially conceived of as an evaluation of shipboard conditions in messing areas. However, the opportunity for men to visit several ships and evaluate them was limited, so a major concern was the exploration of alternate means of presenting shipboard environments. It is also important to be able to explore alternatives not present on board existing ships, so a form of modeling is indicated. In all, six sets of data have been collected for multidimensional scaling from three groups of subjects.

As a preliminary study, 34 subjects evaluated slides of messing areas (Environments 1-12) using Questionnaire No. 1 (Appendix A). This group (A) was divided into two sub-groups, who viewed the slides

in different orders. The subjects were experienced enlisted men with three to twenty years of service.

Group B generated a majority of the raw data by visiting 13 different messing areas (Environments 20-33) at the rate of one environment a day. The 38 individuals in Group B were in technical training following boot camp and only three had more than a year's experience in the service. In addition to visiting the ships, Group B evaluated the same group of slides as were seen by Group A and evaluated the slides taken of the messing areas they had visited (Environments 20-30 including four sets of slides for Ship 24 showing different messing areas on board). For the purpose of the visits, four sub-groups were defined and each group visited the ships in a different order, with the constraint that all visits to any one ship were completed in a single week. Not all of the subjects appeared for any one visit.

Group C consisted of 18 men, all with more Navy experience than Group B. They evaluated the slides of the ships visited by Group B (including Environments 31-33). Groups B and C were only available for a single presentation sequence. Group C also evaluated slides of models of a messing area with different color schemes using a brief set of four rating scales. The rating system used is presented in Appendix A.

The slide presentations used three projectors and screens, and provided for all the slides of a ships' messing area to be presented at one time. The "environment number" was announced with each set of slides. Occasional questions were answered openly ("Yes, the brick is artificial.") but no evaluative comments were made. Some comments were made by the sailors, but this repartee was discouraged; it is likely that these comments had some effect on the responses of the other sailors.

Although collecting so many sets of responses to slides was not anticipated in the initial research design, the relative youth and inexperience of the sailors visiting on board ship indicated that we should obtain responses from older, more experienced sailors. Shipboard tours were not possible, but it was possible to obtain responses from the less experienced Group B to two sets of slides. One of these sets had been evaluated by a more experienced group (A), and the other set was evaluated by the second experienced group (C). The intent was to show, if possible, that both the experienced and inexperienced groups had parallel responses to the slides and that the response of the inexperienced group to the slides was similar to their response to shipboard conditions. It would also be possible to merge the data from different sets of evaluations where either the subjects or the stimuli were common (Group A and B slide evaluation, Group B and C slide evaluation, and the two sets of slides for Group B).

The shipboard visits took place from 16:00 to 18:00 each weekday for three weeks excluding the first Monday and last Friday. The subjects assembled and were taken by bus to the pierhead, arriving at about 16:30. Each of the four groups went to a separate ship. On the ships, small delays were experienced in obtaining clearance to board and in waiting for the serving to begin, but only one ship had delays of more then 15 minutes. In picking a seat, the subjects were instructed to sit facing into the room, not towards a wall. Following the meal the questionnaires were filled out. Then, the group reassembled and returned to the pierhead to be picked up by the bus. In each of the four groups, a leader (the senior enlisted man) was in charge of distributing and collecting the questionnaires.

Measurements were taken in the ships' messing areas. Dimensions, colors, and other stable features were measured during a daytime visit, while sound levels, temperatures, and other variable measures were taken during a meal on board ship. Only one set of measurements could be made during the meal on any one day, so the variation during

the other three days when the ship was visited by an evaluation group remains unaccounted for. The floor plans and the measurements for each ship are given in Appendix B.

ELEMENTS OF MULTIDIMENSIONAL SCALING

The scaling requires stimuli, subjects, and an evaluation process, as well as analysis and interpretation. In each case, there are various alternatives in the design of the research; it is the purpose of this section to explore the alternatives in the light of the existing data. Multidimensional scaling is primarily useful in structuring information about how stimuli are perceived, and determining how complex the descriptions of the stimuli have to be to provide the same kinds of distinctions as are made by the subjects. It is assumed that the subjects perceive one or more attributes of the stimuli and the object of the analysis is to recover information about these attributes. While some perceived attributes may be simply related to a physical measurement, often the human sensory responses are not simply related to one variable, but depend very much on the context in which the variable is perceived. A piece of paper with a luminance of 10 foot-Lamberts will appear black in the context of a sunlit snowfield, but very bright if seen on an overcast night. Even more difficult to associate with simple measurements are perceptions of appropriateness in color schemes and other aesthetic evaluations.

Another purpose of the scaling analysis is to determine preferences where there are a variety of stimuli which may influence opinion. The scaling of such things as ''seating'', with respect to a ''good.. .:...poor'' scale may yield specific variables as significant. But, the variation in the stimuli may not be sufficient to do more than distinguish gross features. While not as specific as ''light quantity'', this kind of information can be particularly useful in making design decisions, because it provides an overview of the desirability of extant alternatives.

Some definitions may be necessary to distinguish between the concepts involved in the methodology. The analysis process is designed to yield *dimensions* which are defined as specific stimulus locations relative to each other and expressed as a graph or table of numbers. An *attribute* is the perceptual equivalent of a dimension, and reflects a characteristic of the environment which allows for meaningful distinctions. It is hoped, that as a result of the scaling and analysis process, the dimensions will approximate attributes. An evaluation or *rating scale* is the means used in this study to allow the expression of perceptions. Due to limitations in vocabulary, it may be necessary to name dimensions after the rating scales which have best allowed an attribute to be expressed. Occasionally it will be necessary to refer to the mathematical model of a dimension in the abstract, in which case a dimension is referred to as an *axis*. The characteristic of the environment which is thought to relate to a dimension is termed either a *physical variable* or a *feature* depending on whether a continuous variable or a set of discrete alternatives is thought to exist.

In addition to aiding in identification of the attribute, the development of quantitative relations between evaluations and physical variables may require the use of the scaling procedure. In developing some quantitative correlates it may be reasonable to conduct research on artificial stimuli, outside of the context provided in assessment of occupied environments. In other cases, the most complete context is desired and it will be necessary to use a multidimensional approach to separate the attributes of interest from other responses. For example, in assessing glare it may not be meaningful to assess adverse responses outside of the context of visual tasks in a library as compared to a dining area, because the implied tasks are different and the adverse response may also differ.

Choice of Stimuli

It is necessary for the subjects to evaluate a set of stimuli, chosen to represent the kinds of variation to be investigated. The stimuli may either be real, full-scale, active environments, or some form of representation. The representation of the environment (slide, model, mock-up, etc.) should be evaluated in the context of either experience or realistic conditions. In evaluating slides of messing area seating, Groups A and C both favored movable seating to cantilevered seating fixed to the table supports. While the stimuli were presented as slides, the evaluation could be considered as taking place in the context of the groups' experience at sea. The less experienced Group B, in evaluating the stimuli as visitors, made a similar distinction; they also preferred movable seating. Without these experiences, the credibility of evaluations would be questionable.

One difficulty in evaluation of models is that the users may see ''new'' alternatives as ''better''. Unanticipated problems may not be perceived and where existing conditions are not seen as particularly favorable, any change may appear to be to the better. To some extent, this problem can be alleviated by including rating scales which assess the ''newness''. In any case, the evaluations under these conditions should be considered as a screening of notably unfavorable alternatives and not as a positive approval of any new schemes.

The number of stimuli used will depend primarily on the number available and the time that can be devoted to the evaluation. The more complex the range of features to be investigated, the larger the sample should be. Where two or three dimensions are expected, it is difficult to distinguish effects if fewer than ten stimuli are used and this generally represents the lower limit of the number of stimuli required. In the evaluation of expensive prototypes, it will probably be worthwhile to develop and work with smaller numbers of

stimuli. This being the case, there is a strong likelihood that the number of dimensions will be restricted by the limitations in stimulus variations, rather than the perceptual capabilities of the subjects. The testing may be useful for evaluation and may provide some data, but would tend not to allow as wide a range of dimensions to emerge as could be the case in working with more stimuli.

The introduction of unusual stimuli within a coordinated set may result in the odd stimuli appearing at the extreme on many dimensions, which would distort the analysis of the remaining stimuli. It may be desirable to introduce several members of a distinct type, so that where there is a range of differences within the type and within the rest of the stimuli, then the dimensions will show these parallels. An unusual example may fit within the pattern of the stimuli on a dimension, but it requires several examples to begin to demonstrate that fit. By including several amphibious ships in the study of ship messing spaces, it was possible to note that the general results applied to both destroyers and amphibious ships. It was noted, however, that the *ship as a whole* dimension tended to be rated lower for amphibious ships, perhaps because of the visual effect of cargo areas of the ships viewed en route to the messing area. Although one carrier might have been available for study, is was not included because it would be difficult to generalize with respect to one example of that messing area type.

The elements which can be scaled include anything which is thought to be perceived and may vary from one environment to the next. This ranges from the friendliness of the occupants of an environment, to the color scheme, to the amount of light. The perceptions will be somewhat the same whether the full-scale environment is visited, or some other form of representation is used, provided that essential features are communicated in the representation. It would be very difficult to communicate an adequate impression of the crew's friendliness in a few slides or a model. This may not be an interesting

topic except to allow expression of a possible response on board ship which could affect other judgments. It is not difficult to communicate color and visual texture, as well as the relative size and position of surfaces using color slides. Also, with slides it is possible to choose particularly favorable or unfavorable scenes in the same environment. Yet, a slide cannot accurately communicate the amount of light in a space because of the limited contrast range of film and the necessity of changing exposures from one space to the next in order to model the adaption of the eye. Therefore, any interpretation of the responses must be based on the slide as the stimulus and not on the environment as a whole. It is possible to select and present portions of environments which convey particular design features and assess their appropriateness without concern for the entire environment as a stimulus.

Another form of stimuli would involve materials for floors, seats, tables, or walls. To some extent, given a sample of the material, an evaluation can be made of the material in isolation. Where the coordination of colors is important, it may be necessary to use a model which incorporates the material in a context, which can be presented as slides. As most materials come in a variety of colors, it may be possible to separate color evaluation from an evaluation of textural and mechanical properties. There is a clear consideration necessary for the conditions of the evaluation. A floor material which may become wet in a high sea, cannot be effectively evaluated for traction under less severe conditions. It would be a practical experiment to install a variety of materials in a passageway and then do an evaluation under varying conditions.

Subjects

The choice of individuals to do the evaluations depends on what kind of experience is necessary. In some cases, the background of the

subjects may lead to a set of aesthetic preferences which differ from other sets of subjects. Architecture students might not have the same color preferences as sailors. These preferences may be divergent or it could be that the sailors would simply be less critical. Where divergent preferences exist, it is necessary to identify the group whose satisfaction is most important and use their evaluations, or to seek a common ground acceptable to the divergent tastes. Where the same kinds of preferences can be expressed by more discerning subjects, then the more critical judgments are appropriate since they will likely make better separations at the most preferred end of the scale.

Some observers because of training or continued interest over a period of time, will make distinctions between stimuli that ordinary individuals would not make. To some extent, the more discerning the observers the better, as long as they are responding on the basis of common human perceptual abilities. In evaluating lighting in libraries, architecture students distinguished between glare from lights and glare from surfaces (Blasdel, 1972). In responding to the same rating scales, the sailors evaluating messing areas did not distinguish between the different types of glare. This may have been due to a lack of variation in the environments, or the irrelevance of separate rating scales in the context of dining, but it is more likely that ''glare'' was a single perception to the sailor group and represented several distinct attributes to the student group. Since in design the problem of surface reflectances (direct and diffuse) can be considered somewhat separately from fixtures and overhead design, it is useful to have this distinction made.

Subjects may have a particular attachment to one or more of the environments to be evaluated. Such a case may occur where subjects come from each of the environments and evaluate other environments as well as their own. This effect could lead to a research approach which would be particularly useful in identifying long term effects,

but to date it has not been possible to assemble such an experiment. The subjects have been ''disinterested'' parties with respect to particular ship environments. The architecture students did evaluate their own library, but the only dimension where the evaluation of the environment showed influence was in the *overall evaluation* which was somewhat better than would be indicated by individual ratings. This suggests that subjects ''objectively'' evaluate individual rating scales on the basis of physical evidence, but may be influenced by other considerations in the more inclusive scales.

If some subjects do not evaluate some of the environments, the analysis can proceed by using the data for the pairs of environments which were evaluated by a particular subject. Account must be made for the number of individuals contributing to each pair. This kind of analysis is possible only for the development of inter-environment dissimilarities for each rating scale. In any experiment where attrition is possible without causing all of the data for the dropouts to be rejected, it is possible to introduce a bias in the environments evaluated early or late in the experiment. While slide presentations result in few missed environments (occasionally a rating scale is skipped), the process of visiting one ship a day resulted in some attrition. Only 11 of the 38 subjects visited all of the ships, and the last week only 23 participated regularly. The average rating for the last week's ships tended to be high, but when each person's data for all the ships together was brought to the same mean, the evaluation for these ships, with respect to the individual dimensions, was in line with the physical features on board. This suggests that the less satisfied subjects tended to drop out, and that satisfaction was not biased toward any particular features.

Evaluation Scales

The rating scales are used to provide multiple assessments of each environment. Ideally, the scales extract the information the subject

has to offer without becoming redundant or asking for distinctions the subject is not prepared to make. It is not possible in advance to know precisely what dimensions will result from analysis of the data. This makes it necessary to ask for more evaluations than are likely to result in dimensions, so as not to miss any areas where the subjects may have information. Each scale will be used by each subject as many times as there are environments to be evaluated and the effects of any extra scales tend to accumulate. A topic for further research involves the adverse affects of too many rating scales. A subject may rate three scales considering each independently, but where numerous, more specific scales are used to extract the same information, the subject may assign common meaning to the scales and actually reduce the amount of information transmitted.

The most common type of evaluation required is to ask for a ''good...:...poor'' rating of some element of the environment. The elements rated in this way can include color, the overall impressions, the arrangement, materials, colors, cleanliness, and even design. Rather than using a general evaluation, it is possible to use specific terms at the ends of the scale: ''the air is: warm...:...cool''. Where it is not clear that the mid point or one end point of such a scale represents the desirable alternative, then it is possible to include an additional evaluative scale. The effect of such a scale, provided both scales result in identifiable dimensions, would be to show that either warm or cool (in this case) is less desirable than a more moderate temperature. The result of a graph would be a $\cap$ shaped curve, where the vertical axis represents desirability and the horizontal axis shows the perceived level of the particular variable. It is an open question which type of scale is to be preferred. Since the subjects define the terms on which quality is based, it may be more appropriate to use ''good..poor'' wherever possible, resorting to more specific scales only where it is necessary to elicit responses to features which would be difficult to describe otherwise. To some extent, the specific scales can be used to clarify potential

responses to complex stimuli by eliciting a description as well as the evaluation. In the shipboard evaluations, the subjects were asked to evaluate the room surfaces on a ''good..poor'' scale, and then to rate whether they were ''cluttered..uncluttered''. This aspect (clutter) could be an important feature, and would be difficult to assess by any physical measurement.

Another form of evaluation is to ask which of two stimuli is the more dominant: ''ship's noises...:...human noises''. This kind of evaluation was particularly difficult as subjects wished to express that both were objectionable and occasionally marked both extremes. In such cases, it would be more appropriate to use the two scales to assess the different stimuli, and then consider the relative impact in later analysis. Further confusion, on this dimension, was caused by television and music being played on the mess decks during the meal.

It is desirable to allow the expression of various degrees of response. Therefore, the scales are usually divided into five, seven or nine alternatives. Some individuals will only use the middle and end points of a scale, while others (college students) will express some dissatisfaction if they do not have the opportunity to express three levels of response to either side of neutral (Osgood, Suci, and Tannenbaum, 1958). Garner (1960) shows the amount of information transmitted uniformly increasing as the scale length is extended from four to 20 steps. Most of the information available was extracted with four categories (about 0.35 bits), with four times that number of categories adding only 0.10 bit. The problem of the number of categories seems to be more one of providing a comfortable scale for the subject to use, than one of trying to obtain marginally additional information. A seven point scale was used for the evaluation of visited environments, but the scale was reduced to five points for the slides, since it seemed unlikely, in this case, to expect as many distinctions.

It is possible that a significant rating scale may be omitted from the scales provided. In the questionnaire (Appendix A) used to evaluate slides, no mention was made of the nature of the overhead, yet the results use a variety of other scales to strongly distinguish between those environments with a hung ceiling and those without. While omission of an important scale may leave the investigator with the problem of interpreting a distinction he has not provided for, it is apparent that a topic of significance to the subjects will appear as a dimension whether it is provided for explicitly or not.

In developing a questionnaire, it may be desirable to think of the subject as having a burden of information which he feels is important, even though it may be unrelated to the purpose of the research. A rating scale inquiring about the ''whole ship'' and about the ''food'' was included on the questionnaire to elicit some of these responses. As it turned out, the quality of the food varied sufficiently over the four day period of the different visits so that no consistent differences were found between environments. But eliminating the scale referring to such an obviously important aspect of the messing experience could have resulted in dissatisfaction with the evaluation process. Such scales can serve to define intervening variables and attach a particular scale to a dimension which would otherwise be difficult to identify.

Evaluation Processes

Ideally, the stimuli should be presented to each subject separately, with the order of the rating scales randomized for each presentation. A step further would be to evoke only one rating scale response on a single presentation to minimize the interaction between rating scales where the meaning is close. Unfortunately, these procedures complicate the presentation process and are not likely to result in additional information. It may be desirable for the subject to become

familiar with the order of the rating scales, so that he can learn to use them as a vehicle to express what he feels, rather than working through a different questionnaire each time.

Guiding the subjects independently through stimulus presentations, in order to reduce sequential effects is probably an unnecessary effort. Three or four distinct presentations would be adequate to reduce the effects of a single strong contrast in one presentation. An analysis of the responses of the two sub-groups from Group A to different presentation orders of the same slides could help to identify order effects. It is likely that after the first few slides are presented, the possibility of a sequential effect is reduced. The subjects develop a background against which the rating can occur and to some extent they develop their own "definition" of the meaning of individual rating scales. A presentation of a set of or all of the stimuli before rating probably helps to establish this background. Such a presentation is difficult where occupied environments are to be visited. Where effects do occur it may be possible to distinguish them in the overall response, but not in the assessments of more specific features in the environment.

Subject interaction is another problem, since even small sounds and motions can communicate general approval or disapproval by some members of the viewing or visiting group. Again, it is likely that the effect will influence the overall evaluation, rather than particular features. To what extent, if any, the opinion developed through "group interaction" differs from the results of more independent evaluations is not now known. A future project could explore the additional variety of responses obtained from one-man presentations and whether such additional effort would be worthwhile. The main question is whether alternate opinions are sufficiently shared as to become separate dimensions. At the extreme, the more vocal opinions could form an artificially influential minority.

In exploring alternative uses for the same environment, it may be difficult to elicit different responses to similar rating scales if the scales are presented at the same time. On the evaluation scale for the appropriateness of various color schemes for recreation and dining, there was some indication of different responses. But, the correlation was sufficiently high as to make separation of the responses difficult. Where multiple modes of use are to be assessed it may be necessary to evaluate each mode separately, presenting the same set of stimuli and reorienting the assessment process on the part of the subjects.

STANDARDIZATION OF DATA

Although raw data could be used to generate the dissimilarities, this would lead to unequal weighting of opinion, since those individuals who tend to use the ends of the scales would have more weight than individuals who tend to be more moderate in expressing themselves. The data may be standardized to bring the ratings from each individual as a whole (across all environments and rating scales) to the same mean and standard deviation. Where all of the evaluative scales tend to be rated together (indicating little discrimination of their separate meaning), it is possible to standardize each individual's ratings of an environment. This would allow a scale rated ''not quite so bad'' or ''not quite so good'' relative to other ratings of the same environment to be more prominent in the analysis. Results using this approach show a smaller *overall evaluation* dimension, but have been unable to provide dimensions not present from the regularly standardized data.

There is some problem in considering all the rating scales together. An alternative procedure is to bring an individual's ratings of a given scale (of all environments) to the same mean and standard deviation. This last approach has not been programmed as yet, but,

could be useful in reducing the possible effects of standardizing broadly evaluative scales (color: good...bad) at the same time as more specific scales (light: little...much). One adverse affect of this form of standardization would be to equalize the relative importance of each scale, even though an individual may evaluate some scales moderately and other scales using the extremes.

More research is necessary in exploring the implications of alternative schemas of standardization. It does appear, however, that using raw data without some accounting for differences in subject rating behavior yields solutions with a smaller number of dimensions. Apparently those individuals who tend to use the extreme points of the scale tend also to perceive fewer distinct attributes of the stimuli.

ANALYSIS AND INTERPRETATION OF MULTIDIMENSIONAL SCALING

In any one analysis it is necessary to choose the appropriate rating scales to be analyzed together (each represented by a matrix of inter-stimulus dissimilarities), to choose an appropriate number of dimensions (or range of dimensions) in which to do the analysis, and to interpret the results. The investigator is searching for attributes, while the mathematical process of the computer analysis is seeking to maximize the variance accounted for given the set of matrices and the number of dimensions permitted. While the goals are ideally in harmony, there are various ways to maximize variance without necessarily providing an interpretable solution in every dimension, or revealing all of the potential dimensions in the data. The process of sorting the rating scales into "compatible sets" and finding the appropriate number of dimensions to request for that set is, to some extent, trial and error with the initial results providing a suggestion of relations which will hopefully emerge later in clearer form.

Perhaps the most common problem is ''overlapping dimensions''. Here two relatively independent sets of scales result in sufficiently similar arrangements of the environments on the dimensions as to inhibit the emergence of two dimensions. Figure 3 shows a dimension exhibiting this problem. In the Figure, the scale on the right is the ''stimulus dimension'' which shows the relative location of each of the stimuli to each other. The length of this axis has no particular significance as the total variance of the stimulus positions is constrained to add up to 1.0. As mentioned previously, there are no ''positive'' or ''negative'' connotations to the position of a stimulus on the axis, as the positions may be reversed end-to-end and still adequately represent the ''dissimilarities'' between stimuli contained in the rating scale matrices. The extent to which the dimension is ''relevant'' to a given rating scale matrix is shown by the axis on the left. If a dimension completely reproduces the dissimilarities in the rating scale matrix, it will have a weight of 1.0; but random variations in response will rarely allow a weight over 0.8 to occur. Weights lower than 0.4 generally represent random variation, although exceptions may be justified.

The interpretation of a dimension depends strongly on the implications of the relevant rating scales. In Figure 3, it is clear that *overhead surfaces* is the dominant rating scale, and *seating*, *tables*, and *color scheme* also contained parallels to this dimension. There is no necessary connection between seating and the overhead, except perhaps that ships with some improvements (hung ceilings) tend to have others (movable seating). Environments 28, 24, 22, and 26 have hung ceilings in good repair with flush fixtures, Environments 30 and 33 have continuous plastic diffuser ceilings, the rest have ceilings in poor repair (27, 29), or exposed piping and ductwork (21, 23, 32, 25, 31). There is no reason why 31 and 23 should differ with respect to the overhead. They do, however, differ with respect to seating, since Environment 23 has independent stackable seating and Environment 31 has cantilevered seating. A separate analysis of the seating

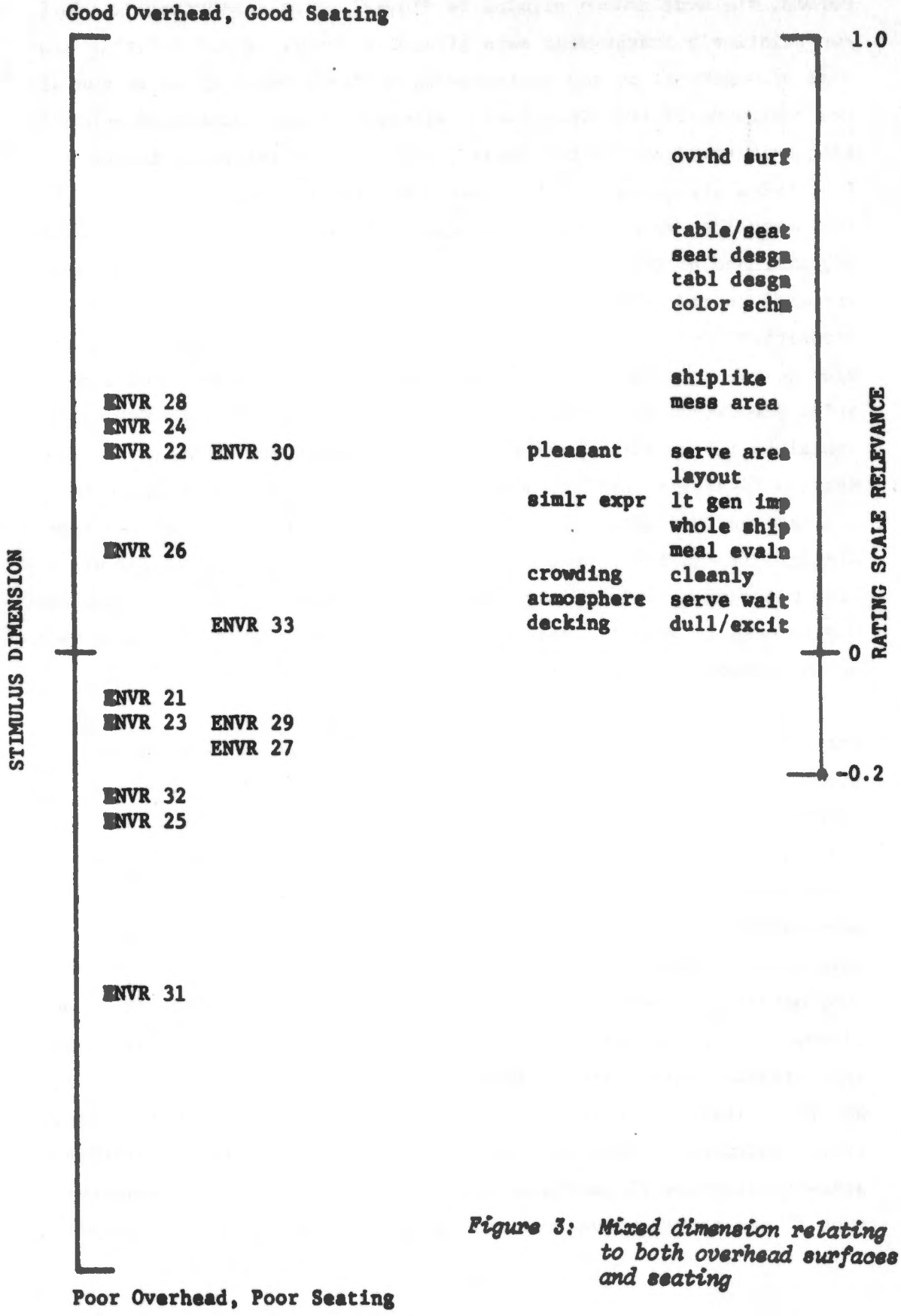


Figure 3: Mixed dimension relating to both overhead surfaces and seating

in Figure 4 shows this distinction in the seating more clearly in separating the fixed from the movable seating.

While the evaluation of the overhead was clearly an important potential dimension, it emerged only in the five-dimensional analysis; the six-dimensional analysis failed to show it. In the six-dimensional analysis the dimension gave greater weight to *seating design* and the *table/seating combination*. The overall correlation of the *overhead surface* matrix to the reproduced dissimilarities was 0.90, while the six-dimensional analysis provided a correlation of 0.89. Rather than having a single large weight of 0.81, the matrix contains two smaller weights of 0.56 in a dimension dealing with color scheme, and 0.49 in a dimension dealing with seating. This illustrates a second problem, in that it is possible to adequately "reproduce" a dissimilarities matrix as a mixture of two somewhat unrelated dimensions. The implication here is that *overhead surface* will need to be isolated from the other rating scales if it is to result in an independent dimension. There is some question as to whether the *overhead surface* scale can properly be isolated from the scales dealing with *color scheme*, since the evaluations may be linked. On the other hand, they may be considered in the context of lighting systems.

