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CONSTRUCT DEFINITION OF TASK DESIGN AND RELATED CONCEPTS.(U)
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# REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

| | | |
|---|---|---|
| 1. REPORT NUMBER TR-1-1 | 2. GOVT ACCESSION NO. AD-A084628 | 3. RECIPIENT'S CATALOG NUMBER |
| 4. TITLE (and Subtitle) CONSTRUCT DEFINITION OF TASK DESIGN AND RELATED CONCEPTS. | | 5. TYPE OF REPORT & PERIOD COVERED Interim - 9/1/79 to 6/1/80 |
| | | 6. PERFORMING ORG. REPORT NUMBER 1-1-X |
| 7. AUTHOR(s) (10) Randall B. Dunham and Larry L. Cummings | | 8. CONTRACT OR GRANT NUMBER(s) (15) N00014-79-C-0750 |
| 9. PERFORMING ORGANIZATION NAME AND ADDRESS Graduate School of Business, University of Wisconsin Madison, Wisconsin 53706 (12) 45 | | 10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS NR 170-892 |
| 11. CONTROLLING OFFICE NAME AND ADDRESS Organizational Effectiveness Research Programs Office of Naval Research (Code 452), Arlington, Virginia 22217 | | 12. REPORT DATE (11) 1 May 1980 |
| | | 13. NUMBER OF PAGES 25 |
| 14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) LEVEL II | | 15. SECURITY CLASS. (of this report) UNCLASSIFIED |
| | | 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE |

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release: distribution unlimited.

DTIC ELECTE MAY 27 1980 D C

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

(9) Interim rept. 1 Sep 79-1 Jun 80

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Job design, job scope, construct definition, construct validation, job redesign, individual contexts, organization contexts.

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A procedure is developed and illustrated with job scope perceptions for determining the stability of the factor structure within a data matrix. Emphasis is given to the importance of determining such stability prior to fixing the number of factors desired, rotated and interpreted. The procedure is applied to the four constructs fundamental to this research program. The procedure is suggested as substantially contributing to the validity of the constructs used in organizational behavior and organizational psychology.

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UNCLASSIFIED 411 762

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

# CONSTRUCT DEFINITION OF

# TASK DESIGN AND RELATED CONCEPTS

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Technical Report Number 1-1
May, 1980

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## CONSTRUCT DEFINITION OF TASK DESIGN AND RELATED CONCEPTS[1,2]

The purpose of this technical report is to describe the construct definition of four constructs (i.e., perceived job characteristics, need strength, behaviors, job analysis dimensions) included in the research project funded by this contract. In addition, this report sets forth in detail a new methodology for establishing the stability of underlying dimensionality when using factor analysis. The first part of this report discusses the various approaches in use for establishing the number of factors to retain when conducting a factor analysis. The factor analysis stability testing technique developed under this contract is then briefly discussed. The stability testing technique is illustrated in detail using the construct definition exercise for one of the four constructs underlying our research program (i.e., perceived job characteristics). Since the techniques used are new, the methodology as well as the constructs under investigation will be considered in detail. The final section of the report presents the results of an application of the same construct definition exercise for each of the remaining three constructs. Since the techniques used with the last three constructs are identical to that used with the first, discussion of the construct definition of the last three constructs will focus on results rather than on methodology.

# Dimensionality in Factor Analysis

During the last two decades the field of applied psychology has made extremely wide use of exploratory factor analysis for construct definition and instrument development purposes. In fact, one or another variations of the factor analysis model has been used in almost all studies in which the underlying dimensionality of constructs has been empirically explored. Unfortunately, many applications of factor analytic procedures for construct validation purposes have been inappropriate in logic and/or application (see Schwab, 1980, pp. 19-21). We will go beyond these problems in this report and argue here that even with appropriate use of existing factor analytic techniques a crucial step in the construct definition process has been universally omitted. This critical omission involves the lack of use of a stability criterion in selecting the number of factors to be extracted, rotated, and interpreted.

A basic problem faced by all users of factor analysis has been the determination of the appropriate number of factors to extract and interpret. Since both our conceptual and operational definitions of constructs have been heavily influenced by the techniques for solving this dimensionality issue, the process used is of great importance to our field. There are several techniques which are frequently used to address this problem [see Kim and Mueller (1978) for a good discussion of these approaches]. A summary of these approaches is presented here.

