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ABSTRACT

Ergometrics, the application of psychometric principles and procedures to the study of human work, draws from theories and principles of human behavior as well as from established procedures in psychological measurement and job analysis. The project described employs ergometrics to describe, compare, and group occupations for educational purposes. An Occupation Analysis Inventory (OAI) was generated containing 622 work elements (descriptions of activities and conditions). Ratings on the work elements were obtained by relevance to 103 defined human attributes (resulting in attribute-requirement weights). The OAI work elements were then correlated and subjected to factor analysis. Five test batteries and inventories measuring various abilities, interests, needs and satisfaction were used to discover relationships between these variables and measurable behavioral potentials. Clusters of occupations were found to be discriminable and significant cross-validated multiple correlations between OAI factor scores and aptitude test scores were obtained. Other findings also indicate that a meaningful and potentially useful set of occupational descriptors has been developed and validated. (MS)



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DEVELOPMENT AND VALIDATION OF THE
OCCUPATION ANALYSIS INVENTORY:
AN "ERGOMETRIC" APPROACH TO AN
EDUCATIONAL PROBLEM

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AN "ERGOMETRIC" APPROACH TO AN EDUCATIONAL PROBLEM

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Department of Psychology

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PREFACE

This paper was originally prepared for the symposium "Directions in Work Analysis," L. R. Taylor, chairman, presented at the 80th Annual Convention of the American Psychological Association held in Honolulu, Hawaii, in September, 1972.

The Center wishes to thank Dr. Cunningham for making this presentation available for publication. It is a concise description of the Center's work in the area of ergometrics.

The author and the Center also express appreciation to Mrs. Sue King for editing the draft of this paper, to Mrs. Joyce Pollard for typing the manuscript, and to the entire Center technical and clerical staff for their contributions to the publications of this paper.

John K. Coster
Director

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Background and Purpose

The project I shall describe is supported by the Center for Occupational Education at North Carolina State University and is directed toward the problem of establishing structure and content in occupationally related education. There has existed for some time in this field the need for a systematic basis for gathering and organizing information from the work domain that can be used for such educational purposes as curriculum development and evaluation, occupational guidance and placement, and occupationally related test development.

Some of us at the Center felt that the existing technology in work analysis could be brought to bear upon this problem. Of particular interest to us was the potential application of the psychometric approach to work analysis, which can be traced as far back as Viteles' job psychograph and which has seen its most recent development in such efforts as E. J. McCormick's worker-oriented approach, the task-inventory approach of the U. S. Air Force, and the worker-function approach of the U. S. Training and Employment Service. The term we have coined to apply to the psychometric approach to work analysis is "ergometrics."¹ The field of ergometrics, as we conceive it, draws from theories and principles of human behavior, as well as from established procedures in psychological measurement and job analysis.

¹The application of psychometric principles and procedures to the study of human work.

The purpose of the project I am reporting is to apply the procedures and concepts of ergonomics--particularly those of McCormick and his associates--in the development of a system for describing, comparing, and grouping occupations for educational purposes.

Instrument Development

The first phase of our project involved the development of the Occupation Analysis Inventory, which contains 622 work elements (or descriptions of work activities and conditions) on which jobs and occupations are rated. Although the Occupation Analysis Inventory (or OAI) employs several rating scales, a six-point significance-to-the-job scale is most frequently used. The OAI work elements were generated within the broad framework of an information processing paradigm. The five labeled components of this paradigm defined the major categories of the OAI, and these major categories were subdivided according to selected conceptual frameworks pertaining to human behavior and work technology. The work elements were constructed within the subcategories.