An example of a clear cut dimension is shown in Figure 5, where a single rating scale matrix is well reproduced by a dimension with the remaining matrices having only a random level of relevance. The scale is perhaps of little interest in the interpretation of the effects of the physical environment, since it suggests that men visiting on board the ships had to wait for their meal (especially on Environment 25). What is of interest here is that the other matrices do not contain this dimension; this suggests that the ratings of the environments on the other scales were unaffected by this event. It might be possible to suggest some relation to the matrices dealing with *serving area* and *atmosphere: friendly...unfriendly*; but this relation would be secondary. The positions of the environments other than 25

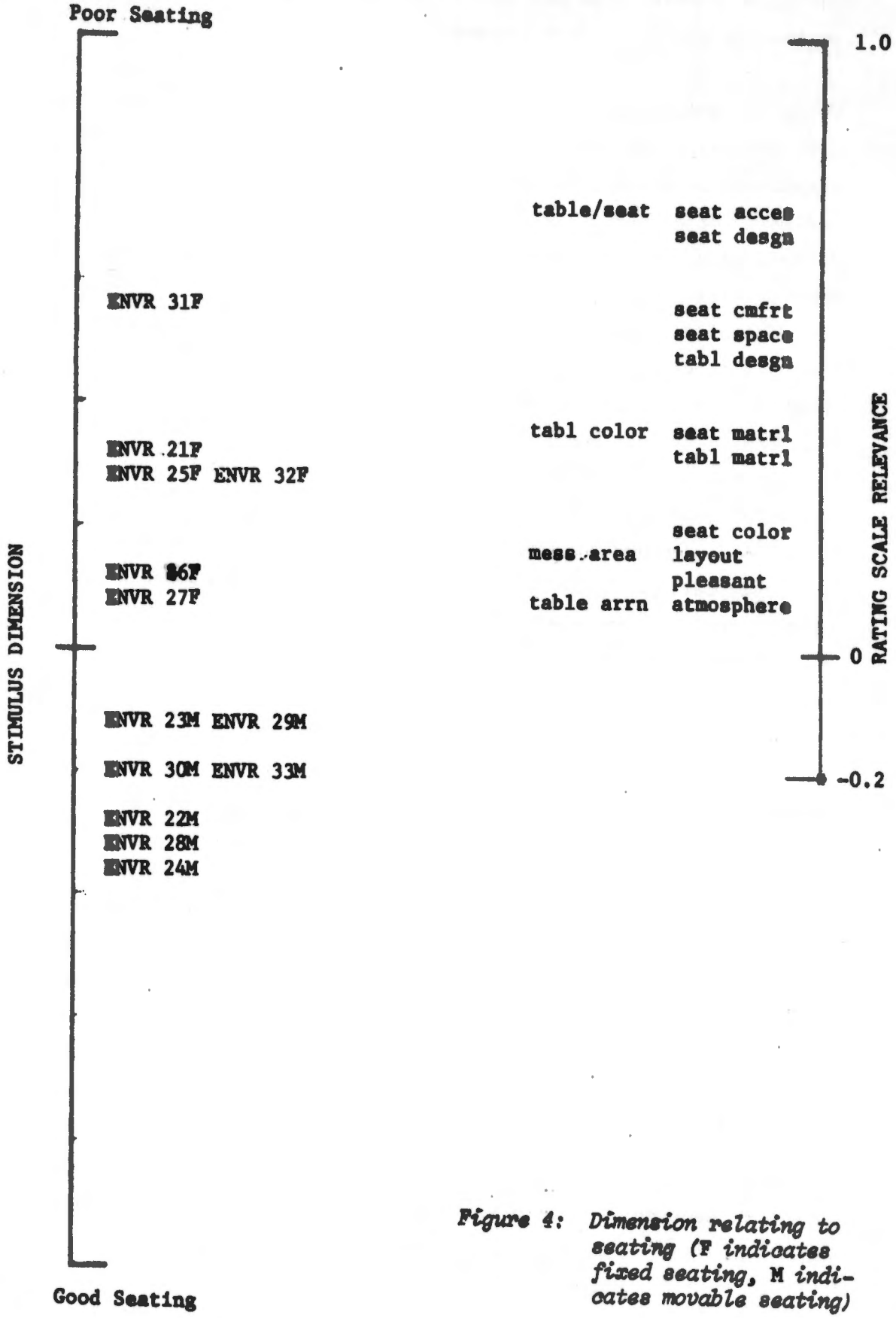


Figure 4: Dimension relating to seating (F indicates fixed seating, M indicates movable seating)

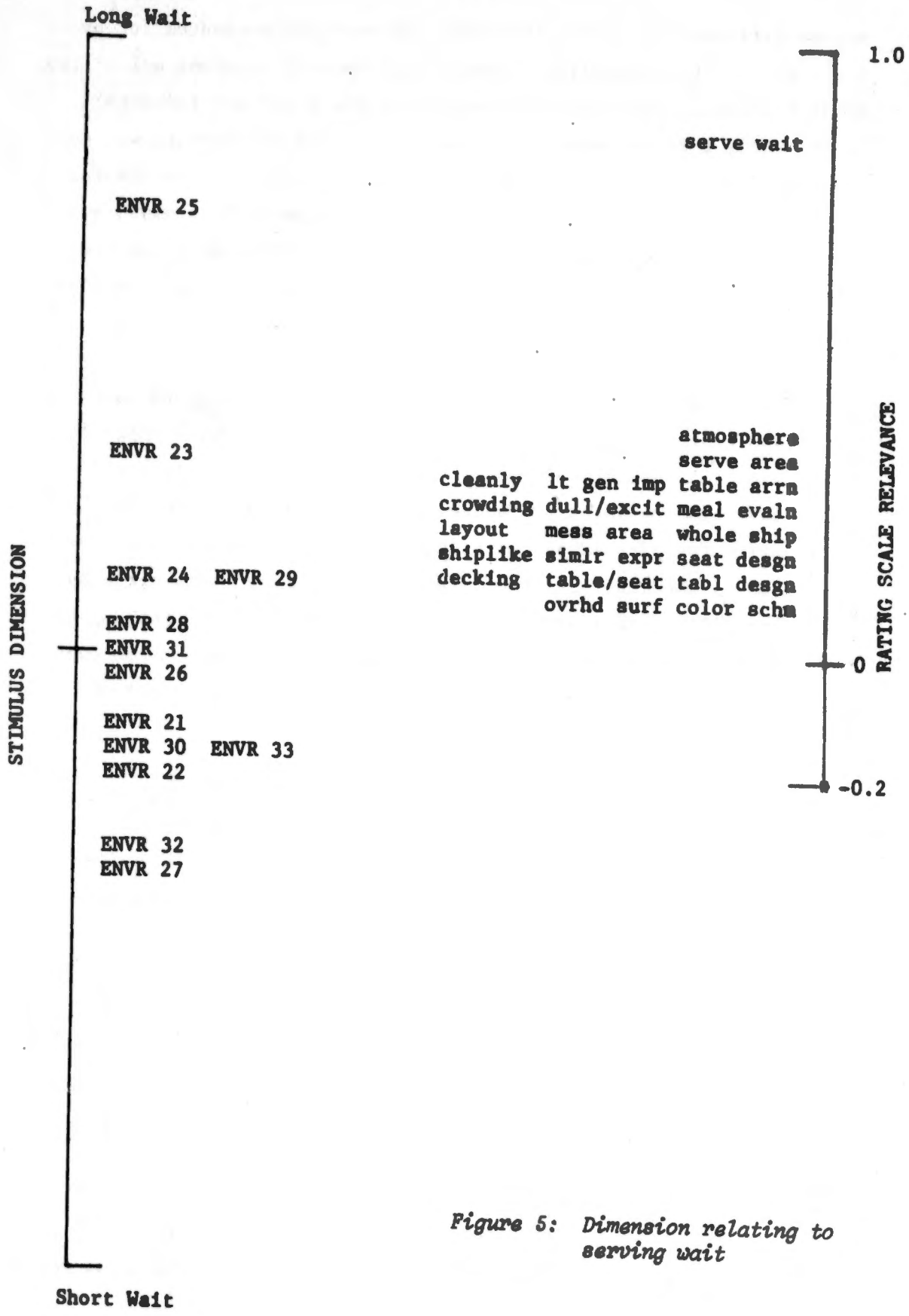


Figure 5: Dimension relating to serving wait

may be difficult to interpret, since the variance accounted for by the position of Environment 25 (at 0.716) amounts to about 60% of the total (including the shift of the mean of the other environments). It is likely that the wait was longer in 23, and the service was especially fast in 27 and 32. When a single environment accounts for so much of the variance, the position of the axis is determined by approximating the dissimilarities between that environment and the others, rather than the dissimilarities of the whole set of environments.

The interpretation of the stimulus axis in Figure 5 required some comparison of the ratings of the environments to determine which end of the axis represents the ''long'' wait and which, the ''short'' wait. The data presented in Table 1 shows the rating frequency distribution for each environment on the rating scale and is a rough indication of the central tendency and variation from this tendency. The ''missed'' column indicates the number of individuals failing to check one position on the rating scale. It was necessary to account for missing data by computing the dissimilarities for each person

ENVIRONMENT	RATING CATEGORIES								COMPUTATION	
	1	*2*	*3*	*4*	*5*	*6*	*7*	*MISSED*	*MEAN*	*S.D.*
ENVR 21	20	8	6	1	0	0	0	3	1.66	0.86
ENVR 22	20	11	2	0	2	0	0	3	1.66	1.01
ENVR 23	14	8	6	2	1	2	1	4	2.35	1.63
ENVR 24	13	13	2	5	3	0	0	2	2.22	1.29
ENVR 25	3	2	4	3	6	2	9	9	4.69	2.04
ENVR 26	12	10	9	2	3	0	0	2	2.28	1.22
ENVR 27	17	5	8	1	1	0	1	5	2.03	1.38
ENVR 28	7	6	10	0	5	2	0	8	2.87	1.54
ENVR 29	7	10	8	3	5	0	1	4	2.79	1.49
ENVR 30	8	13	3	1	0	0	0	13	1.88	0.77
ENVR 31	12	7	4	2	0	0	1	12	2.04	1.37
ENVR 32	20	2	1	0	0	0	0	15	1.17	0.48
ENVR 33	11	5	2	2	0	0	0	18	1.75	0.99

Table 1: Frequency distribution of ratings of different environments for the serving-wait scale

evaluating both environments of each pair, and then dividing the total sum-of-squared-differences by the number of individuals contributing.

In developing selections of rating scales, it is important to include a scale or two which are known to relate to the *overall impressions* of the space, so that where this dimension is present in the more specialized rating scale matrices, it may be separated in the analysis. Where several rating scales seem to be multidimensional, it may be appropriate to do an analysis with as few as three or four matrices. Except in initial exploration, it is rare that more than 10 or 15 rating scales are useful in a given analysis; they either contain far too many dimensions, or were not distinguished by the subjects and are redundant. Some redundancy, especially where the lack of distinction is unexpected, can clarify a dimension and connect ideas not necessarily combined in the selection of the rating scales.

Figure 6 illustrates one such dimension, where the *layout* is related to *table arrangement*, *crowding*, and *table design*. While most ships do well, an old WWII destroyer type (25) does very poorly, as does a more modern destroyer with oversized chairs (22). Perhaps the most interesting distinction is made between two nearly identical ships, one with fixed seating (21) and one with moderately sized movable seating (23); the movable seating rates much better, suggesting that it be used to reduce crowding and to improve layout. Whatever the advantages of movable seating, it should be sized appropriately to the available space. In the interpretation of this dimension, it is necessary to define *layout* in the light of the other related terms. This leaves open such questions as whether the arrangement of Environment 27 with its rows of four man tables separated by six inches or so (allowing the gaps to be ignored or used as a social dividing line without implied ill feeling) was rated well because of this feature, or whether it merely provided adequate space between seats (which were fixed to posts on the floor). Comments were encouraged

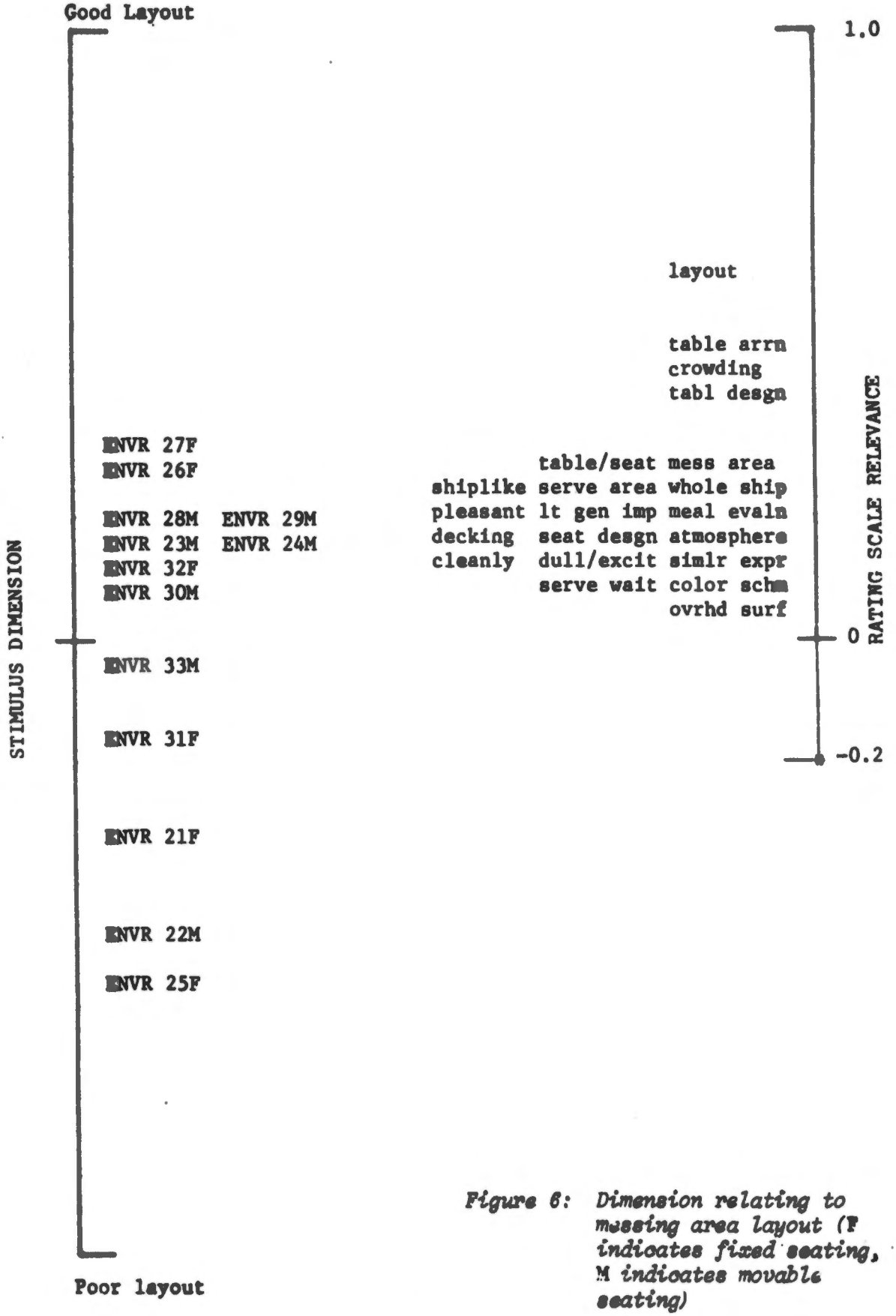


Figure 6: Dimension relating to messing area layout (F indicates fixed seating, M indicates movable seating)

on the questionnaires. There were eight favorable comments on Environment 27 which tended to relate to ease of movement to seats and to space once in the seat. One person comments favorably on the ''four man tables''. These comments help, but they do not provide strong evidence.

This discussion suggests that it is difficult to separate the mathematical analysis from the interpretation of the results. In the preliminary scaling, it is likely that a variety of dimensions will achieve a high relevance to rating scale matrices, although perhaps confounded with other scales related only in a mathematical sense. The analysis has emphasized the interpretability of the dimensions; the stimulus positions on the dimension are explained by concepts related to the rating scale matrices which contain that dimension. Under these objectives, it is difficult to assess the significance of the results in a statistical sense, and it may be possible that some results are due to chance.

In testing the statistical significance of a scaling solution, Carroll and Chang (1970) suggest the use of the ratio between variance accounted for (VAF) and the degrees of freedom ratio (DFR) as follows

$$DFR = \frac{r(n+m-2)}{nm(m-1)/2}$$

where r is the number of dimensions, m the number of stimuli, and n the number of subjects. The Monte Carlo investigation finds that a random data set will yield a ratio of 5.0 or less. This suggests that for mathematical significance the ratio should exceed this figure. Carroll and Chang worked with matrices for each individual rather than for each rating scale, so to use this approach it is necessary to substitute the number of rating scales, g, for n. Unfortunately, the advantage of increasing the number of subjects to improve the significance of the results is lost here, and in fact the use of inter-environment matrices for each rating scale requires a

different model. While analyses based on matrices for each individual rarely account for more than 30% of the variance, the analyses performed on rating scale data often reach 60 to 90%. At this level of VAF, another dimension may account for a small additional percentage, say 5%, and still be accounting for a significant portion of the remaining available variance.

The question of an additional dimension becomes less clear when interpretation of the results shows that while a small fraction of additional variance was accounted for, the interpretability improves because a dimension which formerly mixed two concepts has become two separate dimensions with distinguishable physical implications. Typically, the discussion of statistical significance has focused on whether additional dimensions are justified as accounting for additional variance (Kruskal, 1964). Nevertheless, such approaches do not locate the axes, and may not provide an appropriate means for assessing significance.

An alternate approach to the question of a dimension's legitimacy would be to examine the relevance weights. As any dimension will be partly contained in the "noise" associated with each matrix, some small positive weight for each rating scale and dimension is expected, but large weights would be an indication of significance. It is possible to do additional Monte Carlo simulations with the generation of ratings for environments by individuals, and then to process the ratings as if they were data. Initial simulations have shown that weights tend to concentrate in the 0.2 to 0.4 range with only one in 360 exceeding 0.50. In solutions of many dimensions, the higher dimensions tend to have smaller weights. Although these simulations have used entirely random data, it would be interesting if a certain known percentage of the variance could be assigned to one or more of the artificially generated dimensions. Presumably, the random level of the relevance weights would decrease in some proportion. More programming is indicated to implement this exploration; it should provide tests of significance suited to rating scale analysis.

One strong indicator of having requested an excessive number of dimensions is negative weights. The relevance weights are only positive in the model representing squared terms, but the convergence process allows these terms to become negative and in effect subtract distance already generated by other positive weights. While this process allows for more variance to be accounted for, it does not have a generally applicable interpretation. The problem is caused by not satisfying the triangle inequality and if this inequality occurs in a low number of dimensions it may be due to underestimates of the additive constant necessary to eliminate underestimates of dissimilarities between stimuli. While most metric multidimensional scaling requires an estimate of this additive constant, the generation of dissimilarities using ratings tends to overestimate dissimilarities because of random components in ratings. Thus, it is not generally necessary to compute the constant. The analyses performed using ratings tend to produce residual dimensions with no rating scales having significant relevance weights before added dimensions result in negative weights.

CONCLUSION

This discussion has centered on exploring the problems of using multidimensional scaling and in the interpretation of the results. Many of the questions associated with interpretation would not arise with simpler methods of analysis. With such methods the quantitative results would be simpler to understand, but less informative. One of the difficulties in exploring methodology is that the technique has been used under difficult conditions with stimuli which are complex and not easily shared with the reader. Future exploration should probably be related to more abstract stimuli which can be shared and on which research has already been conducted. The work of Young and Cliff (1972) suggests such a set of stimuli (words describing human locomotion). In such a context, it would be possible to demonstrate

the benefits of this type of scaling by showing relative efficiency in the use of the subject's time and a potential increase in the dimensionality of the results. Such an approach, combined with Monte Carlo simulation, has the potential for providing a firm methodological basis before a rigorous interpretation of data collected under field conditions.

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III. USING SLIDE VIEWS OF MODELS TO STUDY INTERIOR FINISH COLORS

The selection and application of interior finish colors are important determinants of the visual quality aboard ship, and as such, can influence the habitability of the shipboard environment. Colors used in interior space affect one's aesthetic reactions and can contribute to perceptual illusions of apparent size, distance, warmth, coolness, weight, and spaciousness. Also, variation in color schemes from one space to another within the ship's confined environment can effectively help to reduce the monotony experienced in shipboard living. The sameness of interior treatment from one space to another, which was observed as being typical of most ships, can only exacerbate the feelings of monotony experienced by ships' personnel as they repeat their day-by-day routines at sea.

The importance of the relationship between interior color schemes and shipboard habitability has been acknowledged in the Navy as

evidenced by recent pilot projects involving modernization and habitability improvement of ship interiors in which the Naval Ship Engineering Center has specified varied schemes which were to be derived from principles of color dynamics (Castle, Saklem and Weiler, 1971). While variation in schemes may be achieved easily enough, thereby serving to alleviate the monotony of visual stimuli in a ship's environment, the proper determination of each scheme presents a far more difficult problem. If the color selection and application is to be based upon principles of color dynamics, then such principles must be defined, understood, and validated in order to be a useful aid to ship designers.

PROBLEM

The designer would like to be able to specify color applications for ships' spaces which are predictive of desired user response and behavior. Color is, after all, a relatively easy factor to manipulate in the shipboard environment, and, at a minimum of cost and disturbance, considerable effect may be achieved through its proper use. At present, however, the understanding we have of the particular effects of color in interior space is inadequate to provide a basis for such calculated specification.

Of interest to the designer are both the perceptual, or illusionary, effects of color and the affective, or emotional aspects. If, for example, it were found that certain arrangements of color were capable of significantly influencing a crew's perception of the size of a given space (a perceptual effect), then the designer would have a possible means to alleviate the feeling of confinement caused by low overheads and other spacial impingements. If certain attributes of colors in combination were found to significantly and consistently influence a crew's preference for interior color schemes (an affective aspect), then principles of color application could be derived

which would be predictive of positive user acceptance. If, again, certain attributes of colors in combination were found to significantly and consistently influence a crew's mood associations (another affective aspect), then principles of color application could be derived which could be predictive of desirable emotional states.

BACKGROUND

A review of the literature on the perceptual and affective aspects of color has been undertaken in connection with this study, and an analysis of this material will be included in a forthcoming technical report on the subject.

Most investigations in this area have been conducted in laboratory settings where specific variables could be studied under controlled conditions. While information gained from such experiments may have some relevancy to the problem of color application in interior space, simple generalizations would not be appropriate. The experiments pertaining to the perceptual and affective aspects of color have relied mainly upon presentation of relatively small areas of color stimuli, usually samples of chromatic papers. Although such procedures allow the economical testing of a wide range of colors and color combinations under controlled conditions, the effect of a color on a small area may be quite different from its appearance on a larger surface in a room environment where the contextual effects of the lighting quality, reflectances, shadows, texture and form patterns, etc., are combined in a synthesis of visual stimuli, and the response of the viewer is to the combination of elements rather than individual factors.

Few quantitative studies have been made on the effect of color in interior spaces. Designers' rules-of-thumb for the use of colors in interiors are expounded in numerous texts, but the basis for

these assumptions is seldom clear. They are probably the product, to one degree or another, of several components: experience, fashion, common sense, myth, and without question, the personal tastes of many "color experts". It would be most valuable, for the purpose of assessing responses to color in interior spaces, to have data at hand on reactions to color stimuli from actual or simulated interior space.

User acceptance is, of course, a concern of the designer, and an important one. One theory of color application for office spaces advocates the use of colors which are as innocuous and unstimulating as possible (Logan, 1963). Only colors to which people respond with indifference are considered appropriate, the intent being to avoid any distracting influence which might be caused by the color scheme. While there might be some merit in adopting this principle for color application in shipboard work spaces, the appropriateness of its applicaton in messing spaces should be tested against general users' preferences. The color scheme, as an instrument to relieve monotony in the confined shipboard environment, could be used to differentiate the messing space from the other basic spaces on the ship in such a manner as would encourage use of the space and be appropriate to the activities there.

Indications of preference for, and acceptance of, various degrees of stimulation evoked by color applications would be helpful in this regard. While studies of affective aspects of color have provided useful general guides, the variance in response between different groups tested suggests that this information should be used discriminately. Ideally, one would depend upon data which was collected on subjects directly representative of the users for which the design was intended.

In light of the preceding discussion, two compelling reasons for undertaking an investigation to collect original data for the purpose

of this study are apparent: (1) It is desirable to present color stimuli for testing in the context of an interior space—a typical ship's messing area, and (2) it would be highly advantageous to have data from subjects repesentative of the user group—U.S. Navy enlisted personnel.

EXPERIMENTS

Presentation

In line with the strategy outlined for the project, which calls for the exploration of simulated environments as a means for eliciting user response to design variables which were either impractical or unobtainable in existing real environments, it was decided to simulate a messing space in scale model form. The purpose of the model was to obtain color scheme and pattern variations which were representative of real contextual conditions. The testing for user responses was conducted using slide views taken of the model.

A model of a typical mess deck for a ship of Destroyer type was constructed to represent a rectangular space 30 by 22 feet with an overhead clearance of 6½ feet. A scale of ¾ inches to 1 foot was selected as the most convenient size with which to work and still obtain the degree of detail required for realistic simulation. So that interior finish colors could easily be changed, the model was conceived as a construction of separate bulkhead, overhead, and deck elements which snapped together in varied combinations to illustrate different schemes. The model was also furnished with tables and chairs, the colors of which could be changed. For the most part, colors used on the surfaces were achieved with chromatic papers. The model was illuminated by two 500-watt, 3200K, incandescent photoflood lamps to simulate the light distribution of a system of recessed fluorescent luminaires, the interplay of reflections and

shadows from the various surfaces upon one another influencing the appearance of colors in much the same way as would be observed in actual interiors.

The presentation slides were taken with a 21 mm. f/3.8 lens using High Speed Ektachrome type B film. The camera was positioned so as to approximate a vantage point at one entrance to the space. The slides taken of the model appeared convincingly realistic when projected, and compared well with slides taken of actual ship interiors. Because of the high degree of control which was possible in photographing the model, the slides so obtained were much superior to those taken aboard ships in so far as their use for color testing was concerned.

Procedure

Three experiments were conducted using slide views of the model to elicit responses from the observers. In the first two experiments, slides were projected in sets of three by three projectors onto three screens placed side by side. In the third experiment, the slides were projected singly. The observers, all Navy enlisted personnel, viewed the slides in a room darkened to a level which allowed just enough illumination to fill in the questionnaires.

Experiment I. Seven sets of three slides each showing different brightness arrangements of achromatic colors on deck and bulkhead surfaces in the same messing area were presented. The overhead was white and the tables and chairs were a middle gray in all the arrangements. The observers were informed that the actual sizes of all the spaces were the same. While each set of slides was projected, fifty observers selected the scheme that felt "most spacious" and the scheme that felt "least spacious".

Experiment II. Eleven sets of three slides each showing different arrangements of color and pattern on deck, bulkhead, partition, table and chair surfaces in the same messing area were presented. The overhead was white in all arrangements except one. Each set of three slides illustrated variations on the same dominant color scheme, the variations representing a relatively low, medium, and high presentation of chroma, hue contrast, brightness contrast, and/or pattern. While each set of slides was projected, fifty-one observers selected the scheme that they "liked most" and the scheme that they "liked least".

Experiment III. Sixteen slides selected from among those used in the preceding experiment were presented singly, first in rapid sequence to acquaint the observers with the range of schemes, and then again allowing time to rate each one. Nineteen observers rated each scheme in four categories on a five-point scale: from "like" to "dislike", from "stimulating" to "unstimulating", from "appropriate for dining" to "inappropriate for dining", and from "appropriate for recreation" to "inappropriate for recreation".