## Significance Tests

There are two types of significance tests commonly applied for solving the number of factors problem. These are tests of statistical significance and tests of substantive significance. Kim and Mueller point out (1978, p. 42) that the large sample Chi-square test used with the maximum likelihood method is often the most satisfactory solution to the number of factors problem from a purely statistical point of view. In practice, however, the number of factors identified as statistically significant using this method tends to be considerably larger than the number of factors acceptable to most researchers on an a priori theoretical basis. Post hoc interpretation of this relatively large number of factors also tends to prove difficult. In response to this dilemma, researchers typically apply the more subjective test of substantive significance retaining only that number of statistically significant factors which can be reasonably interpreted.

## Eigenvalue Specification

Recently the most popular methods for identifying the number of factors to retain have been based on eigenvalue specification rules. One such rule is to retain all factors with eigenvalues greater than 1.0 when the correlation matrix is decomposed. According to Kim and Mueller (1978), this technique tends to produce results which often match the a priori expectations of researchers. However, similarity to subjective opinion should not be given too much weight given that one of the major purposes of exploratory factor analysis is to empirically determine the most appropriate number of factors. This simple criterion is most appropriate for use with a population correlation matrix. When used with sample correlation matrices, as is typically the case in our field, this criterion is not as appropriate (an excessively large number of factors tend to be retained), and the results are influenced by sample departures from the population correlation matrix. A related rule for eigenvalue specification can be applied when working with a correlation matrix in which squared multiple Rs have been inserted into the main diagonal. This approach involves retaining factors with eigenvalues greater than zero when the matrix is decomposed. Again, however, this approach creates problems when dealing with a sample rather than a population correlation matrix. Harman has proposed a variation of this last method (1975, p. 141) which will typically lead to the acceptance of a smaller number of factors. Using this more restrictive approach, the researcher extracts factors until the cumulative sum of eigenvalues reaches the sum of the estimated communalities.

### Substantive Importance

*This is a subjective approach in which the researcher decides* a priori the proportion of total item variance to be explained by the last or "smallest" acceptable factor. This approach is often attractive to less sophisticated users of factor analysis because the criterion is quite straightforward and easy to understand (as noted by Kim and Mueller, 1978). When working with an unaltered correlation matrix the use of the eigenvalue equal to one criterion produces the same results as the use of 100/n as an index of substantive importance; where n = number of items.

### Scree-test

The Scree-test proposed by Cattell (1965) has been gaining in popularity in industrial psychology and organizational behavior especially in the last five years. Using this approach, the researcher plots a graph of eigenvalues against factor numbers. This graph is then visually inspected to identify a break or "elbow" in the curve. A flattening or straightening of the curve identifies the point at which factors should no longer be extracted. This approach has proven useful for isolating major common factors while excluding minor factors. It must be noted, however, that this approach often becomes quite subjective due to the frequent appearance of more than one "elbow" in the eigenvalue graph.

It should be obvious from the preceding discussion that there is no one best way to solve the number of factors problem. It should also be apparent that the approach selected will depend in part on the purpose of the factor analysis being conducted. To quote Kim and Mueller . . . "the final judgment has to rest on the reasonableness of the solution on the basis of current standards of scholarship in one's own field" (1978, p. 451). We feel that the organizational behavior field needs to add new standards to guide researchers using factor analysis.

Researchers in organizational behavior have committed two types of errors which are traceable to their selection of solutions to the number of factors problem. The first type of error has been to extract too many factors, thus extracting one or more factors which turn out to be unstable. This has caused problems of overinterpretation of construct dimensionality and has led to subsequent confounding of research when overly complex constructs are utilized as independent or dependent variables in hypothesis testing. This type of error is particularly encouraged by the use of statistical significance and eigenvalue specification criteria and often by the criterion of substantive importance when a small proportion is used for the criterion. This first type of error can also occur when using the Scree-test depending on the subjective judgment of the researcher in identifying the critical "elbow." The second type of error has been to extract too few factors thus excluding one or more potentially important factors from further consideration. This has led to the oversimplification of construct dimensionality and to confounding of research through the exclusion of important dimensions. This type of error is often encouraged by use of the substantive importance criterion when the researcher sets a large proportion as the criterion for factor acceptance and can also occur when the conservative researcher subjectively chooses an early "elbow" for the Scree-test.

An important consideration which has been overlooked in the solution of the number of factors problem is that of stability. When exploratory factor analysis is used for construct definition or instrument development, a <u>primary consideration should be that of stability of dimensionality of the factor solution being extracted.</u> We should not be highly interested in factors which account for a substantial amount of the item variance but which are not stable. We should give attention, on the other hand, to factors which are stable even when they account for a relatively small proportion of the item variance. These variables may prove to be very important in subsequent hypothesis testing involving the construct even though they account for a relatively small amount of the item variance in the total set of items included in the factor analysis. None of the criteria for solution of the number of factors problem adequately considers the issue of stability. We propose that a test of dimensional stability be used in conjunction with one or more of the other criteria when identifying the number of factors to retain in factor analysis.