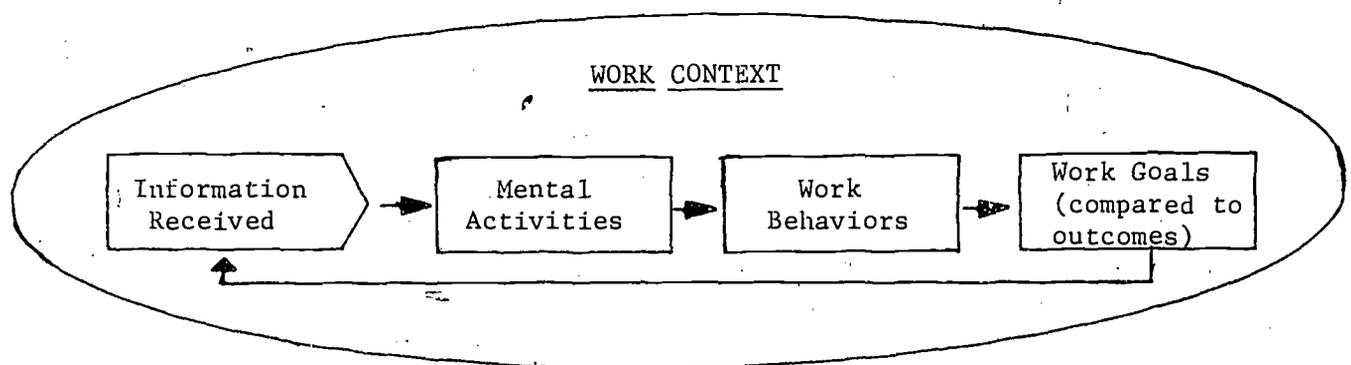


Figure 1. Paradigm for the Occupation Analysis Inventory (OAI)

Procedures and Results

The basic data in our project were obtained from two independent sets of ratings on the work elements in the Occupation Analysis Inventory.

The first set of data consisted of ratings of the relevance of 103 defined human attributes to each of the 622 OAI work elements. The human attributes fell into the six categories shown in Figure 2. Ten advanced graduate students rated each OAI work element on its requirement for each of the 103 attributes; these ratings were then averaged across the judges, yielding a profile of mean attribute-requirement weights for each work element. The resulting attribute-requirement weights are presented by the entries in Matrix A (see Figure 3).

CATEGORIES OF HUMAN ATTRIBUTES
GENERAL VOCATIONAL CAPABILITIES
COGNITIVE ABILITIES
PSYCHOMOTOR ABILITIES
SENSORY CAPACITIES
INTERESTS
NEEDS

Figure 2.

800 occupations. Each entry in Matrix C, the product matrix, represents an attribute-requirement estimate for an occupation. These attribute-requirement estimates were standardized and were found to have adequate inter-rater reliabilities. The median reliability, based on two OAI ratings of a sample of 215 occupations, was .88.

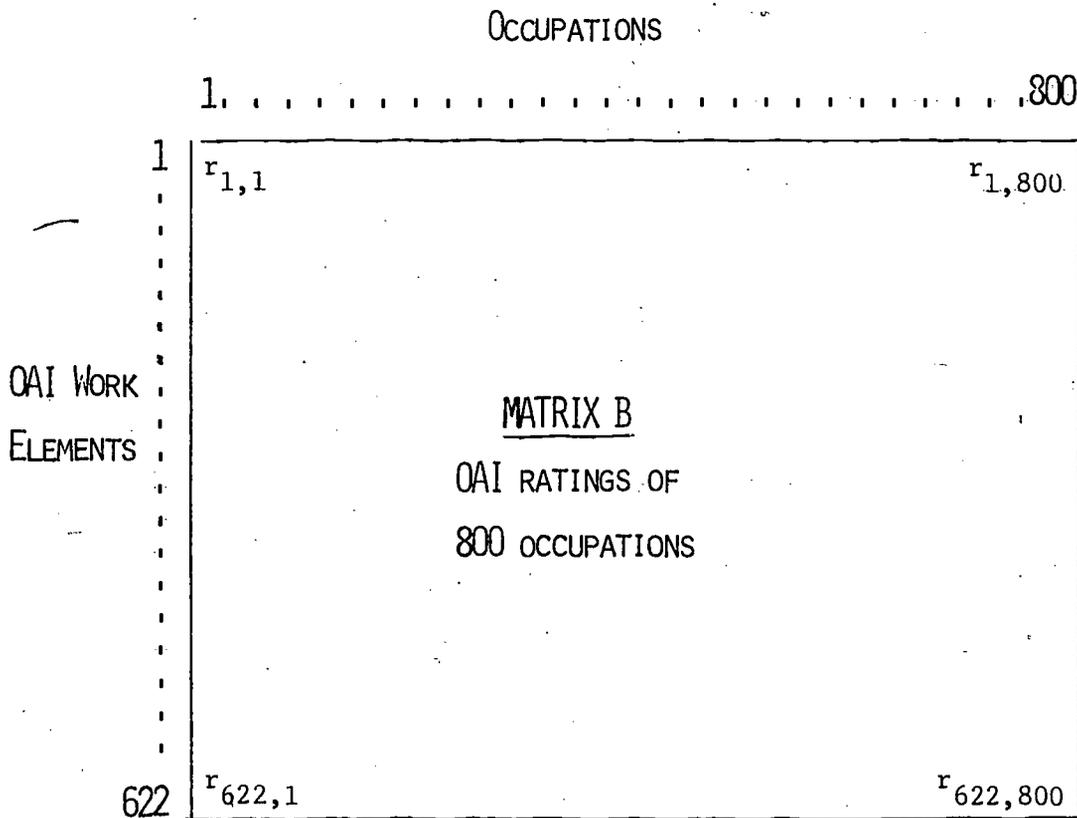


Figure 4.