RESULTS

Specific results of these experiments which may be of value to ship designers will be in the Technical Report to follow. Of interest here is the description and interpretation of the results in general terms which serve to indicate the potential of using slide views of a scale model to study interior finish colors.

In the literature dealing with perceptual aspects of color, there is some agreement that the brightness attribute is most responsible for illusions of distance and space. On the strength of this, the approach chosen for the first experiment employed achromatic color schemes, thereby isolating brightness (also called luminance) from the other attributes of color, hue, and chroma.

A total of eleven different arrangements of color were used in comprising the seven sets of three slides each. In each of the sets the brightness of either the deck or the bulkheads was varied in each of the three slides, while all other surface brightnesses were held constant. Three shades of gray were used to achieve high, medium, and low relative brightness values of the variable surface in each set, and of the constant surfaces between sets. Thus, in each set, the observers were required to make a judgment as to which scheme felt "most spacious" and "least spacious" from a presentation of three slides side-by-side in which either the deck was the same brightness value in each while the bulkheads were of high brightness value in one, medium in another, and low relative brightness in the third, or vice-versa. In one set, only a single accent bulkhead located directly opposite the observer was varied.

The results (Table 2) show a high degree of ambiguity which may indicate that observers had difficulty in making clear distinctions between the variable brightness values. Verbal comments made by some of the observers while being tested tend to substantiate this. The experiment could be simplified by eliminating the medium brightness value entirely, and presenting only two slides at a time. It would be interesting to see if the ambiguity persisted with such polarized choices. It would also be of value to repeat the experiment with the same observers after a period of time as a check on the data.

Because of the ambiguity mentioned, the results of the first experiment must be regarded as generally inconclusive although they produced some indication that the brightness of the deck surfaces is related to the perception of spaciousness; the brighter decks positively influencing the feeling of spaciousness.

The second experiment was designed to determine whether there was consistency in the relationship between preference and the degree

Table 2: Number of observers who judged achromatic color schemes of a simulated ship's messing area "most spacious" and "least spacious" in comparison sets of three, where the brightness of either deck or bulkheads was varied.

Deck		Bulkheads			
% reflection	relative brightness	% reflection	relative brightness	most spacious	least spacious
52	high	57	high	20	11
52	high	34	med.	10	8
52	high	18	low	19	29
				49	48
28	med.	57	high	17	19
28	med.	34	med.	11	8
28	med.	18	low	21	21
				49	48
14	low	57	high	24	12
14	low	34	med.	11	13
14	low	18	low	14	22
				49	47
52	high	57	high	18	5
28	med.	57	high	20	12
14	low	57	high	11	31
				49	48
52	high	4	med.	19	8
28	med.	34	med.	20	9
14	low	34	med.	9	31
				48	48
52	high	18	low	27	13
28	med.	18	low	13	10
14	low	18	low	10	26
				50	49
52	high	34,57	high	15	26
52	high	34,34	med	20	7
52	high	34,18	low	15	6
				50	49

Overhead was white (85% reflectance), tables and chairs were medium gray (34% reflectance), and lighting was constant in all cases.

of chroma, hue contrast, brightness contrast, and pattern of a color scheme. If a significant consistency were determined, this would provide a basis for the formulation of principles pertaining to these attributes which could be predictive of user preference. It is important to note here that, to be an effective aid to the designer, such principles need to be applicable to any choice of dominant color scheme rather than being determinants of that choice.

Eleven sets of three slides each were used in the experiment. In each of the sets, three degrees of the aforementioned attributes were presented as variations on a particular dominant color scheme. As the observers viewed the variations side-by-side in each set, they judged which scheme they "liked most" and which scheme they "liked least".

The results (Table 3) show that in nine sets of the eleven shown, there was a preference for the schemes composed of relatively high chroma, hue contrast, brightness contrast, and pattern. Munsell notations of the colors used in each scheme are listed in Table 4. Although the number of schemes presented was too limited to conclude that this represents a significant consistency, there is, nevertheless, a strong indication that there may indeed be a basis from which principles of color selection and application may eventually be derived.

Results of the third experiment, where 16 different schemes were rated on preference, stimulation, appropriateness for dining and appropriateness for recreation, are shown in Table 5. Each of the observers was given the same weight in determining the results through a normalization process which gave each person's data the same mean and standard deviation. The results were accumulated on the basis of how different the ratings were on a given rating scale for each pair of stimuli. The four sets of differences were then jointly analyzed in the multidimensional scaling program (see

Table 3: Number of observers who judged chromatic color schemes of a simulated ship's messing area "most liked" and "least liked" in comparison sets of three, where hue contrast, brightness contrast, chroma, and pattern of surfaces were varied.

scheme	relative hue contrast brightness contrast chroma or pattern	most liked	least liked
1-H	high	35	5
1-M	med.	15	1
1-L	low	1	45
2-H	high	29	11
2-M	med.	13	9
2-L	low	9	31
3-H	high	18	31
3-M	med.	25	3
3-L	low	8	17
4-H	high	27	17
4-M	med.	12	7
4-L	low	12	27
5-H	high	36	6
5-M	med.	13	0
5-L	low	2	45
6-H	high	23	15
6-M	med.	19	4
6-L	low	9	32
7-H	high	24	16
7-M	med.	22	6
7-L	low	5	29
8-H	high	11	17
8-M	med.	5	25
8-L	low	35	9
9-H	high	34	7
9-M	med.	12	9
9-L	low	5	35
10-H	high	38	0
10-M	med.	12	16
10-L	low	1	35
11-H	high	34	9
11-M	med.	8	2
11-L	low	9	40

Table 4: Munsell notations of color schemes used in tests. H = hue, V = value (brightness), C = chroma.

scheme	high (H)			medium (M)			low (L)		
	H	V	C	H	V	C	H	V	C
1- deck	2.5Y	9	2	2.5Y	9	2	2.5Y	9	2
bulkhead	10YR	8	10	10YR	8	10	10YR	9	6
bulkhead	2.5Y	5	6	10YR	8	10	10YR	9	6
partition	2.5PB	4	10	2.5Y	5	6	7.5YR	8	6
tables	5YR	7	12	5G	6	2	5G	6	2
chairs	2.5YR	4	6	2.5YR	4	6	7.5YR	8	6
2- deck	10B	5	10	10B	5	10	10B	5	10
bulkhead	10YR	8	2	10YR	8	2	10YR	8	2
bulkhead	2.5YR	5	12	10YR	8	2	10YR	8	2
partition	10B	3	8	10B	3	8	10YR	8	2
tables	dark wood-grain			dark wood-grain			dark wood-grain		
chairs	N	0	0	2.5YR	4	6	7.5YR	8	6
3- deck	2.5YR	5	12	2.5YR	5	12	2.5YR	5	12
bulkheads	5Y	9	2	10YR	8	2	10YR	8	2
partition	5Y	6	4	5Y	6	4	10YR	8	2
tables	10B	3	8	5YR	6	6	5YR	6	6
chairs	N	0	0	2.5YR	4	6	2.5YR	4	6
4- deck	5Y	6	4	5Y	6	4	5Y	6	4
bulkhead	5Y	9	2	5Y	9	2	5Y	9	2
bulkhead	5RP	5	10	5Y	9	2	5Y	9	2
partition	dark wood-grain			5G	6	2	5Y	9	2
tables	7.5Y	7	4	7.5Y	7	4	7.5Y	7	4
chairs	2.5YR	4	6	2.5YR	4	6	2.5YR	4	6
5- deck	5Y	6	4	5Y	6	4	5Y	6	4
bkhd. panel	2.5Y	9	2	2.5Y	9	2	2.5Y	9	2
bkhd. panel	7.5Y	7	4	7.5Y	5	6	2.5Y	9	2
tables	7.5Y	7	4	7.5Y	7	4	7.5Y	7	4
chairs	2.5YR	4	6	2.5YR	4	6	2.5YR	4	6
6- deck	10B	5	10	10B	5	10	10B	5	10
bulkheads	dark wood-grain			light wood-grain			2.5Y	9	2
tables	dark wood-grain			dark wood-grain			dark wood-grain		
chairs	N	0	0	N	0	0	N	0	0

Table 4: continued

scheme	high (H)			medium (M)			low (L)		
	H	V	C	H	V	C	H	V	C
7- deck	10B	5	10	10B	5	10	10B	5	10
bulkheads	2.5Y	9	2	2.5Y	9	2	2.5Y	9	2
tables	dark wood-grain			dark wood-grain			dark wood-grain		
chairs	N	0	0	N	0	0	N	0	0
8- deck	10B	5	10	10B	5	10	10B	5	10
bulkheads	2.5Y	9	2	2.5Y	9	2	2.5Y	9	2
tables	dark wood-grain			dark wood-grain			dark wood-grain		
chairs	N	0	0	N	0	0	N	0	0
9- deck	10B	5	10	10B	5	10	10B	5	10
bulkhead	2.5Y	9	2	2.5Y	9	2	2.5Y	9	2
bulkhead	graphic			dark wood-grain			2.5Y	9	2
tables	dark wood-grain			dark wood-grain			dark wood-grain		
chairs	N	0	0	N	0	0	N	0	0
10- deck	10B	5	10	10B	5	10	10B	5	10
bulkheads	2.5Y	9	2	2.5Y	9	2	2.5Y	9	2
partition	framed pictures			murals			dark wood-grain		
tables	dark wood-grain			dark wood-grain			dark wood-grain		
chairs	N	0	0	N	0	0	N	0	0
11- deck	10B	5	10	10B	5	10	10B	5	10
bulkhead	graphic			graphic			2.5Y	9	2
bulkhead	graphic			2.5Y	9	2	2.5Y	9	2
partition	graphic			graphic					
tables	dark wood-grain			dark wood-grain			dark wood-grain		
chairs	N	0	0	N	0	0	N	0	0

	cool (C)			warm (W)		
	H	V	C	H	V	C
12- deck	10B	5	10	2.5YR	5	12
bulkheads	5PB	6	6	5YR	6	6
tables	dark wood-grain			dark wood-grain		
chairs	N	0	0	N	0	0

Table 5: Unnormalized subanalysis of the degree of preference, stimulation, appropriateness for dining, and appropriateness for recreation of 16 color schemes.

PREFERENCE	FREQUENCY BY RATINGS						
	1	*2*	*3*	*4*	*5*	*Average*	*S.D.*
Scheme 6-M	9	9	1	0	0	1.579	.591
Scheme 6-H	9	5	3	2	0	1.895	1.021
Scheme 6-L	5	10	4	0	0	1.947	.686
Scheme 11-H	8	5	2	2	2	2.211	1.360
Scheme 2-L	2	9	8	0	0	2.316	.653
Scheme 9-H	2	8	5	4	0	2.579	.936
Scheme 10-M	2	8	6	2	1	2.579	.990
Scheme 12-W	0	6	8	4	1	3.000	.858
Scheme 2-M	1	0	15	2	1	3.105	.718
Scheme 3-H	0	2	10	6	1	3.316	.729
Scheme 1-H	0	5	5	6	3	3.368	1.037
Scheme 5-M	0	2	8	7	2	3.474	.819
Scheme 3-L	0	3	6	6	4	3.579	.990
Scheme 8-H	0	2	5	8	4	3.737	.909
Scheme 1-M	0	2	5	7	5	3.789	.950
Scheme 1-L	0	0	2	5	12	4.526	.678

STIMULATION	FREQUENCY BY RATINGS						
	1	*2*	*3*	*4*	*5*	*Average*	*S.D.*
Scheme 6-M	6	9	4	0	0	1.895	.718
Scheme 6-H	8	6	4	1	0	1.895	.912
Scheme 6-L	4	11	4	0	0	2.000	.649
Scheme 11-H	2	9	4	4	0	2.053	1.234
Scheme 2-L	1	9	8	1	0	2.474	.678
Scheme 9-H	2	9	14	1	1	2.526	.939
Scheme 10-M	1	2	14	1	1	2.947	.759
Scheme 3-H	0	2	14	3	0	3.053	.510
Scheme 2-M	0	1	13	4	1	3.263	.636
Scheme 12-W	1	2	8	7	1	3.263	.909
Scheme 1-H	0	4	8	5	2	3.263	.909
Scheme 5-M	0	4	7	6	2	3.316	.921
Scheme 3-L	0	4	5	6	4	3.526	1.045
Scheme 8-H	0	2	6	7	4	3.684	.921
Scheme 1-M	0	1	6	8	4	3.789	.832
Scheme 1-L	0	1	0	6	12	4.526	.752

Table 5: continued

APPROPRIATENESS FOR DINING — FREQUENCY BY RATINGS

	1	2	3	4	5	Average	S.D.
Scheme 6-M	10	9	0	0	0	1.474	.499
Scheme 6-H	7	6	5	0	1	2.053	1.050
Scheme 6-L	3	11	5	0	0	2.105	.640
Scheme 2-L	4	8	5	1	1	2.316	1.029
Scheme 10-M	1	8	10	0	0	2.474	.595
Scheme 11-H	7	3	1	6	2	2.632	1.494
Scheme 9-H	2	4	8	3	2	2.947	1.099
Scheme 2-M	0	4	9	5	1	3.158	.812
Scheme 12-W	0	3	11	3	2	3.211	.832
Scheme 3-H	0	3	9	6	1	3.263	.784
Scheme 1-H	1	3	8	4	3	3.263	1.068
Scheme 3-L	0	5	8	1	5	3.316	1.126
Scheme 5-M	0	3	8	6	2	3.368	.871
Scheme 8-H	0	3	8	4	4	3.474	.993
Scheme 1-M	0	1	10	3	5	3.632	.930
Scheme 1-L	0	1	2	4	12	4.421	.878

APPROPRIATENESS FOR RECREATION — FREQUENCY OF RATINGS

	1	2	3	4	5	Average	S.D.
Scheme 6-M	9	5	2	2	1	2.000	1.214
Scheme 11-H	8	8	0	1	2	2.000	1.257
Scheme 6-H	5	8	4	1	1	2.211	1.055
Scheme 6-L	3	9	5	1	1	2.368	.985
Scheme 2-L	3	7	7	1	1	2.474	.993
Scheme 9-H	1	8	5	3	2	2.842	1.089
Scheme 10-M	0	6	9	3	1	2.947	.825
Scheme 12-W	1	5	9	2	2	2.947	.999
Scheme 2-M	0	6	9	2	2	3.000	.918
Scheme 1-H	1	3	9	3	3	3.211	1.055
Scheme 5-M	0	4	7	7	1	3.263	.849
Scheme 3-H	1	2	8	7	1	3.263	.909
Scheme 1-M	0	3	8	4	4	3.474	.993
Scheme 3-L	0	4	5	5	5	3.579	1.091
Scheme 8-H	0	2	5	6	6	3.842	.987
Scheme 1-L	0	0	2	5	12	4.526	.678

Chapter II). A two-dimensional solution proved adequate to give a 0.96 correlation with the data.

Figure 7 shows the information relating to the first dimension indicating the location of the schemes on the stimulus axis to the right, and the relevance of the different rating scales to that dimension on the axis to the left. The relevance axis shows that all of the rating scales were related to the dimension, but that some of the responses to "appropriateness for dining" were not contained in the dimension. The spread of stimuli on the stimulus axis indicates that no one color scheme evoked an extreme response, and that the schemes provided for a range of quality.

Figure 8 shows the same kind of information for the second dimension. The two dimensions are correlated indicating that the two types of judgment are similar. The main difference appears to be in the shift of 11-H and, to a lesser extent, 6-H, to a less desirable position. In this dimension the response relates to the appropriateness for dining.

That all of the rating scales were strongly related to a single dimension in Figure 7 indicates that "stimulating" was thought to be both desirable and appropriate. The second dimension interjects a note of caution, suggesting that the scheme with the extreme application of super-graphics, including high chroma and contrast (11-H), is not appropriate for dining, and that the darker wood-grain scheme (6-H) is somewhat less appropriate than was perceived in the first dimension. The other schemes received similar ratings on the two dimensions. In this analysis, the two dimensions appear to represent two different points of view in the same set of stimuli, with the second dimension representing, perhaps, the more conservative individuals.

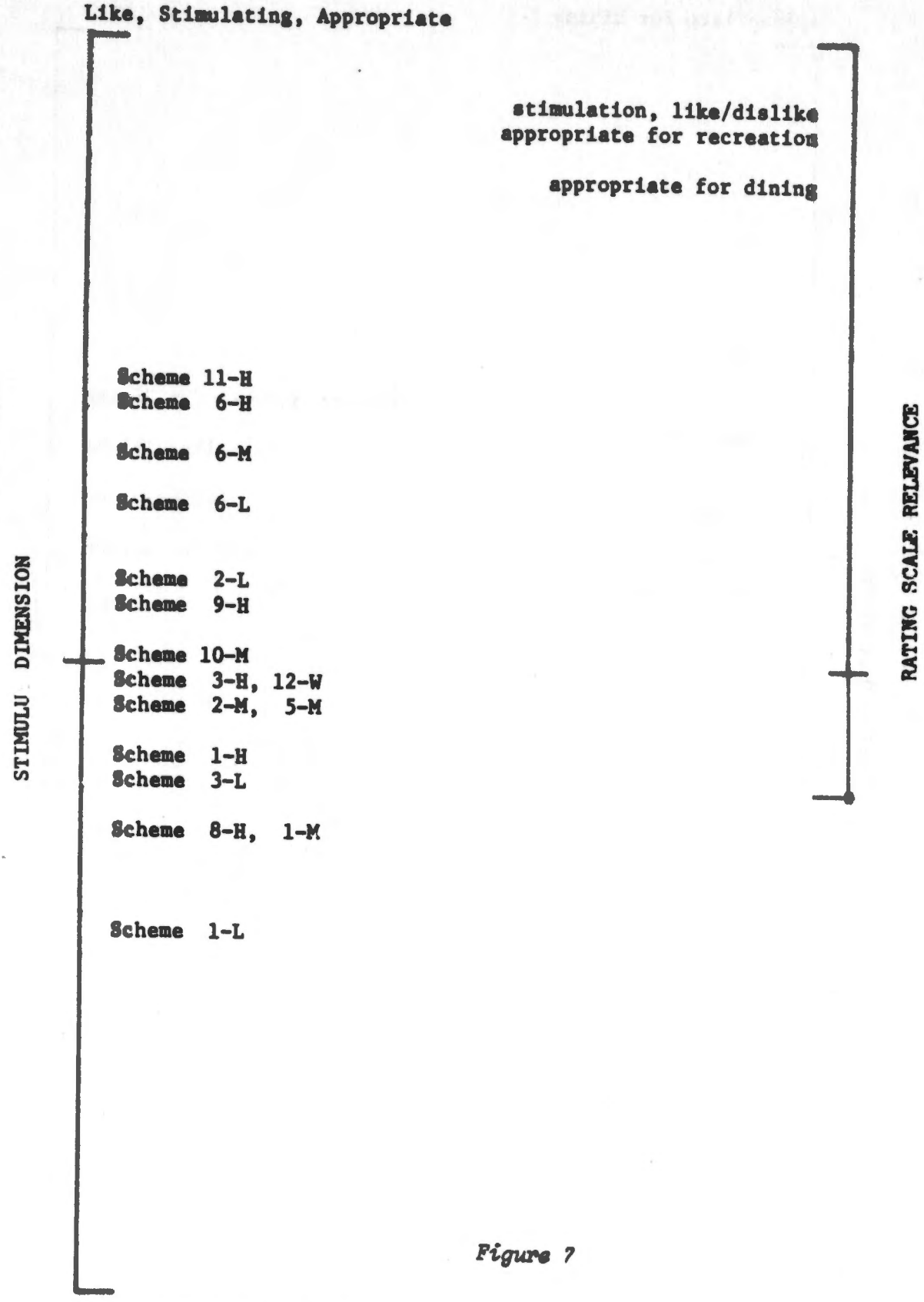
Like, Stimulating, Appropriate
stimulation, like/dislike
appropriate for recreation
appropriate for dining
RATING SCALE RELEVANCE
STIMULU DIMENSION
Scheme 11-H
Scheme 6-H
Scheme 6-M
Scheme 6-L
Scheme 2-L
Scheme 9-H
Scheme 10-M
Scheme 3-H, 12-W
Scheme 2-M, 5-M
Scheme 1-H
Scheme 3-L
Scheme 8-H, 1-M
Scheme 1-L
Dislike, Unstimulating, Inappropriate

Figure 7

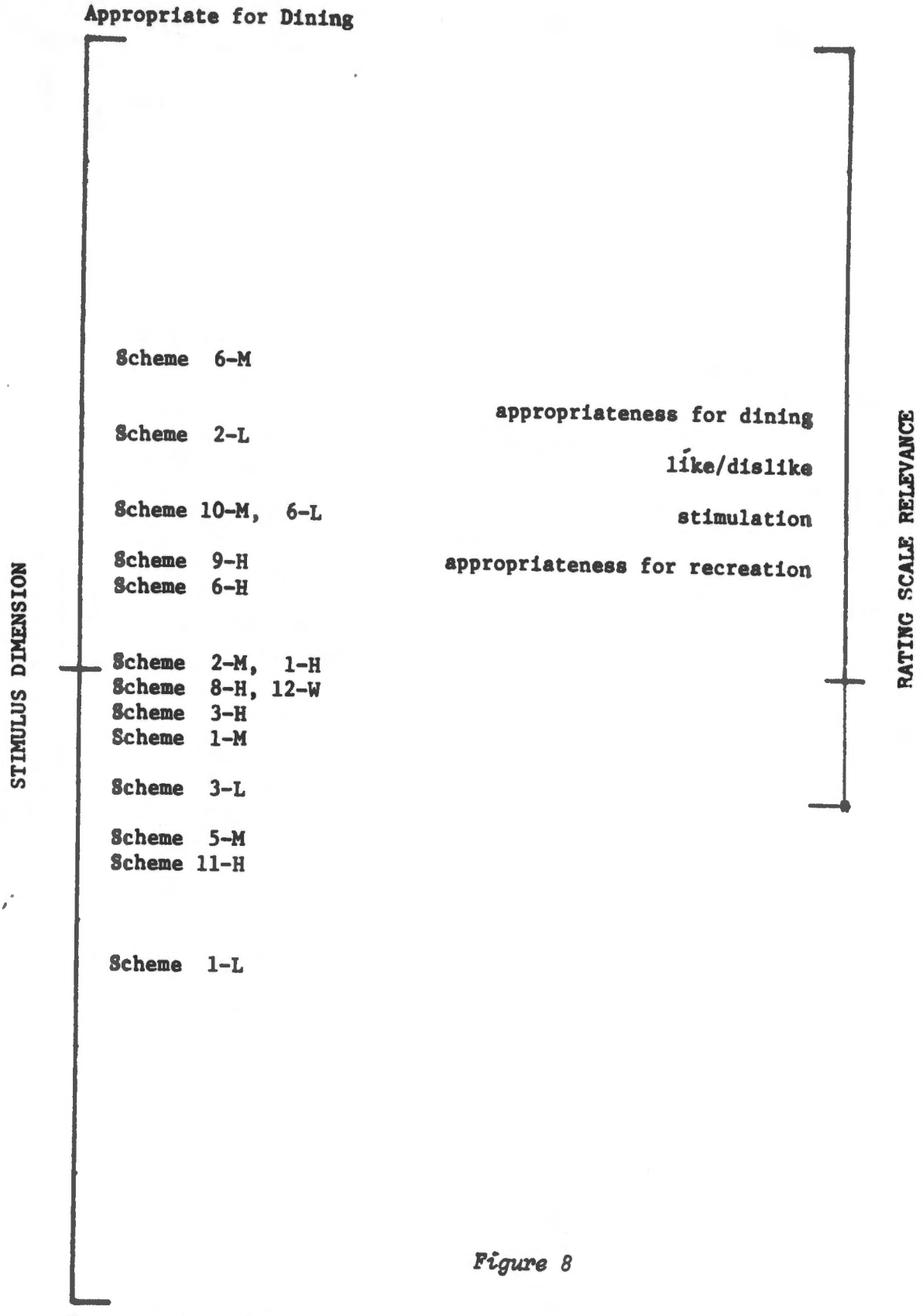
Appropriate for Dining
STIMULUS DIMENSION
Scheme 6-M
Scheme 2-L
Scheme 10-M, 6-L
Scheme 9-H
Scheme 6-H
Scheme 2-M, 1-H
Scheme 8-H, 12-W
Scheme 3-H
Scheme 1-M
Scheme 3-L
Scheme 5-M
Scheme 11-H
Scheme 1-L
Inappropriate for Dining
appropriateness for dining
like/dislike
stimulation
appropriateness for recreation
RATING SCALE RELEVANCE

Figure 8

The means of presenting color stimuli in these experiments through the use of projected slide images of simulated, scaled interior space has proven advantageous in terms of convenience, economy, and control. The validity of this approach for acquiring user reactions to perceptual and affective aspects of color in interior space will need to be ascertained by an additional experiment. This experiment would, by eliciting responses to both real and simulated environments having identical color schemes, allow for a comparison of results. A high correlation of the data would support the validity of using simulated environments in this way as a means of determining user responses to a greater variety of environments than would otherwise be possible.

Castle, J.E., Saklem, A.A. and Weiler, D.J., THE NAVAL ARCHITECT'S ROLE IN ACHIEVING SHIPBOARD LIVABILITY. Association of Senior Engineers Technical Symposium, 1971.

Logan, H.L., COLOR IN SEEING. *Illuminating Engineering, 58*(8), 553-9, 1963.

Simulated Messing Areas

Figure 9

Figure 10

IV. THE INPUT OF DESIGN FOR MULTI-PURPOSE USE OF SPACE

A ship's messing area can be regarded as more than just a space in which meals are served and consumed. It can be defined as a social space where crew members can change roles and moods from those that occupy them while on duty at their stations or work areas. Among the many territories aboard ship, the messing area is a commons, of a sort, where crew members belonging to different living or working groups can meet and socialize. Because of the restriction on space available for recreational activity, especially typical of Destroyer type ships where encroachment of armaments and navigation and propulsion equipment has occurred, multi-purpose use of the messing areas is almost a necessity. It is really the only space of sufficient capacity and availability to accomodate a sizeable portion of the crew. The quality and flexibility of the design which permits and encourages recreational use of the messing space between meal servings is the object of concern in this study.

THE FUNCTIONS OF MULTI-MODE FURNITURE

Furniture that can be altered from one configuration to another in order to facilitate different uses of a space is considered to be multi-mode furniture. There may or may not be a mechanism involved in converting the furniture from one mode to another. Such furniture could be designed that would allow multi-purpose use of the mess decks, and thereby increase the utility of these spaces.

All concepts for the furnishing of the messing area must consider the dining function as primary, and include it as one of the modes. The alternate functions of the furniture can be based on the accommodation of people for the purpose of engaging in any number of possible activities which would be appropriate for the space, or which simply have to be facilitated somewhere aboard ship, the messing area being the most convenient or available space. Use of the messing area for showing movies is an example of the latter condition: although the restrictions of deck space and low overhead clearance certainly limit suitability of the space for use as a theater, it is still the largest space available in which a large number of people can be accommodated for this purpose.

The alternate use of the messing area for cinema is widespread and merits special attention by ship designers. Movies provide a needed "escape" from the reality of shipboard confinement that can be enjoyed by many people at once. Accommodations for comfortable viewing by a sizeable portion of the crew were markedly inadequate aboard the ships observed in conjunction with this study. Multi-mode furniture that could convert from dining accommodations into a comfortable arrangement with increased capacity for cinema viewing would be highly desirable.

Table surfaces necessary for dining may also be suitable for such activities as card games and writing, although this could obstruct

space for other activities. Tables for two, four, or six persons; square ones, round ones; tables for ping-pong, tables that fold away, seats that move and change direction, modules that form groups and patterns—these are some of the ideas that can be considered in designing multi-mode furniture. Arrangements which include or allow for a variety of accommodations have built-in flexibility and a capability to satisfy individual preferences. There are a multitude of recreational and educational activities which could be facilitated by particular arrangements of seating, table, or clear space, and these could have considerable impact on enhancing the social conditions aboard any given ship.