As will be shown in more detail in the remainder of this report, the first step of the proposed process is to apply one of the criteria previously discussed in this paper for the sole purpose of identifying the maximum dimensionality likely to be of interest. Since several approaches discussed were noted to be "overly generous" in accepting factors, researchers have several options to choose from in the first step of the proposed process. As will be seen, we prefer a liberal use of Cattell's Scree-test (selecting a later "elbow" when two or more are apparent in the eigenvalue graph). In step two of our proposed approach, the total sample is divided into two random subsamples and two independent factor analyses are conducted extracting from each the number of factors identified in step one using the total sample. The two resulting factor structures are then jointly rotated using canonical analysis to force an identification of the number of stable underlying dimensions. The sole purpose of this procedure is to identify the number of stable underlying dimensions. The researcher is free to apply other criteria as well if desired. In the construct definition procedures presented in this report, we are attempting to identify and define only those factors which are stable. Given this purpose we will return to the total sample factor analysis and extract and interpret the number of factors identified as stable through the application of the stability technique.

# Construct Definition of Perceived Job Characteristics

## Sample

The sample consisted of 360 employees of a large retail merchandising organization. Over 100 different jobs were included representing broad vertical and horizontal slices from the organizational structure.

## Instrument

A set of 24 items was used to assess worker perceptions of task characteristics. Twenty one of these items were from the Job Diagnostic Survey (Hackman and Oldham, 1975) written in an attempt to tap seven a priori dimensions (task variety, autonomy, task identity, task significance, task feedback, agent feedback, and dealing with others). The final three items were from the Job Characteristics Inventory (Sims, Szilagyi, and Keller, 1976) written to tap friendship opportunities.

## Analyses and Results

The perceived job characteristics (JDS) construct area will be used to provide a complete illustration of the analytical techniques used in construct definition for the four construct areas. This example will include all methodological details. Presentations for the remaining three construct areas will focus on results since the methodology used is identical to that used in the perceived job characteristics area. To best illustrate the use of the procedure, results will be presented as each stage of the analyses is described.

1. A principal axis factor analysis was conducted on the total sample and the resulting eigenvalue pattern was examined using the Scree-test (see Figure 1). A liberal interpretation of the Scree-test was used to identify eight factors as the maximum number to retain. Had we used

the Scree-test as our sole criterion, we would have used the elbow at factor 6 as the cut-off for the number of factors to retain. To be cautious we included eight factors in subsequent analyses rather than the six factors indicated by the Scree-test. This was done to avoid the possibility of excluding potentially stable factors through use of the Scree-test. As will be seen, in the present example the Scree-test identified a number of factors which were greater than the number of factors found to be stable. This finding was repeated in a series of over a dozen applications of this technique in a study by Dunham, Ellis, Verbin, Fritz, and Pierce (1980). If this continues to be the case in future uses of the stability technique, it would be appropriate to use the direct results of the Scree-test to identify the upper bound of factors to consider inputing into the stability technique.

2. The sample was split into two equal size random subsamples.

3. A principal axis factor analysis was conducted on each subsample extracting eight factors (the number of factors identified by Step 1 of the analyses) in each subsample.

4. Joint rotation was then performed on the two eight-factor solutions. The joint rotation was performed using canonical analysis. The procedure of canonical analysis establishes relationships between two sets of data. In the present case, the two sets of data are factor matrices. Data were arranged for the canonical analysis as follows:

> Set A data consisted of eight columns (corresponding to the eight factors) and 48 rows. The first 24 rows contained the loadings for each of the 24 items from the factor analysis for

subsample A. The next 24 rows contained the loadings for the 24 set A items from the factor analysis but with the sign for each loading reversed. Set B consisted of parallel data from the factor analysis for subsample B. Figure 2 depicts the arrangement of the data for this analysis.

Canonical analysis programs are designed to make corrections for differences in column means. Adding the reflected loadings produces a column mean of zero and prevents corrections for mean differences from being made.

5. The results of the canonical analysis are presented in Table 1. To identify the number of stable dimensions we considered the number of significant variates as the maximum possible and then examined the canonical correlation pattern. Each canonical correlation was treated as a congruency coefficient (see Harman, 1975) given joint rotation to maximum congruence (in other words, the canonical analysis forced the two factor matrices to be as similar as possible--the canonical correlations tell us how similar the two matrices were forced to be). In the present case, we conclude that there are four stable dimensions (we consider congruency coefficients of about .90 or above as providing evidence of high congruence which in the present case is an indication of high stability).