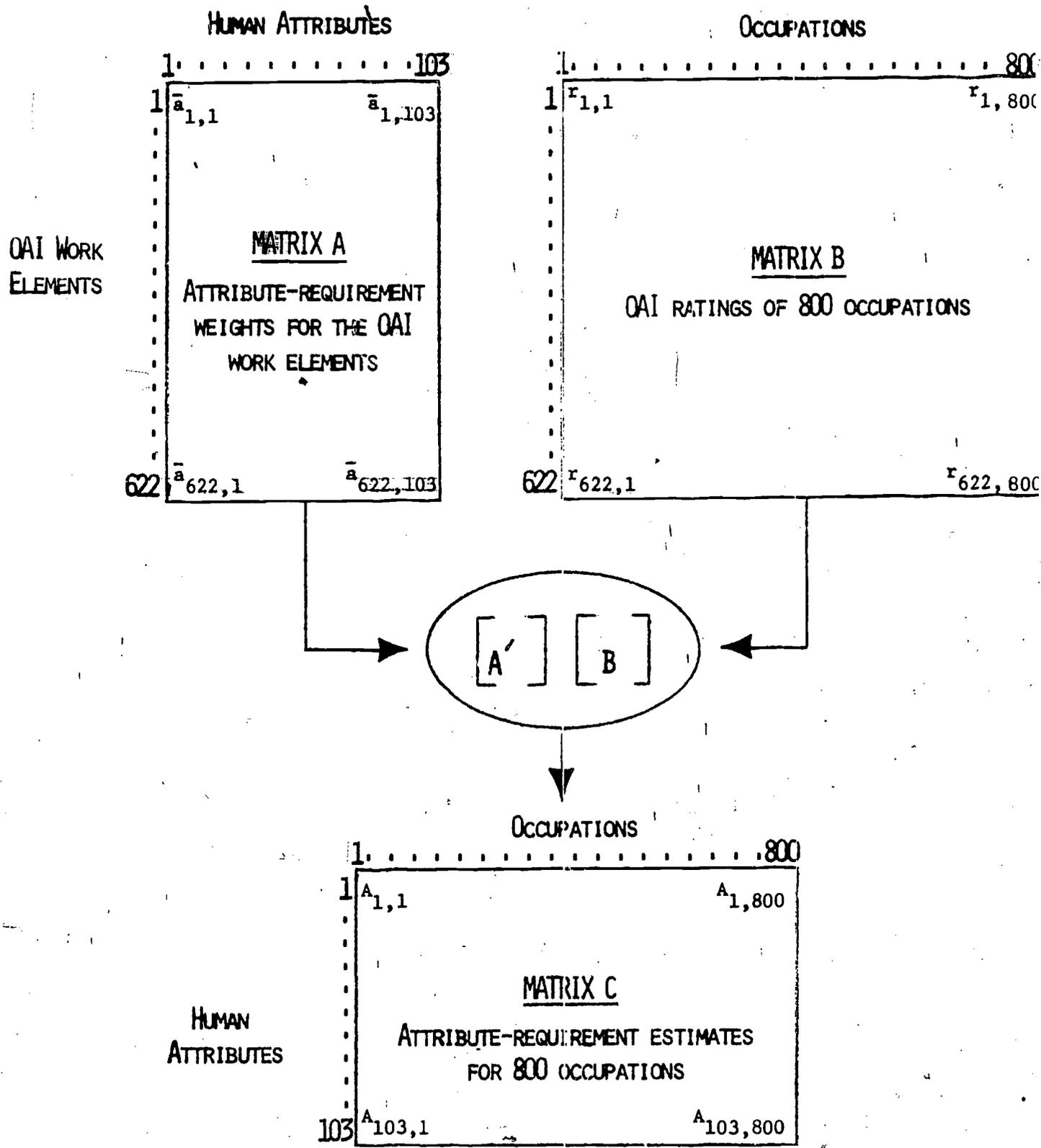


Figure 5.

The two basic data matrices were also subjected to factor analysis. In the case of Matrix B, the OAI work elements were intercorrelated based on the occupation ratings, and the resulting correlations were used in factor analyzing seven separate sections of the OAI (see Figure 6). These seven analyses produced 90 first-order factors which, in turn, were subjected to a factor analysis yielding 22 higher-order factors. The second data base for factor analysis consisted of the attribute-requirement weights for the OAI elements, represented by Matrix A (see Figure 7). In this instance, the work elements were intercorrelated based on their attribute-requirement profiles, and, with the exception of one omitted section of the OAI, the previous factor analyses were repeated. These analyses produced 77 first-order and 21 higher-order factors. For the most part, our factors were meaningful, had adequate inter-rater reliabilities, and showed reasonable stability based on Tucker's coefficient of congruence. For the first-order occupation-rating factors, the median reliability, based on two OAI ratings of a sample of 215 occupations, was .82. The median coefficient of congruence for the first-order occupation-rating factors was .72, and for the first-order attribute-rating factors, .86.