CONCEPTS

Six concepts of multi-mode furniture for Destroyer messing areas have been advanced. At this preliminary stage, they illustrate only design directions to be explored, considered, and compared. The concepts were developed in mock-up form so as to allow initial dimensional and operational assessments to be made. A two-dimensional scale model of a typical messing plan has been used to demonstrate the effects of each furniture concept upon the organization of the space, clearances, traffic flow, visual obstructions, and capacity for seating under alternate uses. For this purpose, a technique using magnetized interior profile components was employed. One concept is a modular approach to the dining function which offers an interesting variety of arrangements for the organization of the total space, while others are directed specifically to the problem of converting from the dining function to an arrangement suitable for cinema.

PERFORMANCE CRITERIA

Performance criteria were outlined in a general way to establish direction for the design, as well as to provide a basis for the

evaluation of the concepts at this stage. These performance criteria can later be translated into specifications which indicate specific design requirements.

Performance Criteria Outline for Multi-Mode Furniture

Accommodation. Seating for dining should take into consideration the anthropometric requirements affecting table height, length and width; seat angle, height, breadth and depth; back angle, height, and lumbar support; knee and foot clearance; freedom from obstructions, and ease of access and movement for ingress and egress. Seating for cinema and recreational activity should provide comfort for extended periods. Orientation of the seating with respect to the ship should facilitate body stability under conditions of ship's motion. Seating capacity of the space should be maximized in both modes.

Operation. The number and sequences of conversion operations involved should be minimized. The operation to change modes should be simple and obvious, requiring little or no training. The physical exertion demanded for operation should not impose difficulty. The number of people needed to perform the operation should be considered.

Appearance. A congenial and inviting ambience should be conveyed by the installation. Effects of simplicity versus clutter should be controlled so as to result in a condition of visual harmony. The potential for achieving variety and change of appearance will allow users to manipulate the visual environment as a means of expression and a way of relieving monotony. Damage or deterioration of interior finishings and furnishings will affect the apearance of the space, and should be avoided.

Structure. Stability of the basic structural concept must ensure safety and performance under extreme conditions of use. The strength to weight consideration and the load-bearing capability should be

high. The dynamic loads caused by sitting on chair backs and tables, impacts from careless operation, or bumping by people or equipment thrown off balance by the ship's motion, must be withstood. The simplicity of the basic concept will affect the cost of manufacture and the ease of installation and removal.

Mechanisms. The durability of the mechanisms in withstanding the dynamic loads caused by the motion and vibration of the ship as well as the use and misuse by personnel in operating the units is very important. The susceptibility to wear and tear that will reduce performance or make the unit inoperational must be minimized. Simplicity of design, in so far as the operation and the number of moving parts is concerned, can affect reliability. The latching or locking requirements should be considered together with other elements which may be regarded as safety factors. The mechanisms should be as fail-safe as possible.

Materials. Strength to weight considerations of the materials may be critical in satisfying user requirements for physical operation of the units, while meeting stability and durability requirements of the structure. Resistance to damage from salt water, lubricants, cleaning agents, food stuffs, abrasion, puncture, and other abuse should be considered. Appearance relates to color and texture of the materials, the way they are combined, and the manner in which they maintain their quality under use. The flammability of the materials should meet safety requirements. The cost and availability of the materials should be considered.

Maintainability. The units should be maintainable by ship's personnel and on-board tools and equipment. The frequency of maintenance and adjustment should be minimized, as should the extent and magnitude of the maintenance actions. The consequences of the lack of, or faulty, regular preventative maintenance (such as adjustment, lubrication, etc.) should be examined. Ease of maintenance is facilitated

by visual and manual access for periodical preventative servicing, repair, and replacement of components. The expected life of the unit aboard ship should be estimated. If there is a requirement for special tools, spare parts, or repair materials, they should be enumerated, and space requirements established for their stowage. The ease of changing appearance by repainting, recovering, reupholstering, etc., should be considered.

Cleaning. Cleaning should be adequately accomplished by conventional on-board means, materials, and personnel. The ease of cleaning the deck in different modes of furniture arrangement should be considered. The sanitary requirements of food service may impose a particular need for cleaning after conversion of a table top from a position where it was in contact with the deck, or with other exposed surfaces.

Hazards and safety. The factor of ship's motion makes any movable object which is not securely fixed a potential hazard. Considerable forces result from the ship's maneuvering which can cause furniture to be thrown dangerously around the messing area. Mechanical hazards involve the danger inherent in the operation of the mechanism to fingers, etc., while failure of locks, latches, or supports would have additional consequences. Structural design hazards are presented by insufficient clearances, sharp edges and corners, or failure modes which may cause injury. Sanitary hazards involve the potential for contamination of food. Material hazards concern factors of fire, toxicity, electric shock, and cutting or splintering.

EVALUATION

A preliminary evaluation of each of the six concepts has been made using the Performance Criteria Outline as a guide. Each concept was illustrated in two ways: first, by a sequence of three photographs showing the mock-up in the dining mode, cinema viewing mode,

and operational between modes; secondly, by two additional photographs of the two-dimensional model, showing the effects of the concept on the space layout, clearances, sight lines, capacity, and traffic flow. By referring to these illustrations, the strengths and weaknesses of each concept were noted in an evaluation by members of the project team. A similar evaluation by Navy personnel, including Navy habitability experts, will provide an additional basis for proceeding in a specific direction from this point.

A complete presentation of all six concepts and of their evaluation will be included in a Technical Report to be issued. The following illustrations are an example of one of the concept presentations together with an evaluation by the project team, and their recommendations concerning further development of the concept.

Evaluation of Concept 1

Accommodation. Foot clearances are good except from behind in the seating mode. Increasing the rotation slightly beyond 90 degrees would provide a little more foot clearance from behind, and would result in a better seat angle. The structure prevents knees and shins from extending more than twelve inches under the table while dining. Movable chairs facilitate ease of access. The unit can be made in different lengths to accommodate either four or six persons for dining.

Operation. Operation is by one person. Upon releasing the latches, the unit can be changed from table to seating mode in a single motion. Returning to the table mode may be accomplished by rotating the unit up until the latches engage. The weight of the unit must be minimized for this lifting operation.

Appearance. Since the table is converted to become seating, there remain no extra components to visually clutter the space when the

messing area is arranged for cinema. The simplicity of the unit's configuration will be aesthetically pleasing. When chairs are stacked and secured for immobility while underway, the appearance of the space may be somewhat barren and uninviting.

Structure. The supports must be securely attached to the deck in order to stabilize the unit. The concept is dependent upon an even deck surface for stability in the seating mode. Strength of the table top and seat must be achieved with low weight to provide for ease of operation.

Mechanisms. The hinges must withstand considerable lateral and shear loading. The latches must secure the table in horizontal position and resist loads caused by persons sitting or leaning on the table surface. The hinge would be relatively fail-safe.

Materials. If the seating surfaces which are under the table in the dining mode, are to be upholstered, they may be vulnerable to some scuffing, chewing gum, etc. Stainless steel could be used on exposed surfaces.

Maintainability. The unit would require little regular maintenance. Upholstered seat and back components could be designed to snap in and out for ease of recovering or replacement of upholstery cushioning.

Cleaning. The table surface and edge should be wiped clean after use in the seating mode, since it will have been in contact with the deck. Cleaning of the deck is facilitated by this design which has minimal surface contact with the deck in the table mode.

Hazards and safety. While underway in a heavy sea or subjected to sudden forces resulting from the maneuvering of the ship, chairs that

are left unoccupied or unsecured become a severe safety hazard. Sharp corners should be eliminated. If not restrained, the table edge could swing down and injure a person's foot. Location of the latch release should be studied from the standpoint of operational safety.

Concept 1
Multi-mode Furniture

Figure 11a

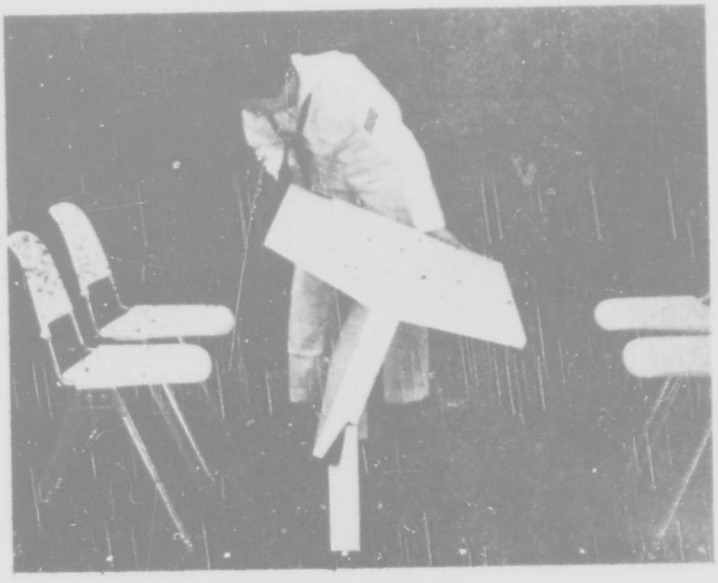

Figure 11b

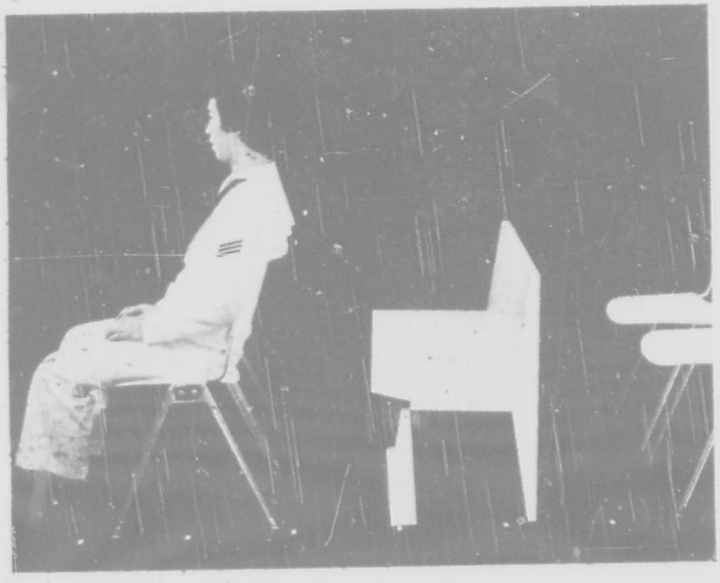

Figure 11c

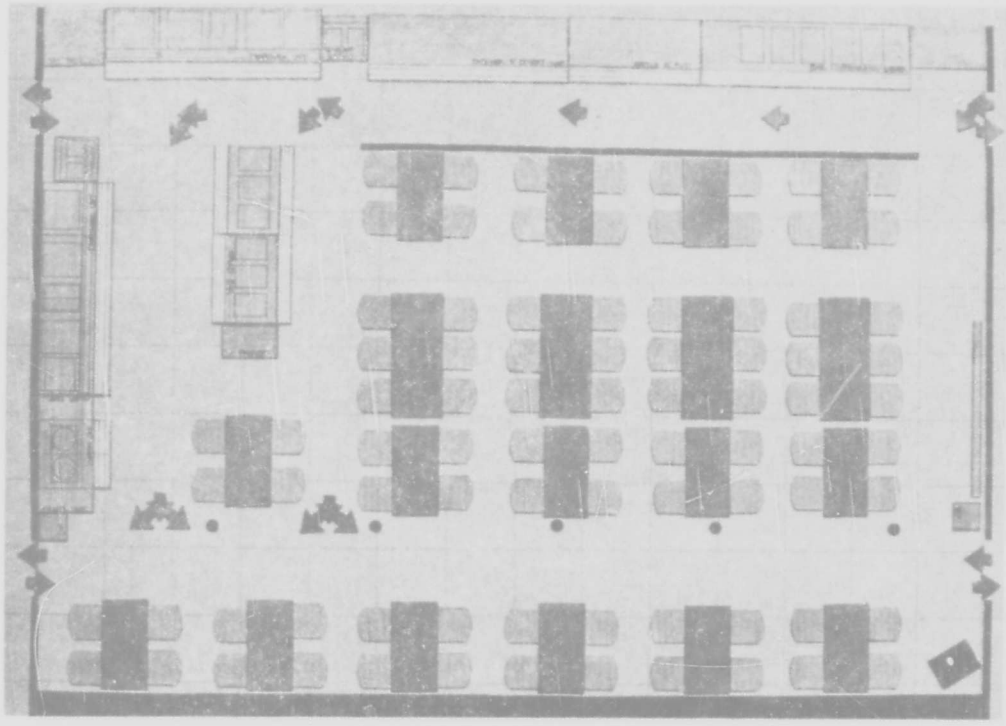

Figure 11d: Dining mode, seating capacity 84

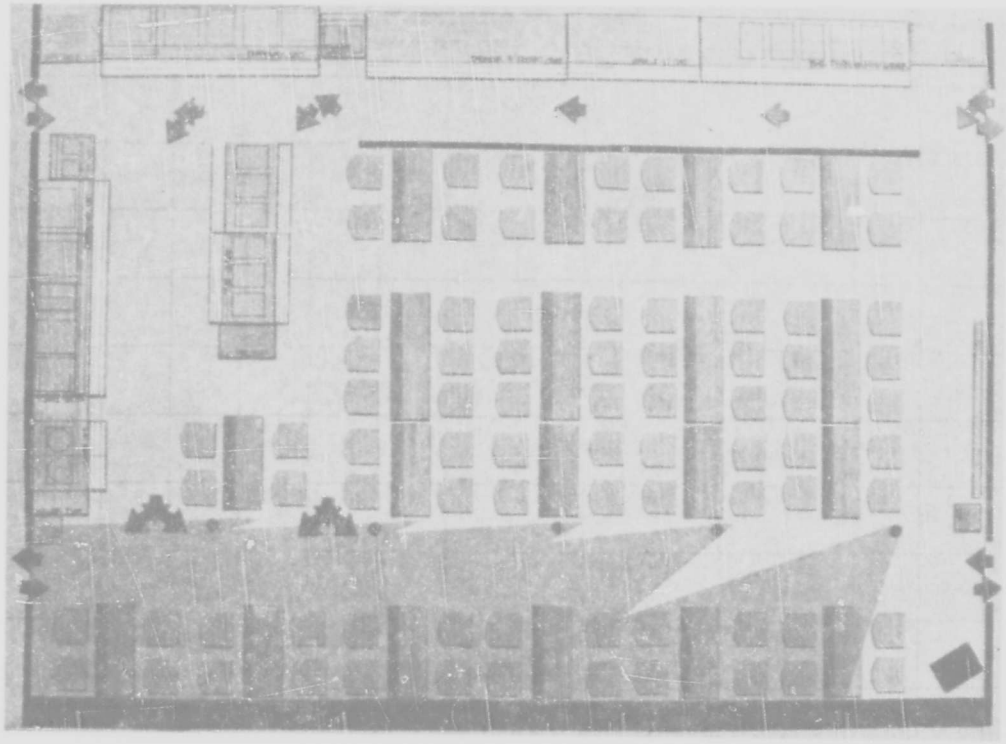

Figure 11e: Cinema mode, seating capacity 126

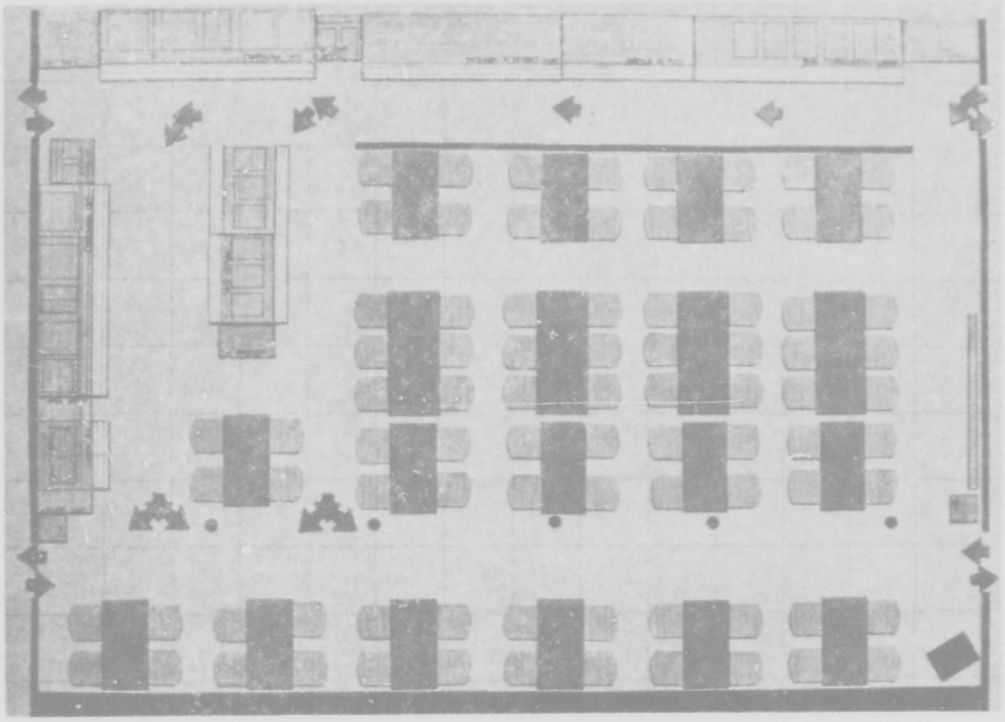

Figure 11d: Dining mode, seating capacity 84

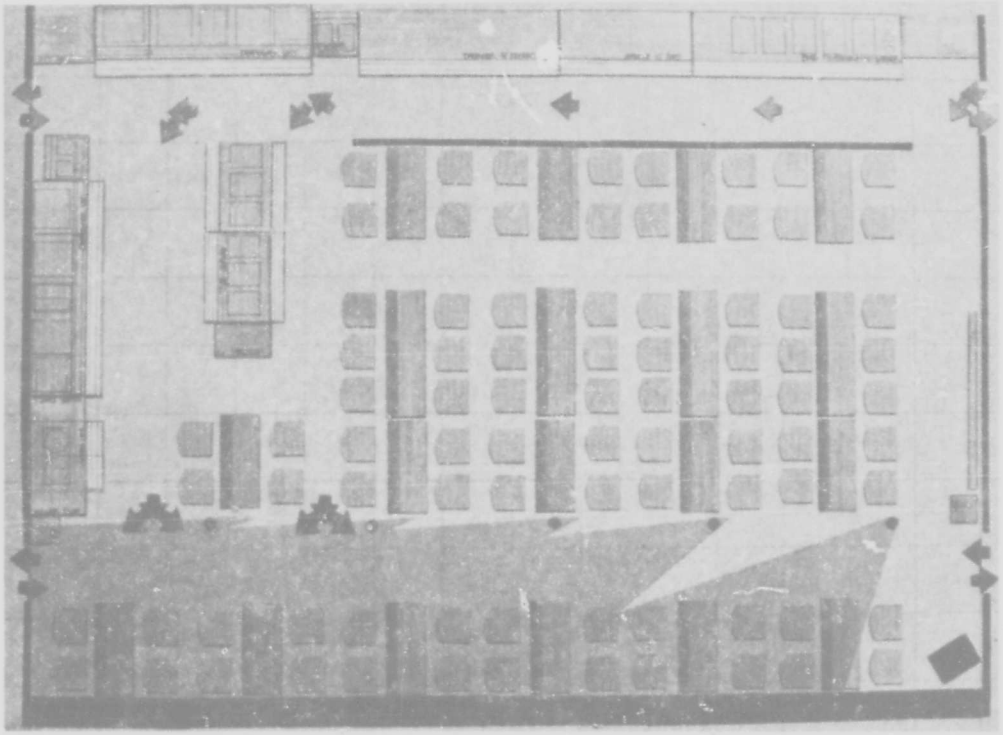

Figure 11e: Cinema mode, seating capacity 126

V. DIFFERENCES IN RATING OF SHIPS BETWEEN VISITORS AND CREW

NEED FOR A PARALLEL STUDY

This portion of the study was intended, among other things, to perform a checking function. The environmental evaluation was developed as a tool for comparative assessment of different messing areas and as a method of assessing crew perceptions with respect to habitability. The groups used to evaluate the various ships studied, however, were not present users and therefore could not be considered ''crew''. To test the methodology for evaluating shipboard environments, these non-user groups were adequate, but the opportunity was taken to see if actual crew stationed on board differed in their ratings. Another objective of the study was to develop examples of design guide criteria for shipboard messing facilities. In this case, it was necessary to ascertain if data from non-users would be reasonably reliable.

A major portion of the study and the only portion involving visiting and rating ships in person was carried out with Group B (38 volunteers from the Naval Training Station in San Diego) resulting in the largest data input into the study. Group B can best be described as potential future users. Most of them had no experience on board ship. They were all young, fairly recent recruits, many of whom were anticipating duty stations on board ships similar to those visited. In fact, many of this group volunteered in order to see the ships and make up their minds as to which type to select for future duty. The following questions were raised in connection with Group B:

1. Would the ratings of the environments be realistic, given the group's lack of experience in living on board ship for long periods? Would "one-shot" experiencing of the environments be inadequate, or would the issues addressed be as important to these visitors as they are to crew?

2. Would visitors' ratings of design and layout be influenced by lack of knowledge of how the environments perform under use in more extreme conditions, such as in high seas, at times of stress, in combat, etc.?

3. Would the fact that many of the inexperienced group members were looking over the ships to decide what duty stations to request, effect results? In a strange environment, might they tend to prefer features that were familiar or reminiscent of home, but not necessarily functional and can this distinction actually be made?

To check what, if any, differences existed, it was decided to run a parallel set of environmental evaluations, using crew members stationed on board the ship. The results of the two sets of data could then be compared.

ORGANIZATION OF THE PARALLEL STUDY

The time allotted to this part of the study was very small, thus an economical procedure was necessary. Group B evaluation procedures took place over a three week period. As explained earlier in this report, the total group of 38 was divided into four sub-groups of approximately ten members each, who visited the ships together. Each group visited one ship a day for five days in the first week and four days each week thereafter. These visits took place in the late afternoon. The volunteers would assemble at the Naval Training Station to pick up their evaluation forms and find out which ship they were to visit, and then take the bus provided (some drove their own cars) out to the pier. On board ship the members of Group B ate the evening meal in the messing facility, and then filled out the evaluation forms.

During the day, over the three week period, the ships were visited by members of the research team, at which time photographs and physical measurements were taken. The parallel study tied in with this schedule. The strategy chosen was to visit the ships at this time to take an available sample of from 15 to 20 of the crew, chosen from a variety of work stations, and to have them fill in the environmental evaluation forms, a short questionnaire on organizational climate, and a questionnaire on women in the Navy. While the evaluations and questionnaires were being filled in, different members of the research team would interview crew, CPOs, and officers to check data on the organizational climate, as well as to enquire about details of the physical environment when in use during cruises.

QUESTIONS AS TO VALIDITY OF EVALUATION BY CREW

Several questions arose as to the validity of responses we might obtain from the crew:

1. Since the crew were only evaluating their own ship, would they have a sufficient idea of the alternatives available to make the results comparable from ship to ship?

2. Would attitudes toward the Navy affect responses? For example, would those who did not feel they were suited for Navy life respond differently than those who were intending to make the Navy a career?

3. Would satisfaction with duty station affect responses?

4. Would feelings toward officers and fellow crew affect responses?

Earlier visits on board ships at San Diego and Treasure Island and interviews with crew members helped to develop questions that would give some indication of attitudes on several of the above concerns. A very simple questionnaire was designed to be given with the environmental evaluation to determine organizational climate: feelings toward authority, the Navy, and job satisfaction.

THE PARALLEL STUDY

Eight ships were surveyed in the parallel study: an LKA, an LST, an LSD, an LPD, two DEs and two DDGs. Sample sizes varied from 12 to 25 respondents per ship, yielding a total sample of 126 subjects. The average time spent filling out the various questionnaires was 15 minutes. The men were briefed not to spend much time on any one question, but to mark the first impression they had. While the questionnaires were being filled in, other members of the crew, CPOs, and officers were interviewed about the ship, life on board during a cruise, what the messing area was like in use under such conditions, and what kind of design or decoration they might prefer if they were given a choice. Some the results are shown in summarized form in the Figures 12 through 16.

DISCUSSION OF DATA

The visitors (Group B) most frequently rated the following environmental characteristics lower than the ship's crew members (listed in order of frequency of low rating):

1. Characteristics relating to lighting: lighting design, light quantity, glare, etc.

2. Color and surface treatment of rooms.

The ship's crew members most frequently rated the following environmental characteristics lower than the visitors (listed in order of frequency of low rating):

1. Seating accomodation.

2. Table design and arrangement.

3. Color schemes.

4. Decking.

The most striking general characteristic of the data shown in Figures 12 to 15 is that the ratings of the crew are, with few exceptions, consistently lower than the ratings of the visitors. Crew's ratings also tend to be in a narrow, more neutral range on the scale, while the visitors' responses indicate a wider spread. Approximately two-thirds of the messing areas were rated in the neutral range (3.5 to 4.5) of the scale by the crew, while the visitors rated slightly less than half the messing areas in the neutral range.