6. At this point we have determined that there are four stable underlying dimensions. The total sample was then used to extract, rotate, and interpret four factors. Table 2 shows the results of the four factor VARIMAX rotated solution for the total sample. Examination

of the four factor solution shown in Table 2 reveals factors interpreted as:

> 1) interpersonal behavior on the job; 2) restrictions imposed by the job; 3) decision making behavior on the job; and 4) feedback provided by others. The four dimensions identified as stable are thus interpreted very differently from the seven dimensions proposed on an a priori basis.

## Construct Definition of Need Strength

A set of 10 items was used to assess employee need strength. These items were from the Job Diagnostic Survey (Hackman and Oldham, 1975) written primarily in an attempt to tap higher order need strength. Several of the 10 items, however, addressed lower order need strength. Unfortunately, Hackman and Oldham have not reported sufficiently rigorous evidence of the validation of this measurement.

A principal axis factor analysis was conducted on the total sample and the resulting eigenvalue pattern was examined using the Scree-test suggesting a maximum of five factors worthy of further consideration. A five factor solution was derived from each of two random subsamples and the resulting solutions were compared using the canonical stability technique. The results identified three stable dimensions. A three factor VARIMAX rotation was then performed on the total sample producing the factor structure shown in Table 3.

Examination of the three factor solution shown in Table 3 reveals factors interpreted as:

1) desire for present-oriented growth opportunities; 2) desire for future-oriented growth opportunities; and 3) desire for receipt of organizational rewards. The three dimensions identified as stable are thus interpreted very differently from that proposed on an a priori basis.

## Construct Definition of Behavioral Variables

A set of 11 variables was used to assess worker behavioral responses. Seven of these items were from the seven dimension performance appraisal system used by the participating organization. The seven dimensions of performance which were assessed were job knowledge, job quality, productivity, response to work demands, work relations, public contact, and adherence to company policy. The remaining four behavioral variables were attendance measures. These four variables were days of unpaid illness, days of personal leave, days of paid illness, and days late (all measured over a three month period by supervisory personnel).

A principal axis factor analysis was conducted on the total sample and the resulting eigenvalue pattern was examined using the Scree-test suggesting a maximum of four factors worthy of further consideration. A four factor solution was derived from each of two random subsamples and the resulting solutions were compared using the canonical stability technique. The results identified two stable dimensions. A two factor VARIMAX rotation was then performed on the total sample producing the factor structure shown in Table 4. Examination of the two factor solution shown in Table 4 reveals factors interpreted as:

1) performance evaluation and 2) adherence to company policy.

## Construct Definition of Job Analysis Dimensions

A set of 32 job analysis dimensions from the Position Analysis Questionnaire [PAQ] (McCormick, Jeanneret, and Mecham, 1972) was used to describe each job in the present study. The 32 dimensions are from the System 1 of the PAQ and were derived using a series of component analyses. Our analyses, therefore, constitute a hierarchical analysis.

A principal axis factor analysis was conducted on the total sample and the resulting eigenvalue pattern was examined using the Scree-test suggesting a maximum of seven factors worthy of further consideration. A seven factor solution was derived from each of two random subsamples and the resulting solutions were compared using the canonical stability technique. The results identified five stable dimensions. A five factor VARIMAX rotation was then performed on the total sample producing the factor structure shown in Table 5.

Examination of the five factor solution shown in Table 5 reveals factors interpreted as:

1) physical activities; 2) skilled activities; 3) independent decision making; 4) cognitive processing; and 5) task intensive behavior.

## Discussion

This paper has described and used a procedure for assessing the stability of dimensionality for use in conjunction with factor analysis. Although the procedure adds steps to the typical process of conducting factor analyses and evaluating factor analytic results, we feel that use of the procedure will, in the long run, save researchers time by improving the quality of research. This procedure should be particularly helpful to those researchers involved in construct definition and/or instrument development. Too often researchers have identified dimensions of a construct using factor analysis only to find through subsequent research that one or more of the dimensions identified are not stable. The use of unstable dimensions has produced problems not only in construct definition and instrument development processes but also in hypothesis testing research which assumes that dimensionality has been adequately established. We are utilizing this technique to firmly establish the stability of our constructs prior to the commencement of hypothesis testing.