Some suggestions can be hazarded as to why the crew rated environments consistently lower and more neutral. The shipboard environment is one the crew is used to and one in which they have been confined. Not only have they used the messing facility in adverse

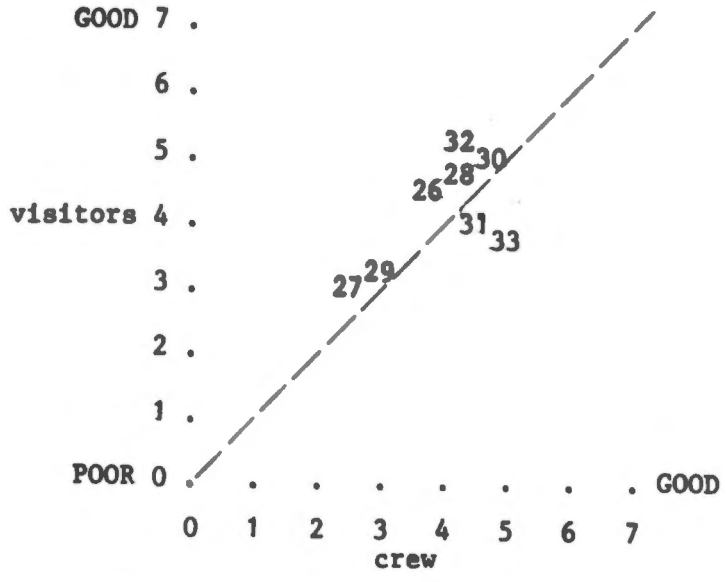

Figure 12: Scatter graph of ratings of the ship as a whole by visitors and crew

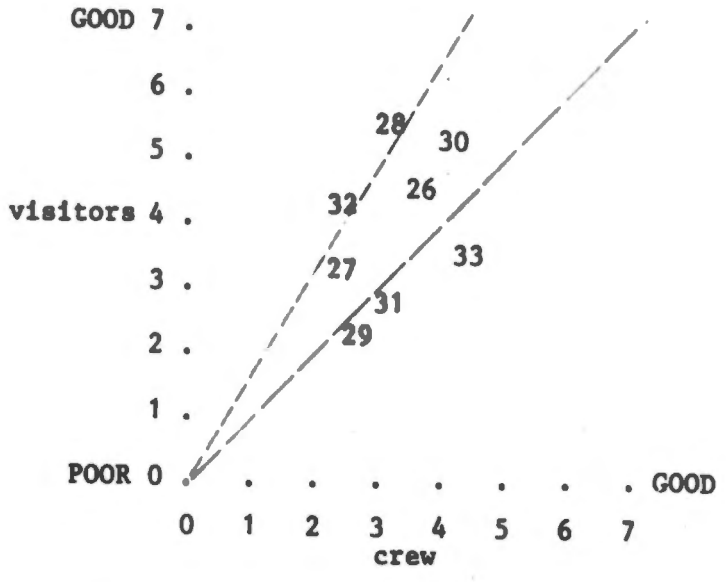

Figure 13: Scatter graph of two ratings combined - messing area as a whole and pleasantness for eating

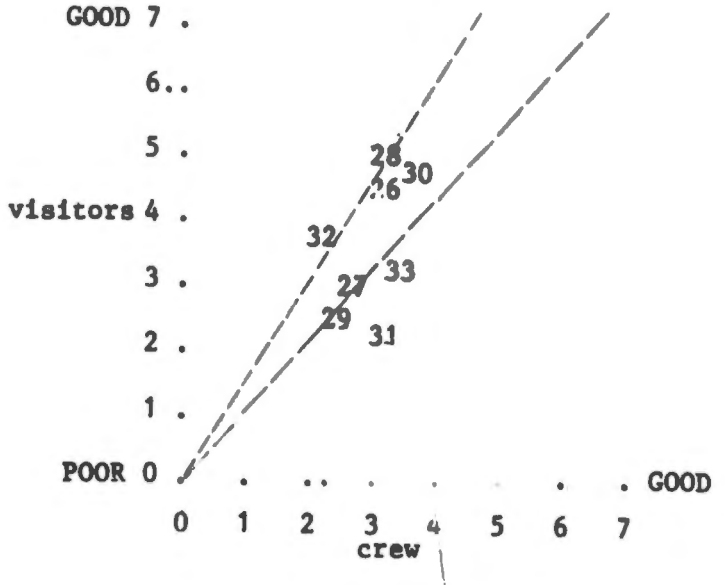

Figure 14: Scatter graph of 14 environmental characteristics, an overall evaluation of the messing area by visitors and crew

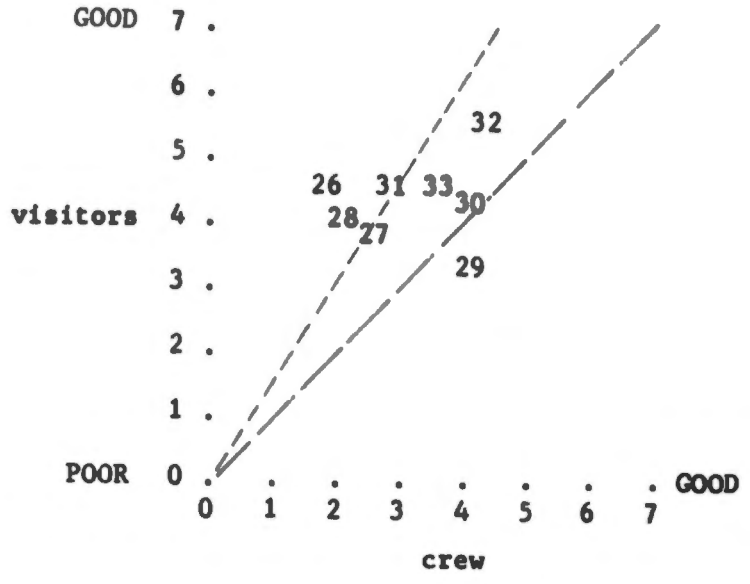

Figure 15: Scatter graph of **meal evaluations** *comparing visitors and crew*

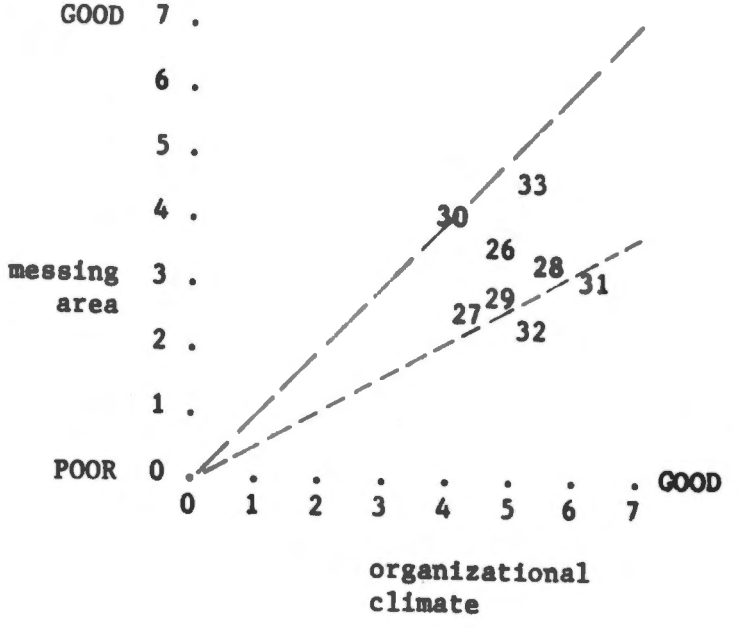

Figure 16: Scatter graph of crew's evaluation of messing area compared to their evaluation of organizational climate

conditions for long periods of time, but also they have had to maintain the area, and thus have seen it at its worst.

On the positive side, it can be argued that crew members who are using the facilities can do more realistic evaluations because they know the extremes of use and understand how uncomfortable some aspects of the design can be, when small annoyances such as bumping a sharp corner build up stress during extended periods of confinement in long cruises. Before definitive statements can be made about how realistic the crew's evaluations are, or if they are in fact better than those of the visitors, more studies would be needed. For example, it would be useful to have the crew evaluate not only their own ship, but the others that the visitors rated, to see if this affected ratings of their own ship, or if their ratings differed in any way from those of the visitors. Another approach would be to allow the crews of all the ships to get together and discuss how the environments are used and how different features function, and only then have them evaluate all the ships. These ratings would then reflect the experience of seasoned sailors and might provide a better check for the ratings of the non-users.

On the negative side, the crew evaluations can be considered less valuable because there is no indication of what the environments are being compared to. Since the crew rated only their own ship, when they rated some attribute as good or poor, it is unknown whether they were comparing it to similar attributes on other ships or what they imagined other ships to be like. Individual's concepts of other ships may represent the case of the grass being greener on the other side of the fence, since with a few exceptions all crews rated their ships lower than the visitors did. They also could have compared the ship environments to equivalent environments on land. In this case, the comparative ratings of the visitors would appear to be more valid or usable for design, since they are more likely to compare one ship to

others they have seen. Since the evaluating groups rotate visits from ship to ship, only a small portion of each sample rating each ship is seeing that ship as the FIRST of the group (thus having nothing to compare with it), or the LAST (when they may be finding the ratings tedious).

Some of the ships proved to be exceptions in that the crew rated their messing spaces higher than the visitors (Figures 13 and 14). By examining these exceptions some light can be shed on the nature of the ratings given by the two groups. Ratings for Environments 29, 31, and 33 were consistently higher in the crew evaluations. Checking the design and finish of the messing facilities on those ships, it was found that they did differ significantly from those on other ships surveyed, in that they were not as completely refinished. For example, at least two walls in each of the above mentioned three environments, did not have wood grain paneling covering the painted metal bulkhead. In some cases, the metal structural walls were simply painted a light color and left exposed. In other cases, pictures painted by the crew had been hung or trophies and other decorations obtained by the crew were used to decorate the walls. Responses indicated that the visitors clearly felt this was less satisfactory than the paneled interiors, but that the crew was not as negative, and in some cases they were positive.

The provision of overhead panels to hide wiring, ducts, and pipes differed in two of the three environments mentioned (29, 31). One ship did not have the entire ceiling covered, due to required openings for an overhead equipment track. The gaps left for the track allowed views into the dark space above the hung ceiling panels. The other ship had no hung ceiling at all, leaving all the overhead wiring, ducts, and structure exposed. This overhead area was clean and well maintained. Studying responses in detail showed that the visitors clearly preferred hung ceilings covering the overhead. Reaction on the part of the crew was not quite so predictable. In

Environment 30, for example, a full hung ceiling system was provided and rated very highly by the visitors. The crew, however, rated the ceiling very low. Interview data reveals that they had recently had a fire on the mess deck, melting the plastic ceiling panels and causing them to drip in flaming blobs onto the floor and onto the heads of the fire fighters in the area. In spite of that experience, the ceiling had been replaced with panels of the same type. In this case, it appears that knowledge of the performance affected ratings.

On some ships, members of the crew mentioned problems with the ceiling panels in high seas. Instances were cited of plastic diffusers and light fixtures falling to the floor as the ship was tossed at sea. In some cases, fibreboard or fibreglass ceiling panels would fall from the suspension system. Another consideration, mentioned most often by older, career Navy men, was the maintenance problem posed by the suspended ceilings. Since the overhead was covered, it could not be kept as clean. This was also cited as a problem by ship's electricians and others who were concerned with having access to the overhead services. Both ceiling and wall paneling were mentioned several times as harboring bugs, such as cockroaches, especially on the mess decks.

Lighting was often indicated as poor by the visitors, but was not rated especially low by crew. Whether the visitors had more basis for comparison, since they were comparing ships, or whether they were considering other lighting systems they were used to, such as those at the Naval Training Station mess hall, is not known. The crew seemed much more tolerant of the lighting levels, fixtures, and distribution.

Factors most frequently rated low by crew could indicate several possible assumptions. Seating accomodation, table design and layout, color schemes, and decking were consistently rated lower by the crew than by the visitors. One assumption is that the constant daily use made small seating discomforts more noticeable and therefore less bearable. Similarly, long periods of confinement to the ship at sea

could make color schemes tiresome. In the case of decking, as well as table design and layout, maintenance seemed to be a factor considered by the crew when questionnaire ratings were compared with interview data. Some tables, rated highly by visitors (as interesting in shape or design, and pleasing in color), were cited by crew as being hard to clean around. Light colored flooring that was, in some cases, rated high by visitors, was rated low by crew, who said it showed dirt too easily. Some flooring materials were described as so hard to maintain that it seemed the mess deck was always being scrubbed, and therefore was seldom open for use between meals for alternate activities.

The meal evaluations (See Figure 15) indicate some interesting differences in ratings. While the crew rated the meals on most ships a great deal lower than the visitors, meals in Environment 29 were actually rated higher by the crew (as were ratings of the messing space). The ratings of the organizational climate on board ship and satisfaction with the Navy and duty stations (Figure 16), failed to give any indication of why this ship should have the messing facility rated higher. In fact, the organizational climate questionnaire would seem to indicate that the rating of the environment and the food should be lower than indicated. Here the visits to the ship and crew interviews provided some insight. At the time the messing facility was evaluated by the crew, a family day was underway. The tables (movable on this ship) were arranged for a banquet with bright tablecloths. Many family members—mothers, brothers and sisters, wives and sweethearts were visiting and eating with the crew, lending a festive atmosphere to the space. At night, when the visitors evaluated the space, it was generally somber and quiet with only a few crew present and no indication of the daytime visiting program being carried on. The food was rated at the bottom of the list by the visitors, but was the second most highly rated among the crews. It turned out that the salad bar in the messing facility had been requested by and obtained for the crew, and they especially enjoyed this

feature. The meals, also at the crew's request, were stressing specialties from different ethnic groups stationed on board. This apparently did not impress the visitors, although the crew found it highly satisfactory. Perhaps the visiting program (which occured on the mess deck primarily), or perhaps the concern with their wishes in meal planning caused the crew to have relatively positive feelings toward the messing facilities on this ship, and thus rate the environment higher than the visitors, breaking the usual pattern.

Crew ratings of environmental characteristics for Environment 31 (Figures 12 - 14) were higher than the visitor ratings. The connection was apparently not with food (Figure 15). Although visitors and researchers found the food quite good and those on the mess deck expressed concern with maintaining quality, the crew rated the food very low. The crew's ratings were more understandable when we discovered that cases of food poisoning had occured on the ship justbefore our visit. Several of the crew had become sick and required hospitalization. In this case, the cause for the high ratings of the environment appear to come from satisfaction with the social system. For almost all of the factors on the questionnaire on organizational climate: attitudes toward officers, the Navy, and job satisfaction, Ship 31 was rated at the top or close to the top of the scale. Visits to the ship and interviews revealed similar findings—the crew, including CPOs, and officers were open, friendly, and seemed to get along well together. When the crew members, selected from a variety of job stations, were filling in the questionnaires on this ship, other members of the crew who were relaxing or working on the mess deck showed great interest, volunteering opinions and suggestions, and many of them remaining afterwards to talk with us. Although the mess deck did not have extensive alterations (the overhead area was exposed and the walls unpaneled), the crew were improving the space themselves. They were especially proud of the new stereo system they had just installed.

There seems to be no clear explanation for the high ratings of Environment 33 by the crew (Figures 12 - 14). The questionnaire on organizational climate provides no significant information in this regard, nor do the interviews. Meal evaluations fall into the usual pattern as well (crew rated meals lower than visitors—Figure 15). On this ship, the messing facility was above the main deck, with portholes letting in sunlight and doors opening onto the deck. Perhaps this was considered by the crew as more desirable than other ships they had experienced, and since the visitors evaluated the messing space at night this may have made less of an impact on them. The space was not as completely paneled as most of the other ships and the visitors rated it lower and rated the walls as more cluttered. SInce some of the clutter consisted of pictures hung by the crew, the crew's perceptions were likely different in this regard. The messing space was smaller, and the visitors noted it as crowded, while the crew did not.

Other ships worth noting in the comparative ratings of the environments are those that are rated by the crew appreciably lower than the usual pattern of ratings relative to the visitors' ratings. Two Environments fall into this category: 28 and 32. The explanation for Environment 32 is quite clear. This ship was very new, having been commissioned only two months before the survey was made. The visitors responded favorably to the newness and even though the interior was exactly stock from the shipyards (with metal chairs fastened to the table and no ceiling or wall finishes), they knew that a complete remake of the area was planned. The crew who were in the midst of planning the changes, were certainly not going to rate the existing environment high. If they thought it was adequate, they would not be planning changes. The crew ratings of the ship as a whole (Figure 12) were not lower than average, only the ratings for the messing space stood out as low (Figures 13 and 14). On the organizational climate questionnaire the ship rated quite high (Figure 16).

Environment 28 is harder to explain. The ship was rated consistently high in the organizational climate questionnaire (Figure 16), and the ship as a whole was rated very highly by visitors (Figure 12). However, the ship was not rated particularly high by the crew. In this case, perhaps the crew did not rate the ship unusually low, but the visitors rated it very high.

As we travelled to the piers with the visitors, we overheard them comparing the ships many times, and advising each other about what the various messing facilities were like (even though they were discouraged from doing this). The consensus among the visitors seemed to be that Environment 28 was one of the best they had visited. It appears that visitors set a norm for themselves as to what was good and what was to be evaluated as bad. Wood grained paneling and wood finished tables were seen as preferable. A full, clean and neat suspended ceiling, hiding all overhead services was seen as best. Separate chairs were the most preferred seating type and the type they were most familiar with. Environment 28 combined all the preferred features.

Wall decorations in Environment 28 were not personalized (no paintings as in Environment 29, and no changes carried out by the crew as in Environment 31), but were purchased decorations such as one might find in a restaurant. It seems the crew did not place the same importance on finishes as the visitors. The food rating by the crew was extremely low, while the visitors rated it neutral. Some food poisoning had ocurred on this ship; this fact might help to explain the low food rating by the crew. The messing area was more spacious than many of the others visited, and in comparison, this could have raised the visitors ratings. Spaciousness of the messing area may have raised crew ratings as well. Experienced sailors and CPO's in discussing Environment 28 mentioned how they liked the existence of more space than other ships on which they had been stationed, however, most of the crew were younger and had less of a basis for comparison.

CONCLUSIONS

Several general conclusions can be made from the work described within this section of the study.

An outside group of non-users or visitors will generally rate the environments in the same order of preference as users, but not necessarily at the same level on the scale. That is, while the order of preference, with minor variations, is likely to be the same, depending on the conditions, actual users are likely to rate the environments either consistently lower or consistently higher. Users, rating only their own environments will tend to rate them in the neutral range, since they are not visiting other ships with which to compare. Environments not rated in the neutral range will likely be exceptions with special factors affecting the ratings. Visitors, comparing several environments, will tend to provide a similar order of preference, but spread their ratings over a greater portion of the scale.

Unusual conditions or extremes will affect the ratings of visitors and crew, but in different ways. Extremes in the visitor ratings are more likely to be related to purely physical criteria, such as size of the space, wall finishes, and color. Extremes or ratings that differ from the usual pattern on the part of the crew are more difficult to pin down, and do not appear to be directly related to physical criteria. Rather, a complex group of interrelated stimuli (such as how they get along with fellow crew members with whom they share the space, or interesting programs underway in the space) seem to affect the responses. In a total institution, like the Navy, it appears that especially negative or positive feelings toward the institution in general, or some superiors, or portions of the organization in particular can also affect ratings of an environment. It is possible that the more closely the people or organization, about whom the evaluator

feels particularly negative or positive, are identified with the space being evaluated, the more directly these feelings will affect the ratings. This point, however, must remain hypothetical at this stage.

The degree to which the users have participated in the creation or decoration of the environment appears to affect the ratings as well. While not enough information is available to acertain this relationship, it seems generally true that the more users have been responsible for and identify with the environment, the more satisfied with it they will feel. Visitors are not likely to note or improve their evaluations because of such factors, although it appears that the more contact the visitors had with the users, the more they became aware of these features of the space and of the organization that generated them. This might begin to alter their ratings.

The visitors are rating strange environments, and it appears that certain features may be singled out by such groups, who then check all environments to see if they contain these features. This consensus selection seems to happen to some extent when the evaluators discuss the environments among themselves. In this study, Group B was discouraged from having such discussions. However, many of the volunteers knew each other before they agreed to do the evaluations; and whether or not they had known each other previously, they stuck closely together during the visits, making such conversation inevitable. The evaluations were an interesting break in routine for them, and since many were using the opportunity to decide what type of ship to choose for a duty station, the evaluations were naturally an important and regular topic of conversation. In some cases, we even overheard arguments between members of Group B, over which ships were the best and why. Such discussions may have influenced many of the ratings. This phenomenon might be avoided if the evaluators are kept separate until all environments ratings are completed.

When strange or unfamiliar environments are being evaluated in detail, apart from the first impression or overall feeling about it, there is some need for criteria on which to judge. There seems to be a tendency to pick out features that are familiar and to rate these as preferable, or to rate the evironments in terms of degree of use of materials considered of higher quality, or to the extent to which they have unusual options or special features provided. In some cases, even if the additions or alterations to the space make it function less efficiently than before, the space may be rated more highly by visitors in comparison to a physically functional, but ''stripped down'' or standard environment. This may be due to the fact that visitors have few other criteria with which to compare, and are not in a position to rate overall performance.

Lack of knowledge of the environment in use, especially under extreme conditions, resulted, in some instances, in different ratings by crew and visitors. In some cases, the crew gave low ratings to some features, such as hung ceilings, preferred by the visitors. Visitors lacked experience with conditions in high seas and were therefore more likely to judge on appearance. It could be argued that since the primary information desired was the evaluators' feelings about appearance, color, and texture, then the visitors ratings were better, because they relied heavily on these criteria in their evaluations. It could also be suggested that the crew tended to combine knowledge of maintenance and performance problems of particular materials with more general considerations of appearance.

Another factor to consider in judging the validity for design, of evaluations done by non-users, is the aesthetic preferences or value systems of the evaluators, as compared to those of the users. In this case, Group B as future users, was probably fairly close to the crew in tastes and preferences. Some of the research team, who had design training commented on slides of the same ships and their responses differed significantly from those of the experimental groups.

For example, plastic materials with a wood grain were disliked by many who had had design training, simply because they were "artificial", a fact that did not bother the crew or the visitors in the least. Such values would have to be considered in choosing the sample of evaluators, if evaluations are to be done by non-users. In some cases, the cultural or ethnic mix of the user group might be an important factor. The food evaluations of Environment 29 are an example of this, here ethnic foods were rated very differently by the crew and the visitors.

In most cases, attitudes toward the Navy did not seem to affect the evaluations of the environment. No connection was found between the extremes of disliking the Navy or desiring a career in the Navy, and the environmental ratings.

Satisfaction with duty station and feelings toward officers and fellow crew did not seem to significantly affect responses except in more extreme cases. An example of such a case is Environment 31, which had an exposed overhead, no wall paneling, standard seating cantilevered from the table support, and a low food rating. High ratings of the organization and job satisfaction seemed to make a difference on this ship. The crew gave Environment 31 a rating that was virtually identical to Environment 28—the most completely remodeled messing space.

For comparative ratings of appearance of different environments, a carefully selected group of visitors, who are similar to but are not users, appears more likely to provide a good range of usuable data with a reasonable spread on the rating scales. The value of these responses can be further improved if the evaluators are kept separate from each other during the test to avoid peer influence.

To test designs where function in use is as important as appearance and seating comfort, it appears that better results might be obtained with experienced sailors, rating a series of alternatives. Since the participation of the crew in creating and decorating their own environments raises the ratings, it appears that in planning for the rehabilitation of a ship, acceptance results can be improved by having the crew of that ship evaluate and choose their own materials from available options. A comparative study would be needed to confirm and determine the conditions for this difference in acceptance.

VI. THE INCLUSION OF WOMEN ABOARD SHIP

This section concerns women in the Navy, not so much those who have served on shore or on hospital duty since 1908, but those who are serving and will serve alongside men at sea. Admiral Elmo R. Zumwalt's "Z-GRAM 116" which announced his plans to provide equal rights and opportunities for women in the Navy, came between this project's inception and the data gathering phase. Thus, the men and women who were questionned, interviewed and observed for this project were aware that changes in personnel composition aboard ship were anticipated. On one ship in the sample the subjects were participating in the first American experiment in equalizing opportunity for women aboard a Navy vessel.

While there are differing opinions about womens's place aboard ship, the decision to expand opportunities for women in the Navy may be traced partially to the pending Equal Rights Amendment, which when ratified will require that jobs previously excluding either sex now

be available to both sexes. In addition, factors such as supportive societal sentiment, the unknowns of a volunteer Navy, experience gained from maritime ventures of other countries, and the interests, education levels, and ability levels of today's women contributed to this decision. Even the traditional name, WAVES (Women Accepted for Volunteer Emergency Services) was changed to Women in Naval Service (WINS). However, many women contacted through this study refer to themselves as WAVES, while some of the more egalitarian prefer ''Women Sailors''. (These factors and a concise history of women in the Navy are presented by Joseph E. Castle and Laurel A. Lewonowski in their report ''Female Personnel Aboard Ship — Habitability Design Considerations'' (1973).)

Including women on board should be viewed as a social design problem as well as a physical design problem. The fit between a design and its users is dependent in part on the social and cultural context into which the design is introduced. Regardless of the quality of the design, if its selection for a particular environment is inappropriate for the people who must use it, then the design cannot be considered to be ''good''. For instance, aboard ship if there were widespread resentment and extreme negativism toward women, it is unlikely that any physical design would be able to smooth the way for the successful incorporation of women sailors. If the social environment were potentially supportive, however, then physical planning and design to enable women's presence would be appropriate. Positive attitudes could be used as levers to effect the process.

The project did not propose to create specific designs concerning women's existence aboard ship, but the various results of questionnaires, interviews, and observations have led to the proposal of some design guides, suggestions as to situations that may arise or that may require attention, and identification of some areas that may require observation over a period of time.

A further technical report will discuss, in detail, the questionnaire design, research results relating to the social environment, and social and physical implications of this work. Included in that report will be data relating to attitudes toward women aboard ship, the influence of wives, expectations about women's abilities including capability for leadership, and expectations about change in Navy traditions. Further data will be presented regarding women who are now stationed aboard the hospital ship.

Appropriate living conditions may not necessarily require radical social or environmental change. An an example, preservation of modesty among women on board was identified as a problem by subjects and by researchers; lack of its solution could lead to embarrassing and potentially dangerous situations for women. If physical design criteria were used alone, a woman in the usual skirted Naval women's uniform might be faced with an intricate set of passageways on board where she could traverse the ship, including the stairways, in modesty. Lack of such consideration produces what one of the female subjects termed "the phenomenon at the bottom of the stairs", where men would casually gather at the bottom of the stairs whenever she in a skirt would walk up or down. An alternative to a labyrinthian plan for maintenance of modesty, of course, would be to issue all women aboard uniforms with trousers, or pants outfits, that would protect modesty and enable ease of movement. This alternative solution was the choice aboard a hospital ship and is a good example of some of the simple adaptations that can be made to an existing environment.

GENERAL DESCRIPTION OF METHODS

Three methods of gathering data were used. Questionnaire No. 1 (See Appendix A) was administered to 162 male respondents, 34 of whom were based at Treasure Island (all on land duty) and 128 of whom were based

at San Diego (primarily sea duty), including respondents from seven ships, with additional respondents from the Naval Training School.

This general questionnaire was later adapted to a hospital ship and expanded. Separate but comparable men's and women's forms were constructed (Appendix A.) in order to show if experience with women aboard would yield responses different from other shipboard environments where women are not yet present.

In each case where questionnaires were distributed, there was informal interviewing, and the environments were observed for possible contributing effects. Nearly all of the first group (N=162) of the questionnaires were completed in messing areas aboard ship. All but one questionnaire from women in the second group (N=18) were completed in the berthing area aboard the hospital ship, while men completed questionnaires at their respective work stations.

The questionnaire was designed to assess or discover the following:

1. Desire of the individual to be part of the change from the traditional to the ''new'' Navy
2. Areas aboard ship that might remain male preserves
3. Attitudes toward women's abilities on the job
4. Attitudes toward female authority on board
5. Attitudes of spouses toward the introduction of women on board
6. Traditions that would be affected by women's presence
7. Other aspects of life that might change with women aboard.

Discussion of the data from this questionnaire is limited here to those points which refer specifically to the physical environment.

Ideally, this questionnaire would have been distributed to those persons who would be most affected by the decision to bring women on board: personnel aboard cruisers, carriers, and hospital ships.

During the study, the former two types of ships were inaccessible. The later has only recently brought women aboard to bunk as well as work, so time limitations necessitated relatively few responses from that ship. This sample, especially of men, may be expanded in future work.

Although some of the present environments of the men questionned are unlikely places for the addition of women sailors, most of these men had had experience on other ships, some of which were cruisers and carriers, and their general knowledge of the requirements of sea duty made them well qualified to respond to hypothetical situations involving women aboard ships.

In constructing the questionnaire and in analyzing the results, it was recognized that the respondents could be apprehensive about women's presence on their ships, because this might require a significant change in the environment and such an unknown change could be difficult to cope with. Individual questionnaires were often punctuated with ambivalence or anxiety concerning women being brought aboard without the respondents having a basis for comparison. Experience aboard a hospital ship reflects this: prior to their presence, there was anxiety over what women sailors would do, how they might affect accustomed behaviors, and how Navy life might change. Most of these fears have been dispelled by contact. This experience is corroborated by early reports from British merchant ships, where women are succeeding in formerly all-male positions (Forsyth, 1972).

RESULTS OF THE GENERAL QUESTIONNAIRE

Overall Patterns

Data from 162 male respondents to the basic questionnaire (Appendix A) indicate generally favorable attitudes toward women. These

questionnaires were rated ''generally positive'' toward women's shipboard duty if the majority of responses were positive for those questions that could be answered relatively unambiguously. These are: Q1-concerning transfer, Q2-concerning women on one's own ship, Q3-whether a man would remain if there were women in the crew, Q4-whether he would remain in the Navy if he were not aboard ship, Q7-concerning a female immediate superior, and Q8-concerning a female executive officer. A positive rating would hold unless other comments on the questionnaire indicated strong feeling to the contrary. In cases where the positive rating was discarded, the general response was rated ''ambivalent'' unless extremely negative, in which case the rating given was ''generally negative''. Although there was great individual variation, the three classifications held up when submitted to different evaluators for the purpose of verification of the ratings.

Positive	= 87 (54%)
Negative	= 41 (25%)
Ambivalent	= 34 (21%)
TOTAL	162 (100%)

More than twice as many men were generally in favor of women sailors on shipboard as were opposed to their presence. Slightly fewer men were ambivalent about the presence of women sailors.

In general, it appears that the men questionned would not seek transfer to a ship where women were, but they would like women on their own ships, and they would be glad to remain if women became crew members. If they felt that they could not remain on shipboard because women were present as crew, they were undecided about whether they would remain in the Navy.

These men felt that they could work with either a female immediate superior or a female Executive Officer. There were places aboard ship that they felt should remain male territories. They indicated possible concern of their wives toward the husbands working with women on board. They envisioned necessary changes in some Naval shipboard traditions, including some initiations, language and behavior, and personal appearance.

Areas Restricted to Men

The following findings are the result of responses to Q-6 on the general questionnaire: "Is there any place on your ship (or others that you know about), excluding men's berthing areas and heads, which you feel should remain available to men only?"

In early interviews, various Naval personnel indicated to us that their views of shipboard Naval life were incompatible with new Naval policies of including female officers and crew aboard ship. Under further questionning, some qualified their objections by saying that women's presence was not so bothersome as long as there were a way in which they could get away from the women.

The men who responded to Q-6 echoed earlier interviews. Four kinds of areas were identified as for male-only access.

Places that affect their work stations. Some respondents indicated that women should be kept out of particular work stations—most often, the work station to which the respondent was assigned.

Areas where rough work goes on. Engineering spaces were quite frequently mentioned as places which should be off-limits to women. (This was also the case in the British maritime study (Forsyth, 1972). When asked why they felt this way, the men most often commented that

women are not strong enough to cope with that sort of work. However, women are functioning in engineering and deck crews aboard the hospital ship visited in this study.

Backstage areas where they can be "men". Men (and women, too) need some way to be able to relax and drop the pretense that is associated with normal social relationships in American culture (Goffman, 1959). Shipboard life for many sailors hardly has the quality of a garden party; an acceptable manner for some sailors to assert their manhood seems to suggest maintaining some of the aspects of rough-and-tumble locker room behavior. Developing some way for men to be free of the women aboard seems a desirable goal of future shipboard planning (including provision for all-male ships). The bunking area alone, as an area of retreat from the opposite sex, is insufficient.

Accessways between spaces. One of the most common examples given of areas that should be accessible to men only is the pathway between berthing areas and sanitary spaces. Unless lockers were installed in the toilet areas to permit storing of one's clothing, towels, toiletries, etc. this pathway may need to be off bounds to the opposite sex perhaps only during specified hours. An alternative has been worked out on the hospital ship studied; the sanitary space for one berthing area is directly off the berthing space and accessible only through that space. Future planning or reorganization of berthing and sanitary spaces could permit ease of access between private areas.

WOMEN AND THE DESIGN OF CERTAIN AREAS

Several areas aboard ship emerge as sources of probable or potential problems for women sailors. Those listed below were mentioned specifically on questionnaires or in interviews. For a fairly thorough discussion of the issues and potential impacts on physical design to accomodate women's presence aboard ship see Castle and Lewonowski (1973).

Berthing areas. Anthropometric data, especially information dealing with comparative heights, etc. of women and men, should indicate the direction for provision of more appropriate living conditions than are now available for women.

Sanitary spaces. While the ship need not take on the luxury of a spa some attention to the differences in use of facilities within sanitary spaces may indicate the need for redesign of these areas to accomodate women. The discussion, in the following section, of realities aboard the hospital ship will illustrate this point.

Passageways. Scheduling of time for showering to eliminate embarrassing meetings between berthing areas and showers, or redesign to give direct access between bunk and shower would remove several passageway conflicts.

Messing areas and other public spaces. Messing areas, general lounges, and other spaces aboard ship where pleasant gatherings normally take place are natural settings for contact between men and women. Lounge spaces where men and women get together may be at a premium, if some spaces are maintained specifically for the use of each sex. The messing areas deserve special attention as possible areas for recreation, since eating areas are often associated with sociability. This possibility for social interaction of both sexes seems preferable to scheduling hours for exclusive use by either sex, since needs for relaxation do not follow a clock.

Out of the way places aboard ship. Dark or secluded areas have been alluded to by a number of persons during the course of the study as potentially dangerous for women. This may be a conjecture based on irrational concerns, but perhaps it is based on experience. It is probably impossible to design a ship with no "out of the way" places. One suggestion for dealing with this problem on very large ships (where the problem could be real due to the scale of the ship),

would be to have a fairly contained area in which women work with men. In this case, women would be in daily contact with a few hundred men, (rather than a few thousand men). These men would probably become concerned with the welfare of their female co-workers and would have a better chance of knowing anyone whose behavior might be erratic.

Another alternative would be to place off limits to women any area known to have a reputation as ''dangerous'' and to design those areas in which women work and live in such a way that in any situation of potential danger there would be someone close by. It should be emphasized that better design could help to eliminate the need for more restrictions or more surveillance, both for women and for men.

WOMEN ON BOARD SHIP NOW: A HOSPITAL SHIP

Women began regular duty on board a hospital ship in the summer of 1972, as jobs became available for them. Many of them were berthed in a barracks near the ship, while some arranged quarters off the base. Within a week or two of their first being berthed aboard the ship in late 1972, women were interviewed in order to make a preliminary assessment of the successes and problems that they were having as equal partners aboard a ship. It must be emphasized that the following data constitutes an initial assessment. A follow-up study after a few months' time would definitely be desirable to check whether and what changes have occurred in adapting to physical and social environments aboard ship.

Preparations for Women Sailors

An interview in December 1972 with the ship's Executive Officer provided information on the way in which women were introduced to the ship's operations and environment.

All women to join the hospital ship are theoretically volunteers, and it appears from our interviews that most women have consciously chosen this particular duty. Some 25-30 women volunteered initially and were assigned at random to the ship. Less than ten of these women remained when we interviewed the Executive Officer. Reductions in the original group occurred because some women were married and could not or would not consider shipboard duty. Others had physical limitations that would make sea duty impossible. Some did not anticipate sea duty when they joined the Navy, and others were not trained for sea duty and did not wish to cope with it.

After this initial mutual selection process, the records of other women in the Navy (some still in boot camp), who had volunteered for shipboard duty were screened. Each woman was telephoned to verify her interest in sea duty. Each woman was to have been told that she would have a berthing area similar to that a male sailor would have aboard ship, and only if she were an officer could she expect a private stateroom.

Aware that women's realistic expectations of what shipboard living would be like could be important in their successful adaptation to the hospital ship and furthermore wanting this project to succeed, the Executive Officer released a guide to the women who would be stationed aboard ship. The guide included information on the physical space available to each woman, military etiquette aboard, and general information about the ship. Each woman was instructed about the dimensions of her bunk, the dimensions of her locker, and the dimensions of the storage space directly under the bunk. She was also told that she could take one suitcase and one locker in storage aboard ship. It was clearly stated that this would be the extent of space and belongings that she could call her own.

An area aboard ship that had previously been storage room was designated as the women's berthing area. While this room and the sanitary space with access to it were being prepared for women sailors' occupancy, the women were temporarily berthed in barracks nearby in two and four-person rooms. Some women indicated that they had felt some lack of privacy in this facility, and although they knew where they would be berthed on board ship, they did not really understand how crowded they would be in their new quarters, nor did they anticipate their relative austerity. When they moved on board, to meet previously determined Navy schedules, their berthing areas were not yet complete, and some sections were not functional.

The Executive Officer made it clear that he favored the women's presence aboard ship, as did the men with whom we talked, and all were working to see that women aboard be given every chance for success. The Executive Officer said, however, that he expected to treat men and women equally, and that in theory he would do nothing special for the women. His goal is "equitable conditions" for all men and women aboard ship. Yet in reality, he realized, for instance, that some provision would have to be made for washers and dryers for women personnel, since some of the components of women's standard uniforms would not survive the punishment of shipboard laundry. Thus, three washer-dryer combinations were installed off the women's berthing area for their use. The Executive Officer explained that a full-length mirror had been installed in the women's quarters and that three steps would be installed to the top women's bunks in the berthing area. He was authorized to make decisions concerning uniforms, and thus in nearly all situations aboard, women wear uniforms that include trousers and flat-heeled shoes.

In a response to a question about any regulations that were necessary in bringing women aboard ship, the Executive Officer replied that there were two rules that covered many situations involving men and women in a contained environment over time. One standard Navy rule

is that "no two people may share the same rack," and the second was in line with the hospital ship procedure of restricting certain areas of the ship stating that "berthing areas for one sex shall not be entered by the other sex." He indicated, too, that he advised discretion among the personnel of his ship, male and female.

When this study was done, 60 women were expected to become officers and crew on the hospital ship, 35 as ship's company and 25 as medical personnel. Since some women lived away from the ship, living conditions aboard ship were not so crowded as they would be at sea, and presumably some of the deleterious effects of an incomplete environment were relieved due to under capacity use of the berthing area.

Questionnaire

As previously stated, a questionnaire for women and one for men were devised to assess environmental conditions aboard the hospital ship. (Appendix A). The women's questionnaire was completed by 18 women. More than half of these women were also interviewed informally and reported further information relating to the ship. A small number of men (5) completed men's questionnaires, to provide a spot check on the other data. These men were also interviewed.

Results

The results presented here focus particularly on the physical environmental data provided by the women's questionnaires. Comments and differences from the men's questionnaires are presented as appropriate.

Fit between expectations and experience aboard ship. About a third of the respondents found the ship as they expected, and an equal number found it not as they expected. Only one of those women who found it as she expected, considered the environment (especially the berthing area) a reasonable one. All of those for whom the environment did not meet expectations cited either very poor living conditions or inappropriate assignment. Those women who found their general berthing area as they expected it were resigned to the conditions or were very unhappy about their living situation.

Changes which would improve living conditions on board. Seven areas were mentioned as particularly problematic. It is interesting to note that none of the men questionned felt that any physical changes in the ship's layout were needed to accomodate women. Half of the female respondents indicated voluntarily that there were too many women in one space, even though the full complement of female crew were not living on ship while in port. In addition, compared with many men's berthing areas seen during the course of the larger study, there was relatively more air space (ceiling estimated at 14 feet in height) and perhaps slightly wider aisles between tiers of bunks. Women often mentioned tenseness due to having so many women in one space. They were concerned about the inability to maintain modesty and about the social friction that had developed since moving on board ship. Equal Rights Amendment notwithstanding, the question must be asked: Could there be different spatial requirements for men and women, based on culturally determined patterns of behavior?

Toilets (compartments) were found to be too small and severely lacking in privacy. This was mentioned frequently both on questionnaires and in interviews. When the women moved aboard ship, they found a room with two rows of toilets facing each other, with partitions between fixtures, but no other form of visual screening. Curtains were quickly located and hung in front of each compartment. The compartment is

so small, however, that anyone using the fixture is easily visible by a ghostly set of knees protruding from behind the curtain.

More locker space is needed due to the types of uniform that have been issued. Many women mentioned that more easily reached storage space is very desirable.

There seems to be a need for upper bunks that are easily reachable by women, who generally have shorter legs than men. According to some women, bunks that would permit sitting up in bed are very desirable; this thought is shared by some men. Even when the women wrote or spoke of design of the bunks for ease of use or access, almost always there was some mention of reducing the number of women who were in frequent and immediate contact with each other in the berthing areas. Several women suggested a ''cube'' of space with berthing area for four women.

Quite a few women mentioned that they needed a lounge or similar space, so that they could be somewhere (excepting the berthing area and the sanitary space) where they would not be accessible to men. Some knew that the space adjoining their berthing area was designated as a lounge space for women and were eager for its completion.

Men aboard ship may be feeling similar needs for privacy. One interviewee was not opposed to women's presence and has always worked with women, yet he wrote, ''Other than the obvious berthing and head facilities, I feel the men should have an area to gather together alone. Even a married man needs to have 'time out with the boys'.''

Bathing facilities were mentioned by a few women. Several indicated that the shower stalls were inadequate in size. This is perhaps another reflection of the desire to maintain modesty in a space that was not designed with women's needs in mind. One woman wistfully longed for a bathtub.

Ventilation was another physical factor that was considered to need improvement, although this should be checked after all physical renovation of the ship is completed.

It must be reiterated that some of the physical problems that these women were having with their environment may have been due to factors related to the degree of environmental completion. These factors should be rechecked in further studies. Any of these factors might also be checked out with men, although in this portion of the project women volunteered more information than men on aspects of environmental change and manipulation. The women's recent habitation may have heightened awareness of particular problems, whereas many men had been involved in some environmental manipulation within their own environments on shipboard. Crowded living conditions present a different sort of problem, which may be coped with fairly well in times of emergency, but which may be a deterrent to retention under peacetime conditions.

Messing Areas

The messing area aboard the hospital ship is a source of pride, especially to those who work there. Its three spatially and visually distinct sections, as well as the galley, have recently been refurbished and seem to embody many of the features found desirable (e.g., flexible seating arrangements, variety in spaces, paneling, different lighting levels, etc.) in environmental evaluations discussed elsewhere in this document. As this messing area was not used in these formal evaluations, a special trip is planned for those researchers who have not seen the ship.

While systematic investigation of messing areas was not carried out aboard the hospital ship, one feature was mentioned during interviews as a potential problem. The only regularly used passageway into the

messing area is a long and very steep flight of stairs. On other ships, where there might be a choice in location for messing facilities, potential hazards should be minimized or eliminated if possible, since messing areas provide a natural setting for many types of leisure and free time activities. This space could become a social center on ships with men and women crew members.

Berthing Areas and Territorial Control

The questionnaire data and interviews indicate a strong need for a secure territory for women only, and the berthing area is not sufficient for this purpose. This special territory needs to be easily accessible for women, to provide protection for the individual such that she is not continually confronted with her uniqueness. (A similar case may be made for officers on some ships visited during the course of this study. Some officers shared a stateroom which served as berthing quarters and office for two or more men and was the only private space available to each man. The only other environment to which they had any territorial rights was the wardroom.) For the women, the berthing space is felt to be quite small, perhaps because this area must provide for group and individual activities as well as the usual activities associated with berthing spaces. The differences in perception of problem and solution are suggested by one man who wrote, "women should only be put on large ships," since their presence "would confine movement of males on small ships".

The environment available to women becomes larger in great port cities, such as San Francisco, which offer a viable extension of the shipboard environment with places to go and things to do at any hour of the day or night. However, not all ports provide such variety in environment with such ease of access. Sea duty will constrain the environment severel, for women.

There may be yet additional explanations for the women's difficulties with berthing spaces. Women's spatial usage has been found to differ from men's in a study of identically designed single sex housing (Drake and Falor, 1965). Women's behavior was marked by reliance upon distinct spatial boundaries to help maintain social order. There was a high value placed on privacy and maintenance of modesty for each individual and each two-person room. Walls and even subtle changes, such as door indentations, provided props with which a functioning social system could be maintained.

On the other hand, men exhibited behavior that was interpreted as showing a need for more direct access between individuals. Walls in this case were barriers to effective maintenance of the social system, and men spent considerable amounts of time and energy reducing the physical barriers that stifled their effective communication with each other.

What this may suggest for shipboard design is that a traditional shipboard berthing area may not be overwhelmingly desired by its male occupants, but they may be culturally attuned to its effective use. Women, however, would find a comparable space very wearing on relationships with other women and possibly disruptive to the group as a whole. To alleviate what appears to be a different reaction by women to the crowding men have always faced aboard ship (one must question whether volunteers will accept these conditions which may have been acceptable in wartime) serious consideration should be given to the redesign of berthing areas to two or four person sleeping areas for women (with similar ones for men) to encourage maintenance of normal social behavior.

SUMMARY

162 men drawn from groups stationed aboard seven ships in San Diego, from the Naval Training Center, and from Treasure Island were

questionned about their views concerning female Naval personnel aboard ship. A second sample of 23 was drawn from men and women aboard the first American Naval ship to have women crew members.

The majority of men were either favorable or ambivalent toward the possibility of women personnel aboard. Some would restrict areas from women's presence, such as their own work stations, engineering areas and other areas where rough work goes on, areas strictly for men, and some areas where the presence of the opposite sex could be embarrassing. Both men and women indicated that they would appreciate an area other than berthing space that would be off limits to the opposite sex. Some of the men on the ships where no women were assigned were concerned about places that could be dangerous for women because they were remote. Perhaps chivalry is not dead, but their concern may also reflect the need for rational appraisal of areas aboard ship that are or could be dangerous by harboring situations that could have unpleasant consequences for men or for women.

Maintenance of modesty is considered desirable by both female and male subjects. Design consideration should include an investigation of actual use of berthing spaces, sanitary spaces, ladders, and passageways. As uniform requirements may be changing for women aboard ship, locker and storage space may need reconsideration. Messing areas on ships with male and female crews may also become important meeting centers aboard as may any public space in which recreation, leisure, or social activities take place.

Many of the male sailors and nearly all the female sailors questionned and interviewed indicated that at some level women's presence on board ship would be a normalizing force for the Navy. Many suggested that this change would create a better atmosphere aboard ship, one more like that in work environments in civilian life. While loss of significant segments of Navy life would seem undesirable if it is to remain an alternative to employment elsewhere, especially for those

persons who have based a career on a pattern of behavior now in jeopardy, the more familiar heterosexual environment may positively influence retention of personnel. This topic, possible differences between male and female spatial needs and usage, and attitudes from and toward women aboard ship are among the areas that should be assessed over time.

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APPENDIX A

QUESTIONNAIRE NO. 1

This study sponsored by the Navy to improve habitability in living areas on board ship.

Name _____ Age_____

paygrade_____ rating_____

Service USN USNR USMC time on active duty___yrs__mo.

Previous shipboard service (three most recent)

ship	type	months on board
_____	_____	_____
_____	_____	_____
_____	_____	_____

Indicate the type of duty that most nearly applies to you at present.

1. deck
2. engineering/ hull
3. electronics/radio/ communications
4. clerical
5. cook
6. steward
7. medical/ dental
8. student
9. instructor
10. recruit
11. ordnance
12. working out of rate

Would you prefer to be aboard:
1. small ships (ATF, mine sweeper, etc)
2. medium ships (destroyer, cruiser, etc)
3. large ships (oiler, supply, etc)
4. very large ships (carrier, LPH, etc).

Which of the following best describes your feelings towards the Navy?

1. I want to get out as soon as possible.
2. I am pretty sure that the Navy is not for me.
3. I am not sure whether I'll leave the Navy or stay in.
4. I'll probably stay in the Navy past this enlistment.
5. I definitely plan to make the Navy a career.

Indicate how much schooling you have had.

1. through 8th grade
2. 9-11 years
3. 12 years
4. some college (no degree)
5. college graduate (two year degree)
6. college graduate (four year degree)

Which description most accurately describes the work performed by your father (or step father etc)?

1. professional (Lawyer, Doctor, Professor, Scientist)
2. semi-professional (Teacher, Engineer, Military Officer)
3. business or management (not self-employed)
4. self-employed (trade or business)
5. clerical (government or business, not managerial)
6. sales or services (Salesman, enlisted military)
7. technical, skilled trade
8. farming, forestry, Fisherman
9. semiskilled
10. unskilled Laborer.

ENVIRONMENT NUMBER _____ SUBJECT NAME _____

MESSING FACILITY SLIDE EVALUATION FORM

				average			
General Impressions	good	.	.	:	.	.	poor
Color Scheme	good	.	.	:	.	.	poor
Lighting System	good	.	.	:	.	.	poor
Seating	good	.	.	:	.	.	poor
Tables	good	.	.	:	.	.	poor
Table/seating Combination	good	.	.	:	.	.	poor
Arrangement of Tables	good	.	.	:	.	.	poor
Wall Surfaces	good	.	.	:	.	.	poor
Decking	good	.	.	:	.	.	poor
Cleanliness	good	.	.	:	.	.	poor
shiplike appearan.	much	.	.	:	.	.	little
pleasantness for eating	much	.	.	:	.	.	little
mood of the space	dull	.	.	:	.	.	exciting
similarity to your experience	close	.	.	:	.	.	little
quality of the slide	good	.	.	:	.	.	poor

What do you like best about this messing area?_____

_____

_____

What do you like least about this messing area?_____

_____

_____

(one of 10 or more pages in the questionnaire)

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Admiral Zumwalt has recently announced that women will be taken on as regular crew members on carriers and cruisers with their own separate berthing areas and heads aboard ship. Given this, how do you think you would react in the following situations?

Would you like to transfer if you could to a ship where there were women?

Would you like to have women on your own ship?

Would you remain aboard ship if women were taken on as regular crew members?

If you decided not to stay on board because women were there, would you still remain in the Navy?

Is there any place on your ship (or others that you know about), excluding men's berthing areas and heads, which you feel should remain available to men only?

The following list indicates types of duty. Some might be done better by women, some by men, and some by either women or men. Place a W by jobs that you think could best be done by a woman; place an M by those best done by a man; and put nothing next to those that could be done either by a woman or a man.

1. deck ____
2. engineering/ hull ___
3. electronics/radio/ communications ___
4. clerical ___
5. cook ___
6. steward ___
7. medical/ dental ___
8. student ___
9. instructor ___
10. recruit ___
11. ordnance ___

Would you remain aboard ship if a woman were your immediate superior?

Would you remain if a woman were your executive officer?

If you are married, what kind of reaction do you think your wife would have to women being on board? Would you comment on this please.

Are there any Navy traditions that would have to be changed if women were included as crew members aboard ship?

Please add anything you think might help us to understand how a ship might function differently if women were aboard as crew members.

QUESTIONNAIRE NO. 2

MESSING FACILITY EVALUATION FORM

ENVIRONMENT_____ Your Name_____

M E S S I N G F A C I L I T Y E V A L U A T I O N F O R M

This study is sponsored by the Navy to improve living areas on board ships. After eating a meal aboard the ship, fill out the evaluations listed below by marking one point on each scale. The middle mark ":" means neutral or average and the marks further out indicate stronger opinion as shown below. Answer each question separately and try to use the whole scale. Try to find the most meaningful interpretation of each scale and use that meaning in your evaluations.

good	very good	somewhat good	slightly good	neutral : average	slightly poor	somewhat poor	very poor	poor

General Impressions

the ship as a whole	good	.	.	.	:	.	.	. poor
the meal you have eaten	good	.	.	.	:	.	.	. poor
the serving area	good	.	.	.	:	.	.	. poor
the serving line wait	short	.	.	.	:	.	.	. long
the whole messing area	good	.	.	.	:	.	.	. poor
the color scheme	good	.	.	.	:	.	.	. poor
the atmosphere	friendly	.	.	.	:	.	.	. unfriendly
the space was	uncrowded	.	.	.	:	.	.	. crowded

Table/Seating Combination

the layout in the space	good	.	.	.	:	.	.	. poor
arrangement of tables	good	.	.	.	:	.	.	. poor
getting into the seat at the table	easy	.	.	.	:	.	.	. difficult
amount of space once you were seated	adequate	.	.	.	:	.	.	. too little

There were _____ seats at the table and as many as _____ people sitting there at one time.

		very	somewhat	slightly	neutral or average	slightly	somewhat	very	
seating comfort	good	.	.	.	:	.	.	.	poor
seating material	good	.	.	.	:	.	.	.	poor
seating color	appropriate	.	.	.	:	.	.	.	inappropriate
table material	good	.	.	.	:	.	.	.	poor
table color	appropriate	.	.	.	:	.	.	.	inappropriate
table design	good	.	.	.	:	.	.	.	poor
seating design	good	.	.	.	:	.	.	.	poor
table/seating combination	good	.	.	.	:	.	.	.	poor

Room Surface Appearance

overhead surface	good	.	.	.	:	.	.	.	poor
side wall surface	good	.	.	.	:	.	.	.	poor
fore/aft wall surface	good	.	.	.	:	.	.	.	poor
walls are	uncluttered	.	.	.	:	.	.	.	cluttered
surface decorations	good	.	.	.	:	.	.	.	poor
decking	good	.	.	.	:	.	.	.	poor

Other Senses

the air is	warm	.	.	.	:	.	.	.	cool
the air is	fresh	.	.	.	:	.	.	.	stale
the air is	dry	.	.	.	:	.	.	.	humid
the air is	motionless	.	.	.	:	.	.	.	drafty
the sound is	noisy	.	.	.	:	.	.	.	quiet
more sound is from	ship's noises	.	.	.	:	.	.	.	human noises

		very	somewhat	slightly	neutral or average	slightly	somewhat	very	
Lighting									
general impression	good	.	.	.	:	.	.	.	poor
lighting fixtures	good	.	.	.	:	.	.	.	poor
glare from surfaces	much	.	.	.	:	.	.	.	none
glare from fixtures	much	.	.	.	:	.	.	.	none
color of the light	good	.	.	.	:	.	.	.	poor
light distribution	good	.	.	.	:	.	.	.	poor
light quantity	too much	.	.	.	:	.	.	.	too little
Concluding Impressions									
cleanliness	good	.	.	.	:	.	.	.	poor
shiplike appearance	much	.	.	.	:	.	.	.	little
pleasantness for eating	much	.	.	.	:	.	.	.	little
mood of the space	dull	.	.	.	:	.	.	.	exciting
similarity to your experience	close	.	.	.	:	.	.	.	little

What do you like <u>best</u> about this messing area? _____

_____

_____

_____

What do you like <u>least</u> about this messing area? _____

_____

_____

_____

QUESTIONNAIRE NO. 3

MESSING FACILITY SLIDE EVALUATION FORM

MESSING FACILITY SLIDE EVALUATION FORM NAME _____

This study is sponsored by the Navy to improve habitability in living areas aboard ship.
You will be shown slides of different color schemes for the same messing area in sets of 3.

While each set is being shown —

Mark a + in the box which represents the position of the scheme that feels MOST SPACIOUS

and a — in the box which represents the position of the scheme that feels LEAST SPACIOUS

Example: 0. [ ] [—] [+]

1. [ ] [ ] [ ]

2. [ ] [ ] [ ]

3. [ ] [ ] [ ]

4. [ ] [ ] [ ]

5. [ ] [ ] [ ]

6. [ ] [ ] [ ]

7. [ ] [ ] [ ]

Mark a + in the box which represents the position of the scheme that you LIKE MOST

and a — in the box which represents the position of the scheme that you LIKE LEAST

8. [ ] [ ] [ ]

9. [ ] [ ] [ ]

10. [ ] [ ] [ ]

11. [ ] [ ] [ ]

12. [ ] [ ] [ ]

13. [ ] [ ] [ ]

14. [ ] [ ] [ ]

15. [ ] [ ] [ ]

16. [ ] [ ] [ ]

17. [ ] [ ] [ ]

18. [ ] [ ] [ ]

19. [ ] [ ] [ ]

MESSING FACILITY SLIDE EVALUATION FORM NAME _____

You will be shown 16 slides of different color schemes for the same messing area. First, they will be shown very quickly in order to acquaint you with the range within the group. Then, as each slide is reshown, mark your opinion of the color scheme across the categories.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
LIKE																
like																
o.k.																
dislike																
DISLIKE																

STIMULATING																
stimulating																
average																
unstimulating																
UNSTIMULATING																

for dining:

APPROPRIATE																
appropriate																
average																
inappropriate																
INAPPROPRIATE																

for recreation:

APPROPRIATE																
appropriate																
average																
inappropriate																
INAPPROPRIATE																

QUESTIONNAIRE NO. 4

ORGANIZATIONAL CLIMATE

This study is sponsored by the Navy to improve habitability aboard ship.

This questionnaire is not for evaluation of your ship. Do not sign your name and do not indicate the name of your ship. These questionnaires form a part of a larger study, and are concerned with how attitudes affect perception.

Answer all questions quickly, off the top of your head. Answer with the first impulse that comes to mind. Do not spend a lot of time thinking about the question in detail.