The procedure for assessing dimensional stability is not intended as a replacement for other criteria which have been used in addressing the number of factors problem. Rather, the procedure is intended for use with other criteria. This was illustrated by our application of the Scree-test as a preliminary to the use of the stability procedure. Other combinations of criteria are also possible. A researcher might decide to extract and interpret the number of factors which are statistically significant and stable. Or a researcher might choose to use the number of factors which explain at least five percent of the item variance and are stable. Obviously many other combinations are possible. We are suggesting that dimensional stability should be one very important criterion in solving the number of factors problem.

The uses of the stability procedure in this paper examined stability within one sample. The same procedure can be applied across samples. In this case, rather than using two random subsamples from one sample, the researcher would use two independent samples. Application of the procedure would be identical in either case. There are situations where examination of stability across samples would be very appropriate. Hopefully, the procedure will be used for this purpose (see Dunham, Ellis, Verbin, Fritz, and Pierce, 1980 for an example of such a use of the technique) as it is reasonable for researchers to retain only the number of factors which are stable across samples even though one or more additional factors might be stable within one particular sample.

We feel that the construct definition techniques described in this paper have provided a more comprehensive understanding of the dimensionality and nature of the four constructs considered than could have been obtained using only traditional methods. Now that this construct definition has been accomplished, hypothesis testing may begin.

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## Footnotes

1. The authors wish to thank L.L. Tucker for his extensive assistance in the development of the stability technique presented in this paper and for his reviews of portions of the paper.

2. The authors would like to thank Tom Kolenko for reading and commenting on an earlier version of this paper.

Table 1

Canonical Analysis Results:
Perceived Job Characteristics

| Variate | Eigenvalue | Canonical Correlation | Wilk's Lambda | Chi Square | D.F. | p< |
|---|---|---|---|---|---|---|
| 1 | .99 | .99 | .000 | 649.8 | 64 | .000 |
| 2 | .96 | .98 | .000 | 442.7 | 49 | .000 |
| 3 | .93 | .97 | .000 | 315.5 | 36 | .000 |
| 4 | .90 | .95 | .004 | 210.7 | 25 | .000 |
| 5 | .75 | .87 | .040 | 123.5 | 16 | .000 |
| 6 | .60 | .77 | .164 | 69.6 | 9 | .000 |
| 7 | .54 | .74 | .409 | 34.4 | 4 | .000 |
| 8 | .10 | .32 | .896 | 4.2 | 1 | .040 |

TABLE 2

FOUR FACTOR VARIMAX SOLUTION--FULL SAMPLE ANALYSIS*

| ITEM | A PRIORI SCALE[1] | FACTOR 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| Interpersonal Behavior on the Job | | | | | |
| Job requires cooperative work with other people. | DWO | .65 | -.16 | .03 | .09 |
| Job requires you to work closely with other people. | DWO | .57 | -.14 | .01 | -.01 |
| A lot of other people are affected by how well work is done. | TS | .56 | -.03 | .12 | .04 |
| Considerable opportunity to get to know other people. | FO | .51 | -.04 | .05 | .29 |
| Restrictions Imposed by the Job | | | | | |
| Denies chance to use personal initiative or judgment. | AUT | -.09 | .60 | -.29 | -.09 |
| Job provides few clues on whether or not I am performing well. | TF | -.05 | .57 | -.17 | -.21 |
| Job is not very significant or important in broader scheme of things. | TS | -.17 | .56 | -.03 | -.14 |
| Job is quite simple and repetitive. | TV | -.19 | .55 | -.17 | -.02 |
| Job can be done adequately by a person working alone. | DWO | -.25 | .46 | .26 | -.02 |
| Decision Making on the Job | | | | | |
| Job provides chance to finish pieces of work begun. | TI | .10 | .01 | .61 | .13 |
| Job gives opportunity for independence and freedom. | AUT | .14 | -.11 | .60 | .20 |
| Job involves doing a "whole" and identifiable piece of work. | TI | .27 | -.15 | .50 | .03 |
| Job permits you to decide on your own how to do work. | AUT | .19 | -.31 | .49 | .10 |
| Feedback Provided by Others | | | | | |
| Managers or co-workers let you know how well you are doing your job. | AF | .15 | .17 | .17 | .76 |
| Supervisors let me know how well I am performing job. | AF | .20 | -.03 | .22 | .72 |
| Supervisors and co-workers never give feedback on how well I'm doing job. | AF | .06 | .37 | -.02 | -.52 |
| Items Not Used in Scales | | | | | |
| Job requires using variety of skills and talents. | TV | .49 | -.27 | .34 | .16 |
| How significant or important is your job. | TS | .39 | -.15 | .28 | .10 |
| The work itself provides clues about how well you are doing job. | TF | .26 | -.22 | .34 | .35 |
| Job allows you to chat with other workers while on the job. | FO | .03 | -.00 | .16 | .06 |
| Job requires use of a number of complex or high level skills. | TV | .38 | -.23 | .28 | .10 |
| I do not have chance to do entire piece of work. | TI | .05 | .30 | -.32 | .08 |
| Doing the work provides chances to figure out how well I'm doing. | TF | .36 | -.15 | .26 | .34 |
| Job gives opportunities to develop close friendships. | FO | .32 | .15 | .13 | .31 |

*Items have been abbreviated and re-ordered in this table to aid interpretation.

[1] **DWO = dealing with others**
**TS = task significance**
**FO = friendship opportunities**
**AUT = autonomy**
**TF = task feedback**
**TV = task variety**
**TI = task identity**
**AF = agent feedback**

Table 3

Three Factor VARIMAX Rotation of 11 Need Strength Items (n=360)

| Need Strength Items | FACTOR I Desire for Present Oriented Growth Opportunities | FACTOR II Desire for Future Oriented Growth Opportunities | FACTOR III Desire for Receipt of Organizational Rewards |
|---|---|---|---|
| Respect and fair treatment from supervisors | .57 | -.07 | .19 |
| Stimulation and challenging work | .74 | .15 | .03 |
| Chance for independent thought and action | .65 | .29 | -.02 |
| Opportunities to learn new things | .19 | .61 | .04 |
| Opportunities to be creative and imaginative | .03 | .52 | .24 |
| Opportunities for personal growth and development | .15 | .43 | .46 |
| Sense of worthwhile accomplishment | .29 | .55 | .10 |
| Salary and fringe benefits | .11 | .06 | .62 |
| Quick promotions | -.05 | .10 | .63 |
| Unrotated eigenvalues | 4.1456 | .74390 | .29689 |

Table 4

Two Factor VARIMAX Rotation of Behavioral Variables

| Specific Personnel Items | FACTOR I Performance Evaluation | FACTOR II Adherence to Company Policy |
|---|---|---|
| 1. Job Knowledge | .79 | -.12 |
| 2. Job Quality | .79 | -.19 |
| 3. Productivity | .77 | -.15 |
| 4. Work Demands | .58 | -.16 |
| 5. Work Relations | .46 | -.10 |
| 6. Public Contact | .50 | -.04 |
| 7. Company Policy | .14 | -.86 |
| 8. Unpaid Illness | -.12 | .52 |
| 9. Personal Days | -.08 | .54 |
| 10. Lates | -.07 | .76 |
| 11. Paid Illness | -.02 | .01 |
| Unrotated Eigenvalues | 3.4786 | 1.4909 |