SAMPLE QUESTION

THE MOVIES ON BOARD SHIP ARE:

excellent first run films		X				old, third rate films

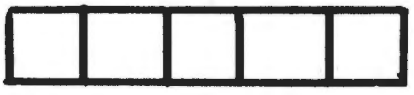
DO YOU FEEL YOUR OFFICERS ARE:

some of the best in the Navy  lousy

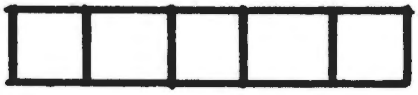
ARE YOUR OFFICERS:

open and interested in your views  closed and unapproachable

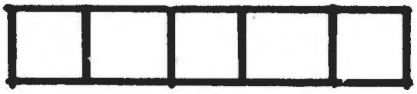
WOULD YOU ENJOY SOCIALIZING WITH YOUR OFFICERS WHEN OFF DUTY:

definitely not  definitely yes

DO YOU FEEL YOUR OFFICERS MAKE:

strtegically good decisions  bad decisions strategically

DO YOU FEEL YOUR OFFICERS MAKE:

fair decisions for the men  decisions that are unfair to you

DO YOUR OFFICERS:

enforce rules strictly by the book  act lax about regulations

If rules are not enforced strictly by the book, do you feel they are altered for your benefit, or for the benefit of the highest ranking officers only:

altered for my benefit  altered for benefit of high ranking officers only

remarks: _____

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ARE YOUR DUTIES ON BOARD SHIP:

clearly defined  vague and open to interpretation

ARE RULES OF CONDUCT ON BOARD:

unclear and depend on who defines them  openly stated and enforced

ON YOUR SHIP IS THERE

great opportunity to advance and do well in your career  no opportunity for achievement

DO YOU ENJOY BEING ON BOARD SHIP:

look forward to cruise with anticipation  hate being on board and can't wait for cruise to finish

CONSIDERING THE ECONOMIC AND SOCIAL CONDITIONS IN THE COUNTRY, DO YOU FEEL THAT:

the Navy is really a pretty good place to be  you are missing great opportunities in civilian life

What type of ship has the best opportunities for advancement?

_____ Why? _____

What type of ship would you most like to be stationed on?

_____ Why? _____

DO YOU FEEL YOUR DUTIES ON SHIP BOARD ARE:

important and necessary  unimportant, time fillers to keep you busy

IS YOUR SHIP:

one of little importance or use or out of date  of great strategic importance to the Navy

What percentage of your spare or leisure time on board ship do you spend with the following: (circle the amount)

Alone (or in as private a spot as possible)	0-25%	25-50%	50-75%	75-100%
In small group activities (card games, etc.)	0-25%	25-50%	50-75%	75-100%
In large group activities (sports events, etc.)	0-25%	25-50%	50-75%	75-100%
Watching movies	0-25%	25-50%	50-75%	75-100%

What activities would you like to see more of on ship board, or would you like that are not provided at present?

_____

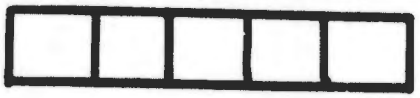
WHO DO YOU SOCIALIZE WITH MOST, ON BOARD SHIP: (circle answer)

1. your work crew
2. different people from various job categories
3. those who bunk near you
4. other (note who) _____

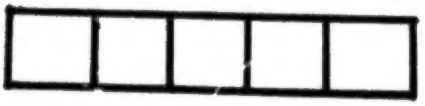
Do you use the messing area for activities other than dining and watching movies? What acticities do you use this space for?

_____

ARE THERE MANY FIGHTS ON BOARD YOUR SHIP?

many  none

ARE THERE MANY RACIAL INCIDENTS ON BOARD YOUR SHIP:

many  none

DO MOST OF THE FIGHTS OR RACIAL INCIDENTS HAPPEN: (circle one or more)

1. after large group activities
2. after movies
3. after competitive sports events
4. at mess time
5. after long periods of duty
6. unpredictable when they will happen
7. none of the above
   If none of the above, when? _____

WHERE DO MOST FIGHTS OR RACIAL INCIDENTS OCCUR: (circle one or more)

1. in the mess area
2. in the bunk areas
3. on work stations
4. other
   if other, where? _____

DO MOST FIGHTS OCCUR: (circle answer)

1. when ship is at sea
2. when the ship is in port

If their are fights aboard you ship, do you think they can be avoided? How? _____

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QUESTIONNAIRE NO. 5

ATTITUDES TOWARD WOMEN ABOARD SHIP

(WOMEN'S FORM)

This questionnaire is sponsored by the Office of Naval Research to improve shipboard habitability. Your responses will be kept confidential, and information that you give will be used in a general or illustrative way but will not identify you specifically.

Name_____ Age_____

Paygrade _____ Rating_____

Time on active duty_____ How long do you expect to remain in the Navy?_____

Indicate the type of duty that most nearly applies to you at present.

1. deck
2. engineering/hull
3. electronics/radio/ communications
4. clerical
5. cook
6. steward
7. medical/ dental
8. student
9. instructor
10. recruit
11. ordnance
12. working out of rate

Which of the following best describes your feelings towards the Navy?

1. I want to get out as soon as possible.
2. I am pretty sure that the Navy is not for me.
3. I am not sure whether I'll leave the Navy or stay in.
4. I'll probably stay in the Navy past this enlistment.
5. I definitely plan to make the Navy a career.

Indicate how much schooling you have had.

1. Through 8th grade.
2. 9-11 years
3. 12 years
4. some college (no degree)
5. college graduate (two year degree)
6. college graduate (four year degree)

1. Some of the reasons for joining the Waves (WIMS) are listed below. If your reasons are there, please indicate with a check mark that the reason or reasons stated are ones that influenced your decision to join. Please add any that were important to you if they are not listed below.

_____ I could receive the training I wanted without the expense of civilian life.

_____ I could receive education that would have otherwise been financially impossible. (What kind?_____)

_____ I wanted to "see the world".

_____ I could work around a lot of men, which I like.

_____ I could get away from home.

_____ The Navy's retirement program was very attractive.

_____ I didn't know what to do, and the Navy sounded okay.

_____ I joined because my husband (fiance, boyfriend) is in the Navy, and we wanted to be together.

_____ The Navy seemed to offer good opportunities for advancement in my field.

_____ I joined because a good friend convinced me Navy life was good.

_____ I was brought up in a Navy family, so being a Wave was a natural for me.

_____ The Navy could provide a more exciting place to do the kind of work I was trained for than would have been possible in civilian life.

Other reasons_____

_____

_____

_____

2. When you joined the Waves (WIMS), did you expect to be assigned to the Sanctuary?

Yes_____ no_____ other ship_____ on land_____

3. Has your experience on board matched up with your expectations of what life would be like? Could you explain please.

4. Are there any aspects of Navy life aboard ship including the ship's physical layout that should be changed or altered to make life on board ship better for Navy women? What problems would these changes solve?

Do your suggestions apply to the Sanctuary?yes_____ other ship_____

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5. When facilities for women are available on board cruisers and carriers, would you like to be stationed there? Yes_____ No_____

6. Would you remain in the Navy beyond this tour of duty if you were reassigned from the Sanctuary to a cruiser or carrier? Yes_____ No_____

7. Have you ever been aboard a cruiser_____? A carrier_____? Have you heard much about what life is like aboard either type ship?

8. If there is anything aboard cruisers or carriers that should be changed before women become crew members (besides separate berthing areas and bathroom facilities), what would that be?

9. Are you married?_____If not, do you plan to marry? Yes_____
Near future_____
Maybe_____
Uncertain_____
No_____

If you are married or engaged, how does your husband or fiance feel about your being aboard ship?

How would he react if you were to be stationed aboard a cruiser or carrier?

10. The following list indicates types of duty. Some might be done better by women, some by men, and some by either women or men. Place a W by jobs that you think could best be done by a woman; place an M by those best done by a man; and place both W and M next to those that could be done by either a woman or a man.

1. deck_____
2. engineering/hull_____
3. electronics/radio/ communications_____
4. clerical_____
5. cook_____
6. steward_____
7. medical/ dental_____
8. student_____
9. instructor_____
10. recruit_____
11. ordnance_____

11. Would you have any difficulty in accepting a woman as your immediate superior?

As your executive officer?

12. Please add anything else that you think might help us to understand how ships should or might function with women crew members aboard.

Thank you for your help.

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QUESTIONNAIRE NO. 6

ATTITUDES TOWARD WOMEN ABOARD SHIP

(MEN'S FORM)

This questionnaire is sponsored by the Office of Naval Research to improve shipboard habitability. Your responses will be kept confidential, and information that you give will be used in a general or illustrative way but will not identify you specifically.

Name_____ Age_____

Paygrade _____ Rating_____

Time on active duty_____How long do you expect to remain in the Navy?_____

Indicate the type of duty that most nearly applies to you at present.

1. deck
2. engineering/hull
3. electronics/radio/ communications
4. clerical
5. cook
6. steward
7. medical/ dental
8. student
9. instructor
10. recruit
11. ordnance
12. working out of rate

Which of the following best describes your feelings towards the Navy?

1. I want to get out as soon as possible.
2. I am pretty sure that the Navy is not for me.
3. I am not sure whether I'll leave the Navy or stay in.
4. I'll probably stay in the Navy past this enlistment.
5. I definitely plan to make the Navy a career.

Indicate how much schooling you have had.

1. Through 8th grade.
2. 9-11 years
3. 12 years
4. some college (no degree)
5. college graduate (two year degree)
6. college graduate (four year degree)

1. Some of the reasons for joining the Navy are listed below. If your reasons are there, please indicate with a check mark that the reason or reasons stated are ones that influenced your decision to join. Please add any that were important to you if they are not listed below.

_____I could receive the training I wanted without the expense of civilian life.

_____I could receive education that would have otherwise been financially impossible. (What kind?_____)

_____I wanted to "see the world".

_____I could work with men, which I would prefer.

_____I could get away from home.

_____The Navy's retirement program was very attractive.

_____I didn't know what to do, and the Navy sounded okay.

_____I joined because my (brother, friend, girlfriend, wife) is in the Navy, and we wanted to be together.

_____The Navy seemed to offer good opportunities for advancement in my field.

_____I joined because a good friend convinced me Navy life was good.

_____I was brought up in a Navy family, so being a sailor was a natural for me.

_____The Navy could provide a more exciting place to do the kind of work I was trained for than would have been possible in civilian life.

Other reasons_____

_____

_____

_____

2. When you joined the Navy, did you expect to be assigned to the Sanctuary?
Yes_____No_____Other ship_____On land_____

3. Has your life aboard ship changed since women have come aboard as crew?

4. How do you feel about women being here?

5. Would you transfer if you could to a ship where there were no women?

6. Are there any spaces or facilities aboard ship that you feel should be available only to men? What are they?

Preceding page blank

7. Are there any aspects of Navy life aboard ship including the ship's physical layout that should be changed or altered to accommodate women? What problems would these changes solve?

Do your suggestions apply to the Sanctuary? Yes_____ Other ship_____

8. The following list indicates types of duty. Some might be done better by women, some by men, and some by either women or men. Place a W by jobs that you think could best be done by a woman; place an M by those best done by a man; and put both W and M next to those that could be done either by a woman or a man.

1. deck_____
2. engineering/hull_____
3. electronics/radio/ communications_____
4. clerical_____
5. cook_____
6. steward_____
7. medical/ dental_____
8. student_____
9. instructor_____
10. recruit_____
11. ordnance_____

9. How would you react if your immediate superior were a woman?

10. How would you react if your executive officer were a woman?

11. Are you married? _____ If not, do you plan to marry? Yes_____
Near future_____
Maybe_____
Uncertain_____
No_____

If you are married or engaged, how has your wife or fiance reacted to women being on board? Could you comment on this please.

12. Are there any Navy traditions that will have to be changed now that women are included as crew members aboard ship?

13. Please add anything else that you think might help us to understand how ships should or might function with women crew members aboard.

Thank you for your help.

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APPENDIX B

FACTS AND OBSERVATIONS DURING THE THREE WEEK SURVEY AND DOCUMENTATION TRIP IN SAN DIEGO (OCTOBER 31 - NOVEMBER 17, 1972)

FACTS

The following is an outline of the main events that took place and of the work accomplished during the second survey and documentation trip to San Diego in October and November 1972.

Mr. Lawson, of the Office of Naval Research in Pasadena, contacted Lt. Deaton of COMCRUDESPAC (destroyers) and Com. Garmus of COMPHIBPAC (amphibious ships) who gave us information on the availability of ships, contacted the executive officers of the ships selected, and sent them teletypes containing the details of our visits. We also received copies of these teletypes to aid the officer of the watch in identifying us and accepting our presence on board ship.

Commander White of the Naval Training Station asked several school directors to solicit volunteers for the survey and produced 40 persons (including four women) of whom 38 were randomly placed in four groups of approximately ten persons each. Each group was led by an officer who took attendance, handed out and collected questionnaires from the group's envelope and kept the image of authority within the survey group. The four groups were rotated around 13 ships in 13 days, a total of 52 visits. They filled out questionnaires after eating dinner on the ship they were surveying. On the fourteenth day, the whole survey group responded to a debriefing showing of slides of the ships visited, other ships, and model mess decks (this is discussed at length in other sections of this report). The ships visited were: FOX (DLG), GOMPERS (AD), HORNE (DLG), WADDELL (DDG), OWENS (DD), DURHAM (LKS), TUSCALOOSA (LST), THOMASTON (LSD), DULUTH (LPD), KIRK (DE), McCAIN (DDG), ROARK (DE), and HULL (DD).

The following is an outline of a typical day of activities:

Visit one ship in the survey to obtain the following data:

a. Photograph the mess deck including wide angle whole room shots (with a 35mm camera and a 21mm lens), furniture details, sequences through the serving line, etc. This was preceded by a determination of the color illumination of the ship according to specifications on the fluorescent bulbs (white, daylight, etc.) which could only be seen after taking apart the light fixtures. Appropriate filters were selected for Ektachrome EH daylight film and compensations were calculated from a fluorescent filter chart by C. W. Jerome, and by using Kodak information of their film and gelatin filters.

b. Photograph the mess deck a second time without filters with black and white film, including a standardized light source constructed by us for this use. The concept here is that the obtained slide, when projected, would include a pre-calibrated light source, consisting of a calibrated range of transmittance

values (an illuminated log neutral density scale), and thus the luminance could be determined for any surface in the photograph by comparing it with the standard source with a spot photometer.

c. Determine reflectance, hue, value, and chroma for all room surfaces as these factors compare to the standardized Munsell color and reflectance charts.

d. Measure the amount of light falling on various room surfaces with a footcandle meter (G.E. DR100-200) by taking several random readings for each surface and averaging them.

e. Measure the dimensions of the room and sketch the room and its furniture. The overall dimensions were approximated due to the number of non-uniform bulkhead projections. The dimensions to the outside edges of the tables are exact.

f. Talk to crew members and officers and subjectively obtain their environmental and social impressions.

g. Have crew members fill out questionnaires.

Board one ship with one survey group and eat dinner while:

a. Measuring the sound levels in various frequencies and bands with a B & K sound meter model 2203 with a model 1613 filter.

b. Measuring temperature and humidity with a standard sling psychrometer. (Steps a. and b. were repeated twice, before and during the meal.)

c. Recording any subjective notes on what was experienced on the mess deck while in use.

The survey and documentation work described above was completed at the end of the third week.

OBSERVATIONS

The ships surveyed were all under "in-port" conditions, some having just returned from long tours and thus in very strained physical and

psychological shape. The ships varied in age from a WWII DD to a two month old DE, and in purpose and construction from a destroyer tender (complement 1800 men) to an amphibious transport (complement 300 men). Some had returned from combat duty just days before our visit, others were training ships, while others had been in port constantly except for short test cruises.

Some comment on food is necessary. While discussing survival level needs, food certainly rates higher than the color of the walls or what kind of chair one is sitting on—institutional food is institutional food! Also, at first the group was generally enthusiastic at the prospect of visiting a large variety of ships and getting tours if they were early. But later, after the survey visits became routine and most types of ships had been visited once, this fascination wore off.

SUMMARY DOCUMENTATION OF MESS DECK ENVIRONMENT: SHIP NO. 21

1. COLORS Material and Reflectance Hue Value/Chroma f-c

Side Wall	Panels WG	
End Wall	Bulkhead	
Floor	Tile	W
Tables	Formica	W
Ceiling	Bulkhead	
Chairs	Lam Wood	

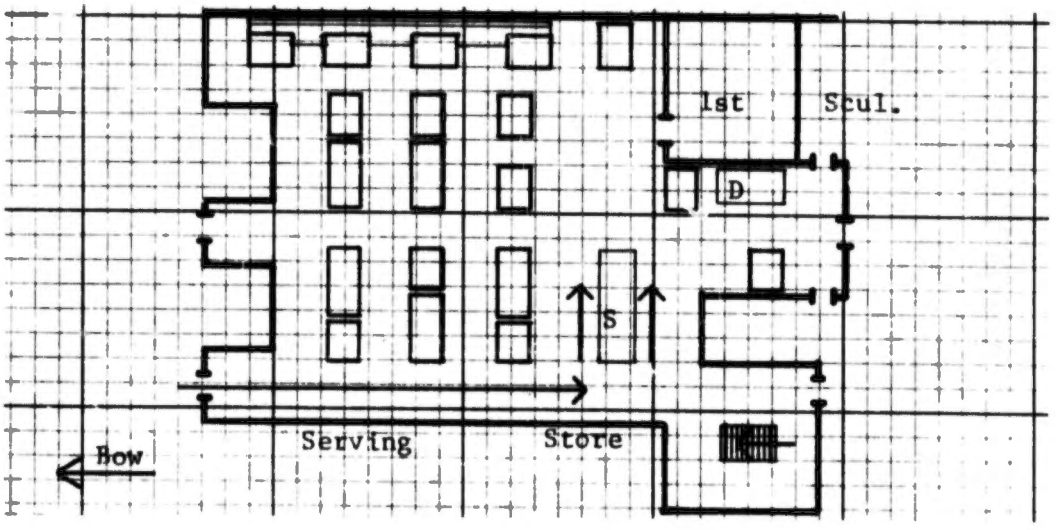
2. CONDITIONS AT EVENING MEAL (Measurements 20 minutes apart)

Sound	1.	dBA		2. dBA	Music
Temp/Hum	1.	°F	%RH	2. °F	%RH

3. DIMENSIONS

Tables	2man	4man	6man	8+man
Count	-	14	5	-
Length	-	3'9"	5'9"	-
Width	-	2'6"	2'6"	-

Overall Size 16'4" fore/aft 28'4" side/side
Chairs wide column type Ceiling height 6'4"



SUMMARY DOCUMENTATION OF MESS DECK ENVIRONMENT: SHIP NO. 22

1. COLORS Material and Reflectance Hue Value/Chroma f-c

Side Wall	Panels WG	7.75	5YR	4/4	8
End Wall	Bulkhead	8.00	5YR	8/2	2
Floor	Tile	7.00	10YR	7/8	10
Tables	Formica	8.75	2.5Y	8.5/6	18
Ceiling	Accus Tile	9.50			2
Chairs	Plastic	8.25	5R	5/12	

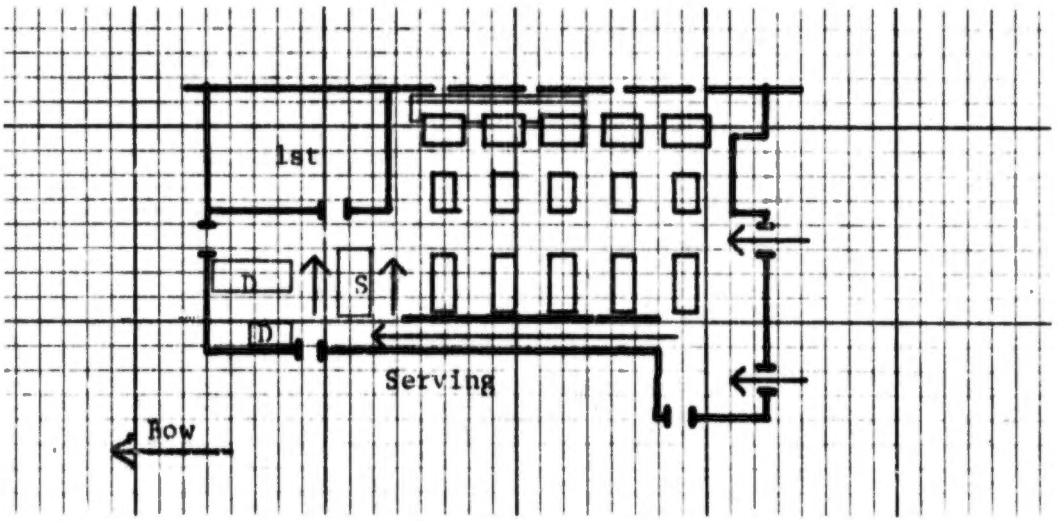
2. CONDITIONS AT EVENING MEAL (Measurements 20 minutes apart)

Sound	1. 67 dBA	2. 68 dBA Music soft
Temp/Hum	1. 76°F 50%RH	2. 77°F 55%RH

3. DIMENSIONS

Tables	2man	4man	6man	8+man
Count	3	7	4	-
Length	3'6"	3'6"	5'6"	-
Width	2'	2'	2'	-

Overall Size 22'9" fore/aft 16'8" side/side
Chairs 20" wide stacking type Ceiling height 6'1"



SUMMARY DOCUMENTATION OF MESS DECK ENVIRONMENT: SHIP NO. 23

1. COLORS Material and Reflectance Hue Value/Chroma f-c

Side Wall	Panels WG	5.50	7.5YR	6/8	11
End Wall	Bulkhead	8.50	5GY	9/2	12
Floor	Tile	8.25	10Y	8/2	12
Tables	Formica	8.50	5Y	8.5/4	17
Ceiling	Bulkhead	8.50	7.5Y	8.5/4	5
Chairs	Plastic	4.50	5GY	5/4	

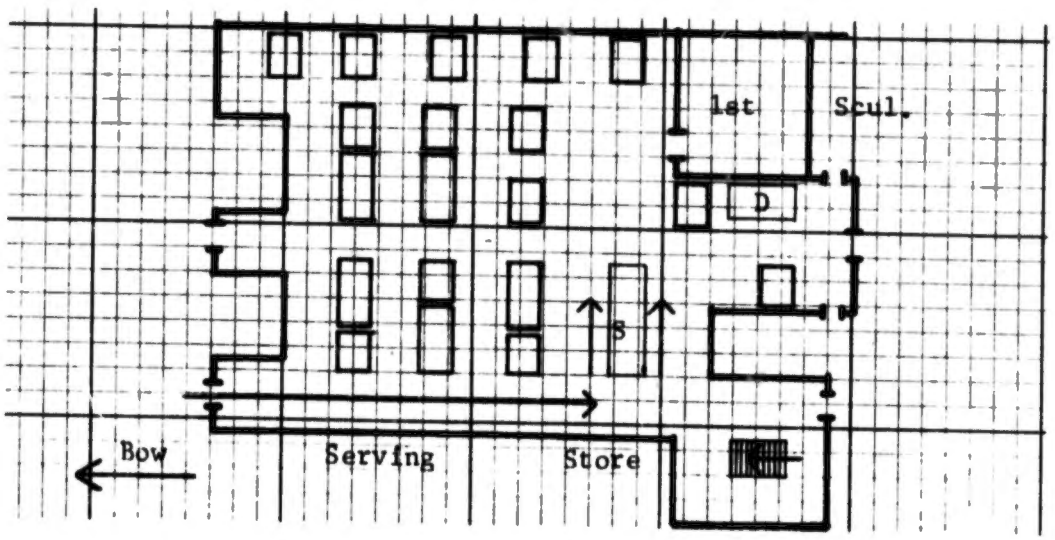
2. CONDITIONS AT EVENING MEAL (Measurements 20 minutes apart)

Sound	1. 72 dBA	2. 74 dBA Music loud
Temp/Hum	1. 70°F 60%RH	2. 77°F 40%RH

3. DIMENSIONS

Tables	2man	4man	6man	8+man
Count	-	14	5	-
Length	-	3'9"	5'9"	-
Width	-	2'6"	2'6"	-

Overall Size 16'4" fore/aft 28'4" side/side
Chairs 15" wide stacking type Ceiling height 6'4"



SUMMARY DOCUMENTATION OF MESS DECK ENVIRONMENT: SHIP NO. 24A

1. COLORS Material and Reflectance Hue Value/Chroma f-c

Side Wall	Panels WG	7.00	7.5YR	5/2	2
End Wall	Panels WG	8.25	5YR	6/4	4
Floor	Tile	9.00	10YR	4/2	6
Tables	Formica	8.50	2.5GY	6/4	8
Ceiling	Acous Tile	9.50			2
Chairs	Plastic Met	8.25	Black		

2. CONDITIONS AT EVENING MEAL (Measurements 20 minutes apart)

Sound	1.	dBA		2.	dBA Music
Temp/Hum	1.	°F	%RH	2.	°F %RH

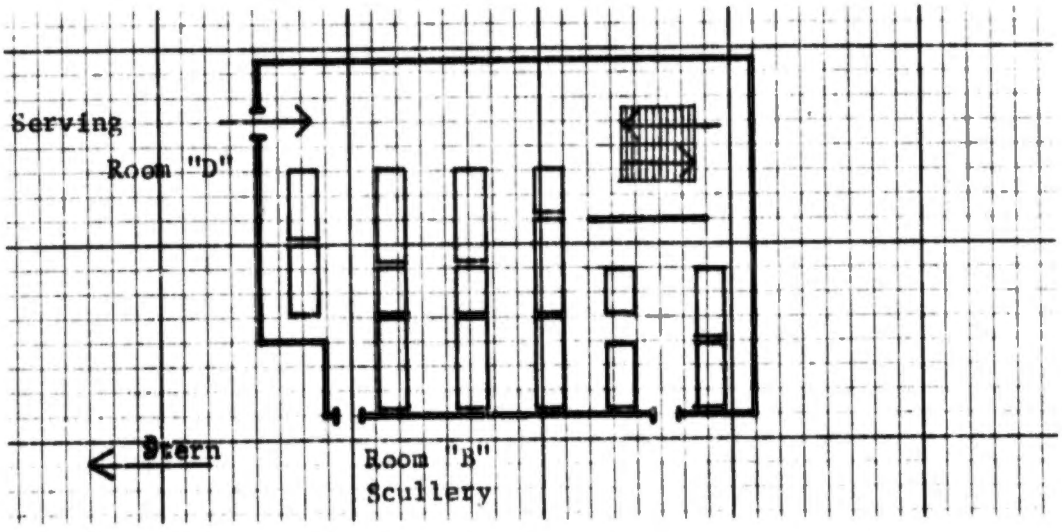
(Did not eat on this deck)

3. DIMENSIONS

Tables	2man	4man	6man	8man
Count	-	4	5	6
Length	-	3'9"	5'9"	7'9"
Width	-	2'5"	2'5"	2'5"

Overall Size 36'5" fore/aft 20'5" side/side

Chairs 17" wide stacking type Ceiling height 6'10"



SUMMARY DOCUMENTATION OF MESS DECK ENVIRONMENT: SHIP NO. 24B

1. COLORS Material and Reflectance Hue Value/Chroma f-c

Side Wall	Panels	8.75	W		5
End Wall	Graphics	6.25	7.5R	5/12	4
Floor	Tile	9.25	W		9
Tables	Formica	8.75	7.5R	4/12	9
Ceiling	Acous Tile	9.50			2
Chairs	Plastic Met	8.25	Black		

2. CONDITIONS AT EVENING MEAL (Measurements 20 minutes apart)

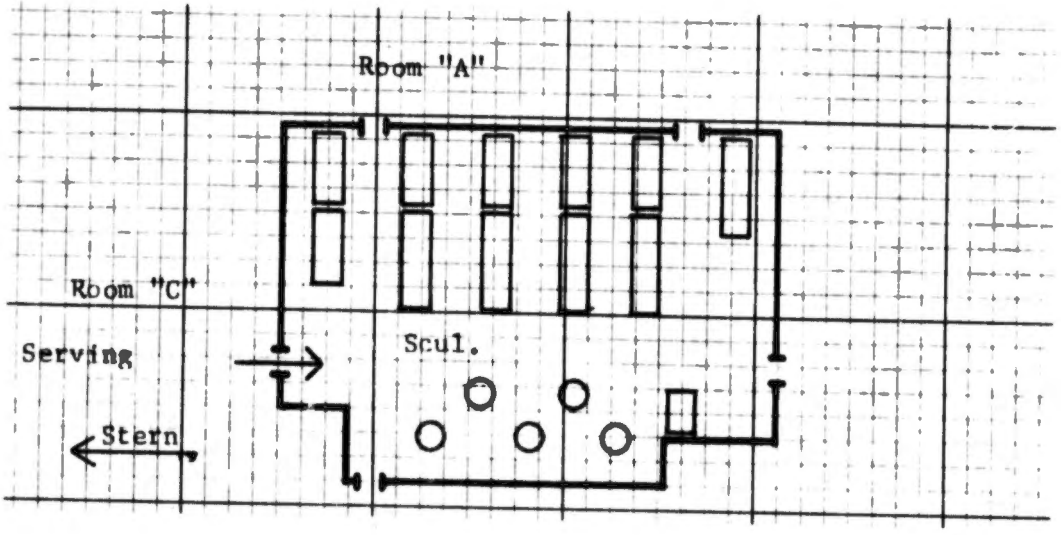
Sound	1.	dBA	2.	dBA	Music
Temp/Hum	1.	°F %RH	2.	°F	%RH