TABLE 5

FIVE FACTOR VARIMAX ROTATION OF THE 32 PAQ DIMENSIONS

| SPECIFIC PAQ JOB DIMENSIONS | FACTOR I PHYSICAL ACTIVITIES | FACTOR II DOING AND PERFORMING SKILLED ACTIVITIES | FACTOR III DECISION MAKING IN INDEPENDENT CONTEXT | FACTOR IV COGNITIVE PROCESSES | FACTOR V TASK INTENSIVE BEHAVIOR |
|---|---|---|---|---|---|
| 1. WATCHING DEVICES/MATERIALS FOR INFORMATION | .06 | .80 | .25 | -.25 | -.14 |
| 2. INTERPRETING WHAT IS HEARD OR SEEN | .58 | .25 | .20 | .48 | -.25 |
| 3. USING DATA ORIGINATING WITH PEOPLE | -.06 | .29 | .87 | .12 | .19 |
| 4. WATCHING THINGS FROM A DISTANCE | .76 | .17 | -.29 | -.11 | -.03 |
| 5. EVALUATING INFORMATION FROM THINGS | .13 | .23 | .03 | -.35 | .65 |
| 6. BEING AWARE OF ENVIRONMENTAL CONDITIONS | .00 | .15 | -.22 | -.35 | -.73 |
| 7. BEING AWARE OF BODY MOVEMENT AND BALANCE | -.50 | .17 | .01 | -.10 | .29 |
| 8. MAKING DECISION | -.50 | .32 | .69 | .08 | .07 |
| 9. PROCESSING INFORMATION | -.42 | .31 | .17 | .61 | -.37 |
| 10. CONTROLLING MACHINES/ROCESSES | .80 | .26 | .17 | -.13 | .13 |
| 11. USING HANDS AND ARMS TO CONTROL/MODIFY | -.09 | .68 | -.13 | .23 | -.08 |
| 12. USING FEET/HANDS TO OPERATE EQUIPMENT/VEHICLES | .35 | .75 | -.11 | .10 | .02 |
| 13. PERFORMING ACTIVITIES REQUIRING GENERAL BODY MOVEMENT | .12 | -.79 | .14 | .02 | -.06 |
| 14. USING HANDS AND ARMS TO MOVE/POSITION THINGS | .77 | -.30 | -.14 | -.36 | .23 |
| 15. USING FINGERS VS. GENERAL BODY MOVEMENT | -.03 | .06 | -.04 | -.96 | -.13 |
| 16. PERFORMING SKILLED/TECHNICAL ACTIVITIES | -.11 | .94 | .26 | .03 | -.05 |
| 17. COMMUNICATING JUDGMENTS, DECISION, INFORMATION | .29 | -.25 | .87 | .05 | -.08 |
| 18. EXCHANGING JOB-RELATED INFORMATION | -.83 | .28 | -.04 | .02 | .03 |
| 19. PERFORMING STAFF-RELATED ACTIVITIES | -.32 | .76 | .03 | .16 | .12 |
| 20. CONTACTING SUPERVISOR OR SUBORDINATES | .26 | -.22 | .71 | -.03 | -.09 |
| 21. DEALING WITH THE PUBLIC | .63 | -.12 | .52 | -.18 | -.08 |
| 22. BEING IN A HAZARDOUS/UNPLEASANT ENVIRONMENT | .85 | -.02 | .26 | -.28 | .10 |
| 23. ENGAGING IN PERSONALLY DEMANDING SITUATIONS | -.06 | .10 | .66 | -.06 | .56 |
| 24. ENGAGING IN BUSINESSLIKE WORK SITUATIONS | -.45 | -.53 | -.10 | .56 | .14 |
| 25. BEING ALERT TO DETAIL/CHANGING CONDITIONS | .29 | .25 | .68 | .17 | .27 |
| 26. PERFORMING UNSTRUCTURED VS. STRUCTURED WORK | .50 | -.58 | -.16 | .09 | .28 |
| 27. WORKING ON A VARIABLE VS. REGULAR SCHEDULE | -.01 | .18 | .04 | -.14 | -.73 |
| 28. HAVING DECISION MAKING, COMMUNICATION, AND SOCIAL RESPONSIBILITY | -.35 | .19 | .88 | .03 | -.09 |
| 29. PERFORMING SKILLED ACTIVITIES | .38 | .85 | .34 | .00 | .03 |
| 30. BEING PHYSICALLY ACTIVE/RELATED ENVIRONMENTAL CONDITIONS | .72 | -.07 | .01 | -.51 | .00 |
| 31. OPERATING EQUIPMENT/VEHICLES | .75 | .36 | .08 | .23 | .29 |
| 32. PROCESSING INFORMATION | -.24 | .15 | .09 | .89 | .14 |
| UNROTATED EIGENVALUES | 7.73 | 7.03 | 4.54 | 3.05 | 2.37 |