(Did not eat on this deck)

3. DIMENSIONS

Tables	2man	4man	6man	8+man
Count	5	1	6	5
Length	2'6"	3'9"	5'9"	7'9"
Width	2'6"	2'5"	2'5"	2'5"

Overall Size 36'5"fore/aft 20'5" side/side
Chairs 17" wide stacking type Ceiling height 6'10"



SUMMARY DOCUMENTATION OF MESS DECK ENVIRONMENT: SHIP NO. 24C,D

1. COLORS Material and Reflectance Hue Value/Chroma f-c

Side Wall	Panel WG	7.50	5YR	5/8	1
End Wall	False Brick	4.75	5Y	9/2	3
Floor	Brick Tile	6.75	7.5R	4/6	6
Tables	Formica WG	8.75	2.5Y	8.5/4	6
Ceiling	Acous Tile	9.50			1
Chairs	Plastic Met	8.25	Black		

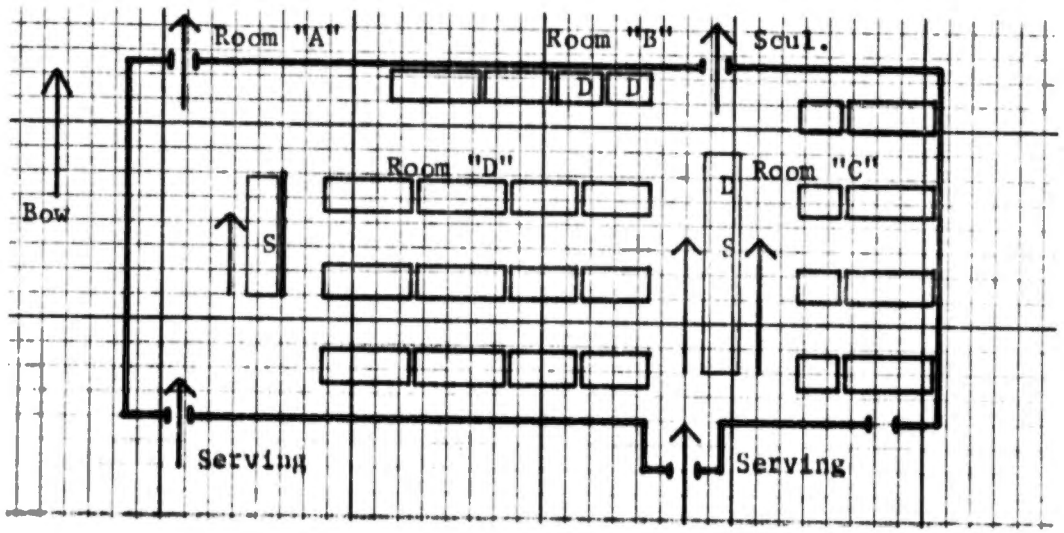
2. CONDITIONS AT EVENING MEAL (Measurements 20 minutes apart)

Sound	1. 72 dBA	2. dBA Music
Temp/Hum	1. 73°F 45%RH	2. °F %RH

3. DIMENSIONS

Tables	2man	4man	6man	8+man
Count	-	6	7	11
Length	-	3'9"	5'9"	7'9"
Width	-	2'5"	2'5"	2'5"

Overall Size 24'(C) fore/aft 11'6" side/side
Chairs 17" wide stacking type Ceiling height 6'10"



SUMMARY DOCUMENTATION OF MESS DECK ENVIRONMENT: SHIP NO. 25

1. COLORS Material and Reflectance Hue Value/Chroma f-c

Side Wall	Panels	6.50	5GY	6/6	15
End Wall	Bulkhead	9.25	W		12
Floor	Tile	8.50	2.5GY	7/2	8
Tables	Formica	8.25	7.5YR	6/12	18
Ceiling	Bulkhead	9.00	W		2
Chairs	Pads	7.00	2.5YR	3/4	

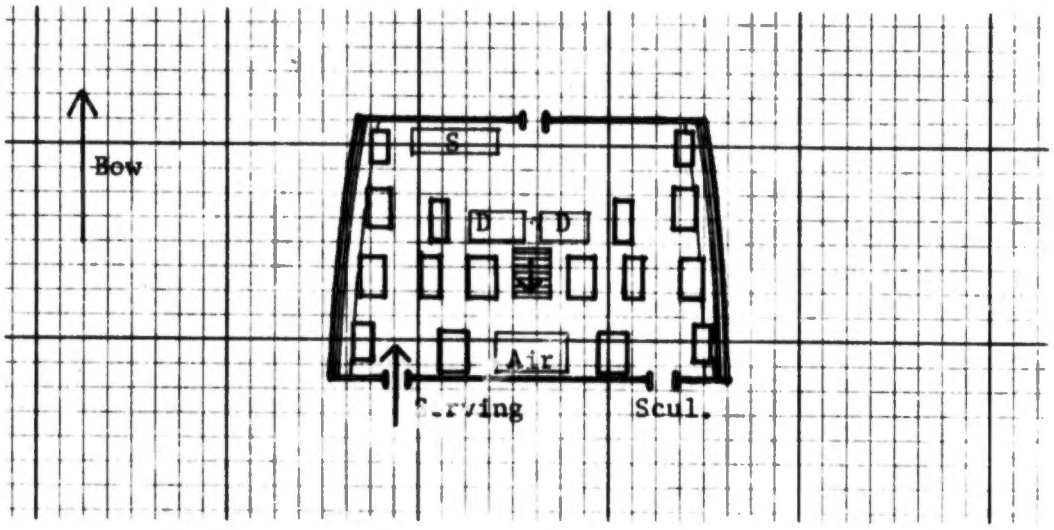
2. CONDITIONS AT EVENING MEAL (Measurements 20 minutes apart)

Sound	1. 75 dBA	2. 74 dBA Music none
Temp/Hum	1. 77°F 40%RH	2. 79°F 60%RH

3. DIMENSIONS

Tables	2man	4man	6man	8+man
Count	8	8	-	-
Length	3'7"	3'7"	-	-
Width	1'4"	2'1"	-	-

Overall Size 17'7" fore/aft 27'7" side/side
Chairs 3'3" wide bench type Ceiling height 5'10"



SUMMARY DOCUMENTATION OF MESS DECK ENVIRONMENT: SHIP NO. 26

1. COLORS Material and Reflectance Hue Value/Chroma f-c

Side Wall	Panels WG	9.00	5YR	4/4	10
End Wall	Bulkhead	7.75	7.5YR	5/8	4
Floor	Tile	8.25	W		10
Tables	Formica	9.00	5Y	9/2	20
Ceiling	Acous Tile	8.75			4
Chairs	Pads	8.75	5YR	5/6	

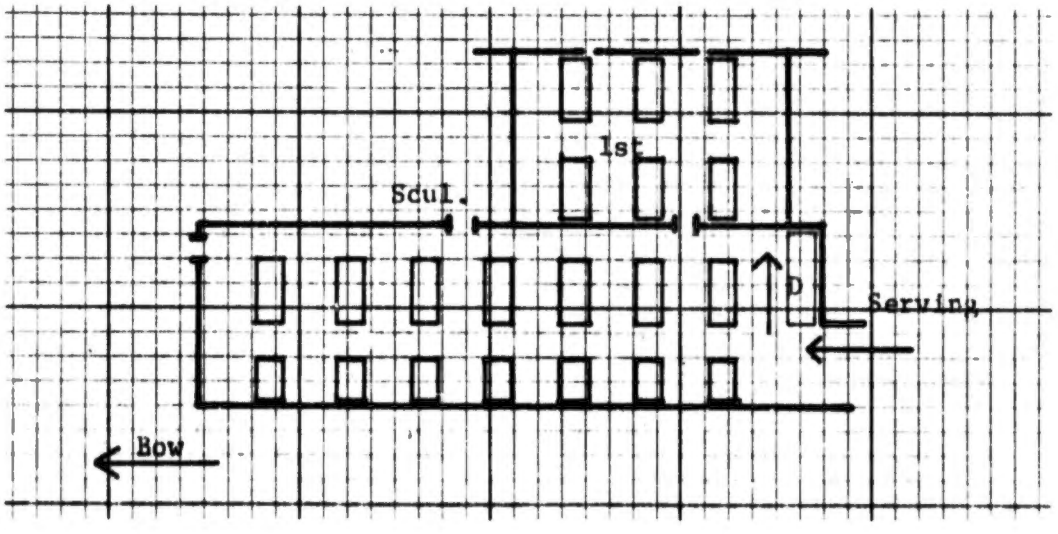
2. CONDITIONS AT EVENING MEAL (Measurements 20 minutes apart)

Sound	1. 59 dBA	2. 61 dBA Music none
Temp/Hum	1. 75°F 50%RH	2. 75°F 50%RH

3. DIMENSIONS

Tables	2man	4man	6man	8+man
Count	-	7	12	-
Length	-	3'8"	5'8"	-
Width	-	2'3"	2'3"	-

Overall Size 34'10" fore/aft 29'4" side/side
Chairs 17" wide column type Ceiling height 6'5"



SUMMARY DOCUMENTATION OF MESS DECK ENVIRONMENT: SHIP NO. 27

1. COLORS Material and Reflectance Hue Value/Chroma f-c

Side Wall	Panels WG	8.50	10YR	8/2	3
End Wall	Panels WG	8.50	10YR	8/2	4
Floor	Tile	8.75	10Y	9/2	5
Tables	Formica	9.50	W		9
Ceiling	Acous Tile	9.00			2
Chairs	Plastic	8.25	5PB	5/10	

2. CONDITIONS AT EVENING MEAL (Measurements 20 minutes apart)

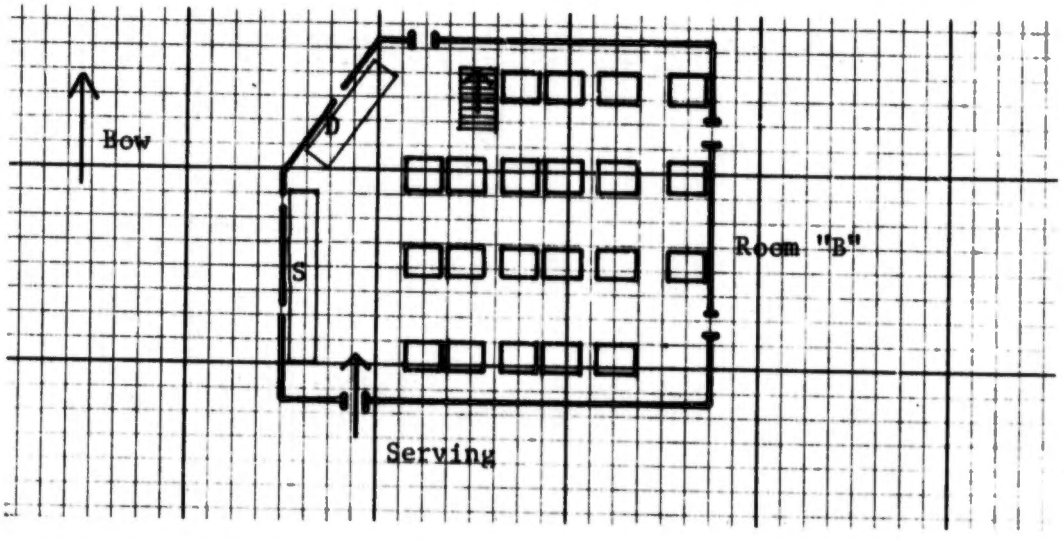
Sound	1. 71 dBA	2. 70 dBA Music
Temp/Hum	1. 78°F 50%RH	2. 81°F 50%RH

3. DIMENSIONS

Tables	2man	4man	6man	8+man
Count	-	21	-	-
Length	-	3'6"	-	-
Width	-	2'3"	-	-

Overall Size 25' fore/aft 27' side/side

Chairs 15" wide floor type Ceiling height 6'6"



SUMMARY DOCUMENTATION OF MESS DECK ENVIRONMENT: SHIP NO. 28

1. COLORS Material and Reflectance Hue Value/Chroma f-c

Side Wall	Bulkhead	9.00	10GY	9/2	6
End Wall	Panels WG	7.50	7.5YR	5/4	6
Floor	Tile	9.00	W		20
Tables	Formica	8.75	5YR	3/2	24
Ceiling	Acous Tile	9.50			6
Chairs	Plastic	9.00	10B	8/4	

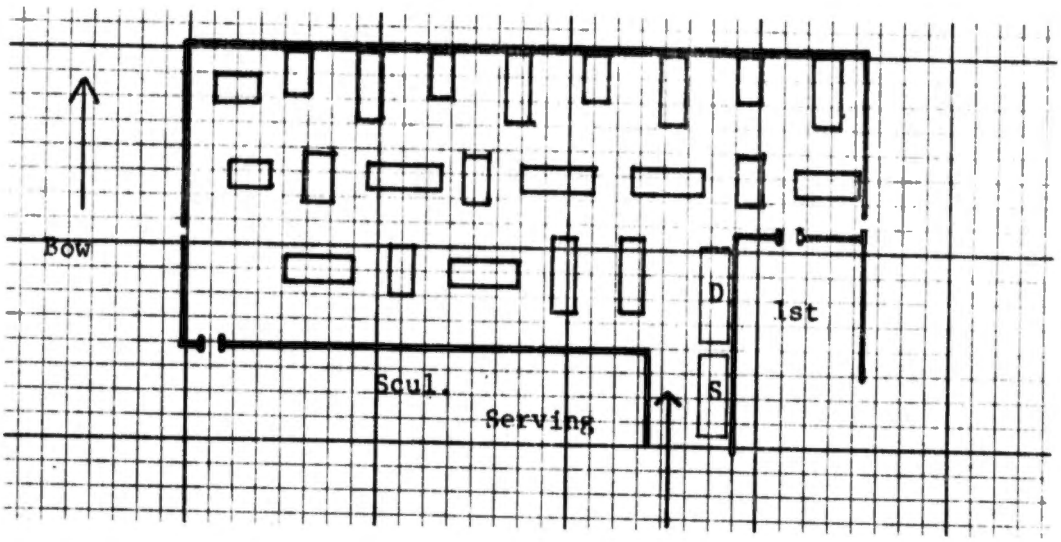
2. CONDITIONS AT EVENING MEAL (Measurements 20 minutes apart)

Sound	1. 62 dBA	2. 63 dBA Music none
Temp/Hum	1. 74°F 60%RH	2. 72°F 55%RH

3. DIMENSIONS

Tables	2man	4man	6man	8+man
Count	-	10	12	-
Length	-	3'9"	5'8"	-
Width	-	2'2"	2'2"	-

Overall Size 21'4" fore/aft 53'4" side/side
Chairs 20" wide stacking type Ceiling height 6'5"



SUMMARY DOCUMENTATION OF MESS DECK ENVIRONMENT: SHIP NO. 29

1. COLORS Material and Reflectance Hue Value/Chroma f-c

Side Wall	Bulkhead	8.75	W		7
End Wall	Panels	9.25	7.5Y	8.5/4	9
Floor	Tile	8.25	5GY	4/4	6
Tables	Formica	8.25	5YR	6/4	10
Ceiling	Acous Tile	9.25			2
Chairs	Metal Plas	8.50	7.5YR	5/10	

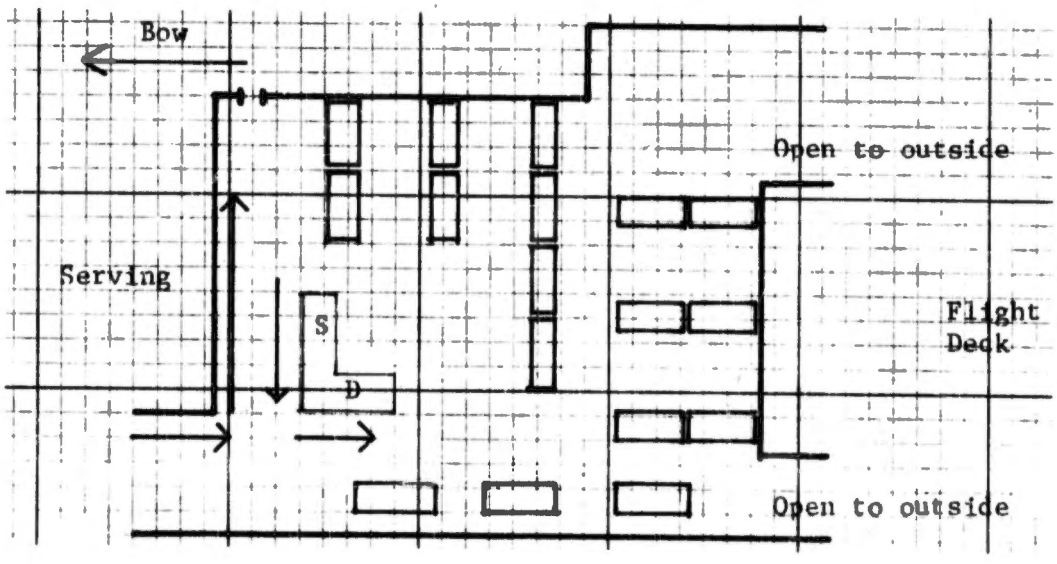
2. CONDITIONS AT EVENING MEAL (Measurements 20 minutes apart)

Sound	1. 67 dBA	2. 69 dBA Music
Temp/Hum	1. 71°F 50%RH	2. 71°F 50%RH

3. DIMENSIONS

Tables	2man	4man	6man	8+man
Count	-	-	17	-
Length	-	-	6'	-
Width	-	-	2'6"	-

Overall Size 36' fore/aft 31'6" side/side
Chairs 16" wide stacking type Ceiling height 6'8"



SUMMARY DOCUMENTATION OF MESS DECK ENVIRONMENT: SHIP NO. 30

1. COLORS Material and Reflectance Hue Value/Chroma f-c

Side Wall	Panels WG	8.00	7.5YR	5/6	4
End Wall	Bulkhead	7.75	10R	3/6	2
Floor	Tile	9.00	5G	4/6	6
Tables	Formica	8.50	10YR	2.5/1	10
Ceiling	Plastic Grid				2
Chairs	Plastic	8.25	10YR	7/8	

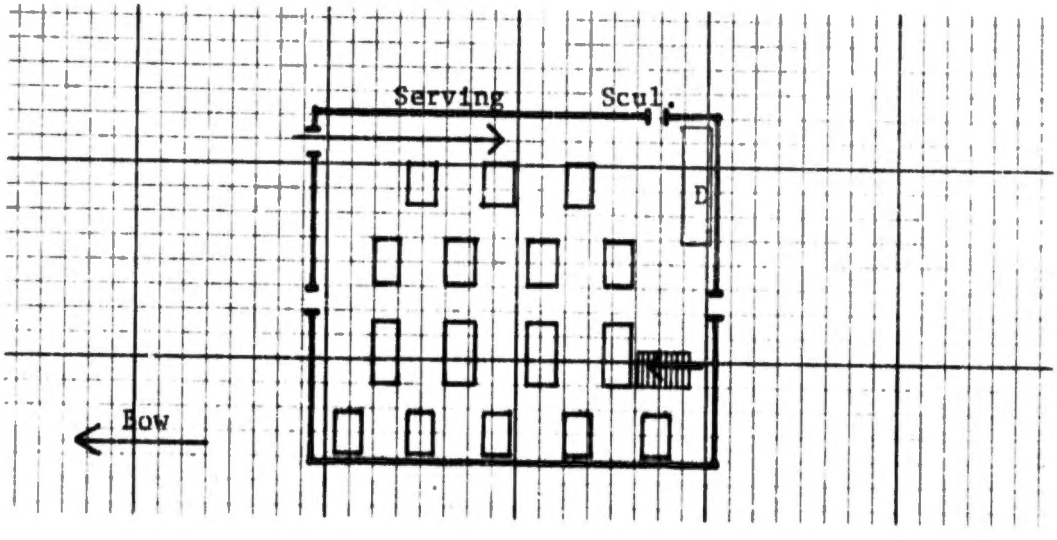
2. CONDITIONS AT EVENING MEAL (Measurements 20 minutes apart)

Sound	1. 67 dBA	2. 67 dBA Music none
Temp/Hum	1. 73°F 55%RH	2. 74°F 55%RH

3. DIMENSIONS

Tables	2man	4man	6man	8+man
Count	-	12	4	-
Length	-	3'8"	5'8"	-
Width	-	2'2"	2'2"	-

Overall Size 20'4" fore/aft 24'7" side/side
Chairs 20" wide stacking type Ceiling height 6'5"



SUMMARY DOCUMENTATION OF MESS DECK ENVIRONMENT: SHIP NO. 31

1. COLORS Material and Reflectance Hue Value/Chroma f-c

Side Wall	Bulkhead	8.75	5BG	9/1	15
End Wall	Bulkhead	8.75	5BG	9/1	4
Floor	Tile	8.25	10YR	7/2	12
Tables	Formica	9.25	W		21
Ceiling	Bulkhead	8.75	5BG	9/1	4
Chairs	Pads	8.25	2.5Y	7/6	

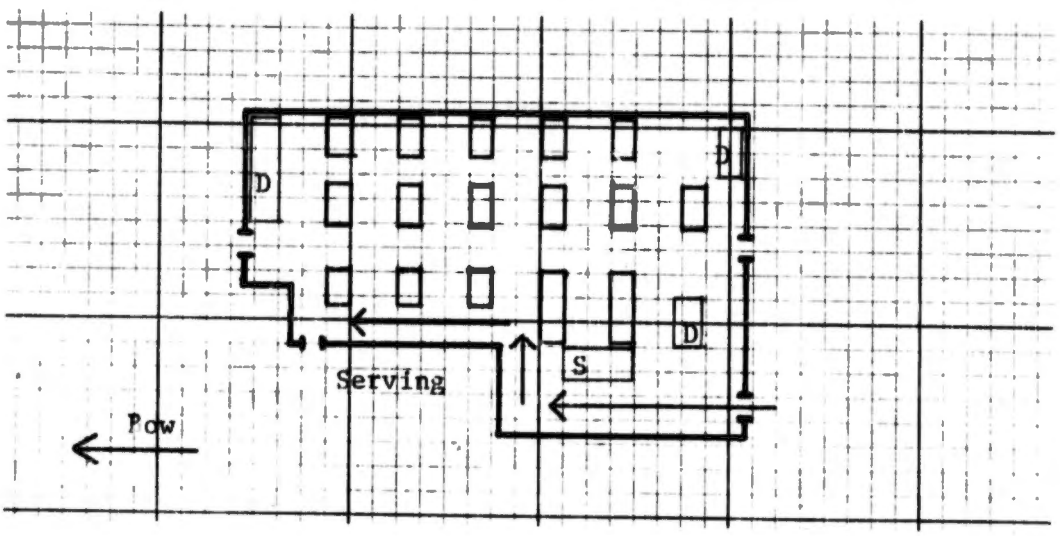
2. CONDITIONS AT EVENING MEAL (Measurements 20 minutes apart)

Sound	1. 71 dBA	2. 70 dBA Music
Temp/Hum	1. 73°F 45%RH	2. 71°F 70%RH

3. DIMENSIONS

Tables	2man	4man	6man	8+man
Count	-	14	2	-
Length	-	3'6"	5'6"	-
Width	-	2'	2'	-

Overall Size 27'10" fore/aft 15'5" side/side
Chairs 17" wide column type Ceiling height 6'4"



SUMMARY DOCUMENTATION OF MESS DECK ENVIRONMENT: SHIP NO. 32

1. COLORS Material and Reflectance Hue Value/Chroma f-c

Side Wall	Bulkhead	8.75	10GY	8.5/1	18
End Wall	Bulkhead	8.75	10GY	8.5/1	14
Floor	Tile	9.00	5G	4/6	16
Tables	Formica	8.75	W		26
Ceiling	Bulkhead	9.25	10Y	9/1	4
Chairs	Metal	6.50	5B	3/4	

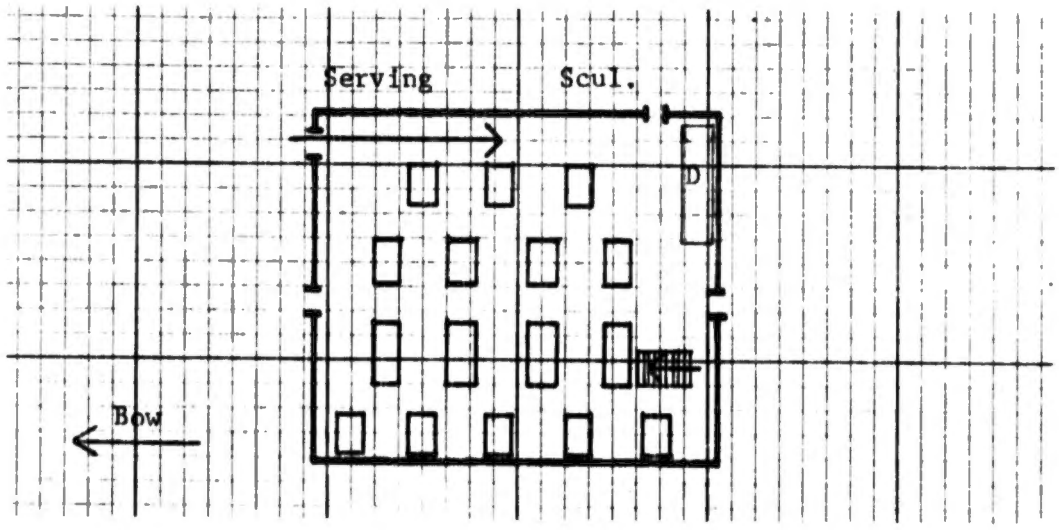
2. CONDITIONS AT EVENING MEAL (Measurements 20 minutes apart)

Sound	1. 74 dBA	2. 72 dBA Music
Temp/Hum	1. 76°F 45%RH	2. 75°F 45%RH

3. DIMENSIONS

Tables	2man	4man	6man	8+man
Count	-	12	3	-
Length	-	3'5"	5'5"	-
Width	-	2'	2'	-

Overall Size 20' fore/aft 24'2" side/side
Chairs 16" wide column type Ceiling height 6'9"



SUMMARY DOCUMENTATION OF MESS DECK ENVIRONMENT: SHIP NO. 33

1. COLORS Material and Reflectance Hue Value/Chroma f-c

Side Wall	Bulkhead	8.50	10B	8/4	12
End Wall	Curtain		7.5GY	6/8	6
Floor	Tile	9.00	10YR	4/2	10
Tables	Formica	9.25	W		22
Ceiling	Plastic Grid				3
Chairs	Plastic	9.25	5Y	8/10	

2. CONDITIONS AT EVENING MEAL (Measurements 20 minutes apart)

Sound	1. 74 dBA	2. 75 dBA Music
Temp/Hum	1. 75°F 60%RH	2. 76°F 60%RH

3. DIMENSIONS

Tables	2man	4man	6man	8+man
Count	-	11	6	-
Length	-	3'5"	5'5"	-
Width	-	2'	2'	-

Overall Size 19'3" fore/aft 28'8" side/side
Chairs 15" wide stacking type Ceiling height 6'3"