FIGURE 1

Scree-test: Perceived Job Characteristics

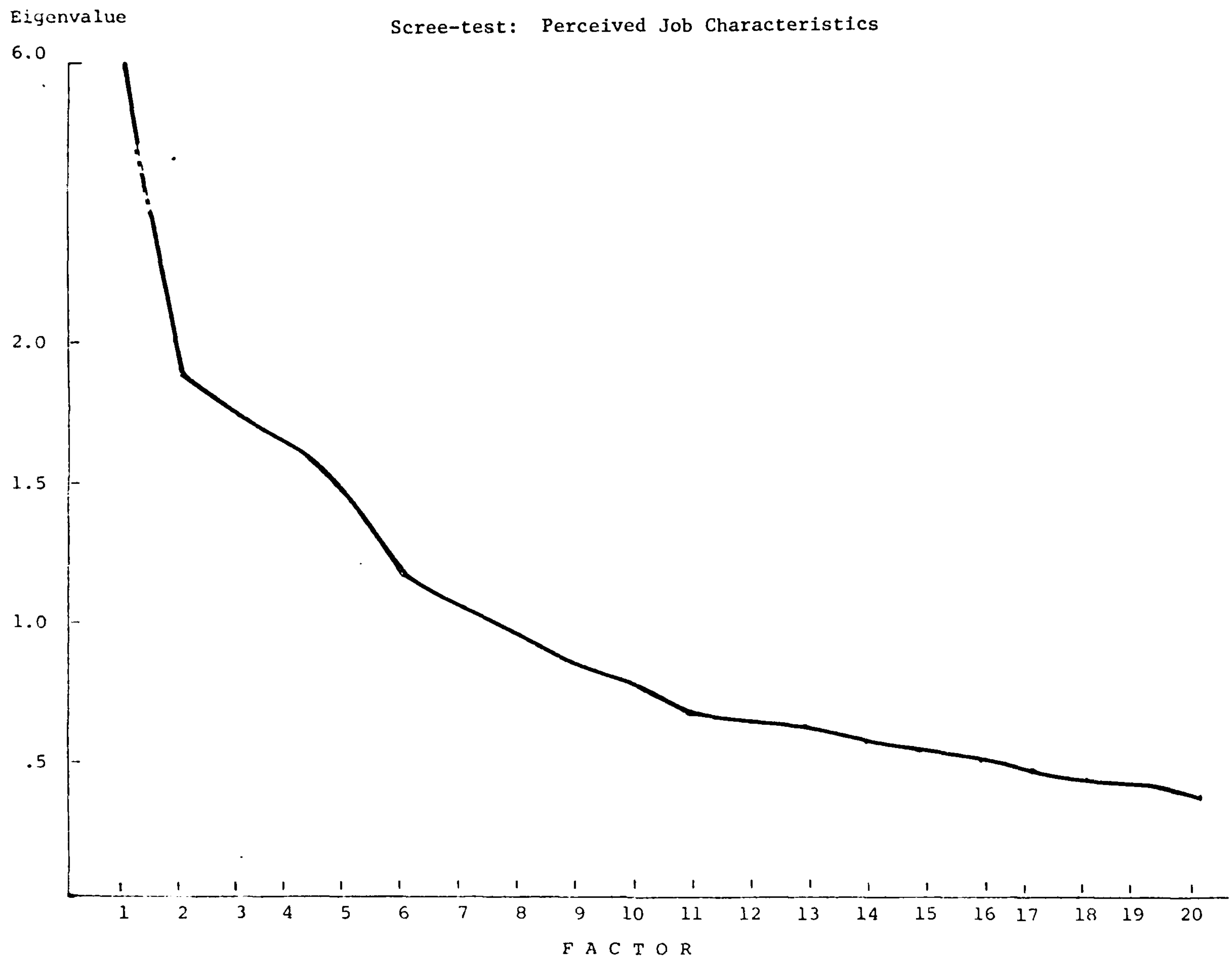

FIGURE 2

ARRANGEMENT OF DATA FOR CANONICAL ANALYSIS

| | SET A* | | | | | | | | SET B* | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | FACTOR | | | | | | | | FACTOR | | | | | | | |
| ITEM | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 1 | .45 | .31 | .22 | -.09 | -.18 | -.23 | .10 | -.01 | .41 | -.05 | .38 | .19 | .27 | -.03 | .04 | -.12 |
| 2 | .55 | -.13 | -.15 | .30 | -.16 | -.20 | .04 | -.02 | .56 | -.08 | -.16 | .34 | .11 | .17 | .07 | .01 |
| 3 | .45 | .16 | -.01 | .29 | .17 | .12 | -.16 | -.11 | .58 | .08 | -.11 | .45 | -.04 | -.46 | -.14 | .29 |
| . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 23 | .54 | -.02 | .38 | .01 | -.19 | -.10 | -.02 | .05 | .40 | .09 | .50 | -.10 | .33 | -.02 | -.17 | .08 |
| 24 | .38 | -.39 | .58 | .13 | -.26 | .19 | -.41 | .18 | .29 | .33 | .29 | .03 | .30 | .06 | -.08 | .08 |
| 25 | -.45 | -.31 | -.22 | .09 | .18 | .23 | -.10 | .01 | -.41 | .05 | -.38 | -.19 | -.27 | .03 | -.04 | .12 |
| 26 | -.55 | .13 | .15 | -.30 | .16 | .20 | -.04 | .02 | -.56 | .08 | .16 | -.34 | -.11 | -.17 | -.07 | -.01 |
| 27 | -.45 | -.16 | .01 | -.29 | -.17 | -.12 | .16 | .11 | -.58 | -.08 | .11 | -.45 | .04 | .46 | .14 | -.29 |
| . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 47 | -.54 | .02 | -.38 | -.01 | .19 | .10 | .02 | -.05 | -.40 | -.09 | -.50 | .10 | -.33 | .02 | .17 | -.08 |
| 48 | -.38 | .39 | -.58 | -.13 | .26 | -.19 | .41 | -.18 | -.29 | -.33 | -.29 | -.03 | -.30 | -.06 | .08 | -.08 |

* Matrix consists of the factor loadings from the eight factor solution (rows 1-24) plus the reflected item loadings (rows 25-48).

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ATTN: Professor John Senger
Operations Research and
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Monterey, CA 93940

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