Based on our results, we were able to describe occupations in two ways: (1) in terms of their estimated requirements for defined human attributes for which there are tests and (2) in terms of their scores on factors representing different types of work activities and conditions. In addition, we could say that whatever we were measuring with these variables could be measured with reasonable precision.

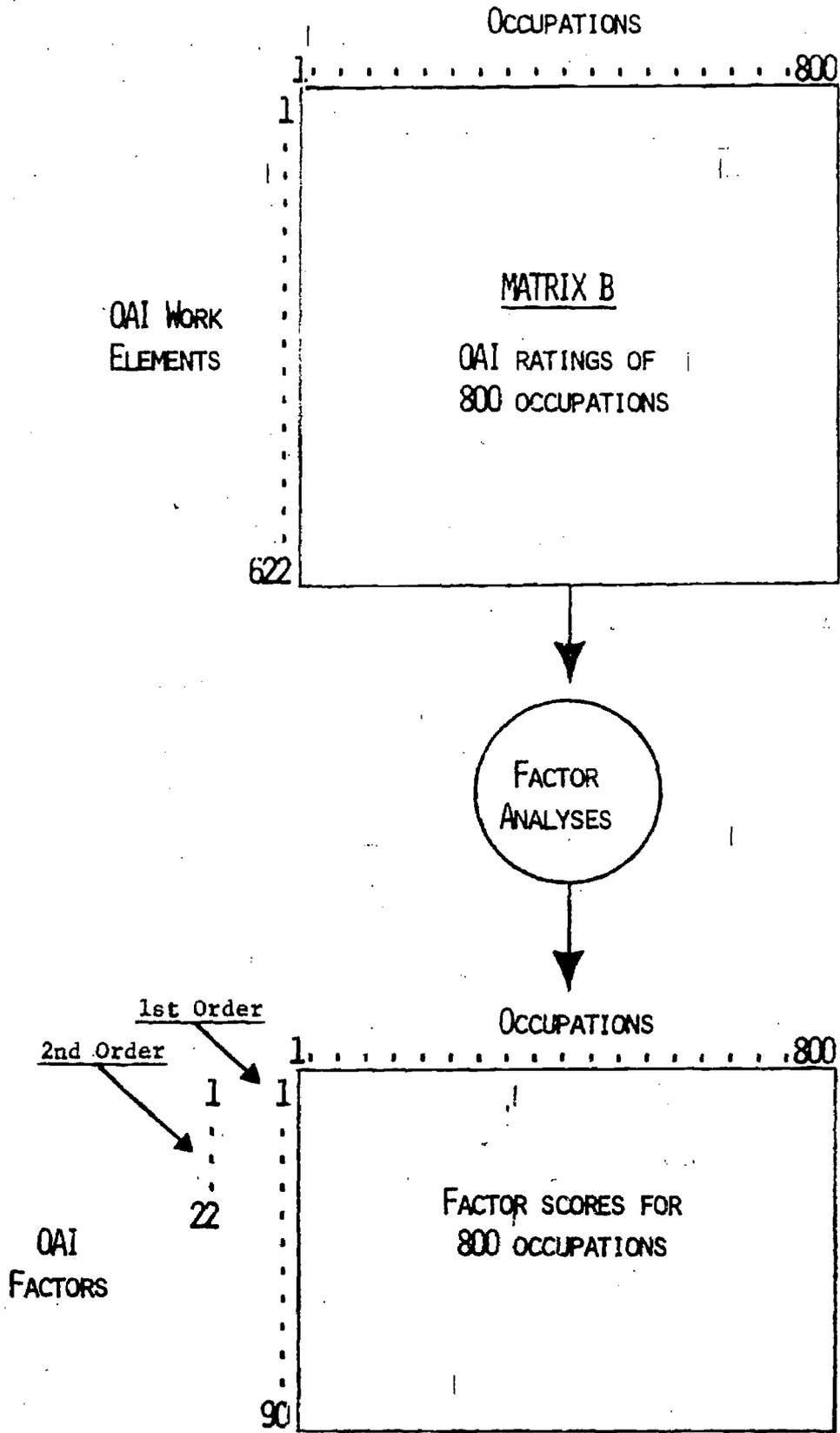


Figure 6.

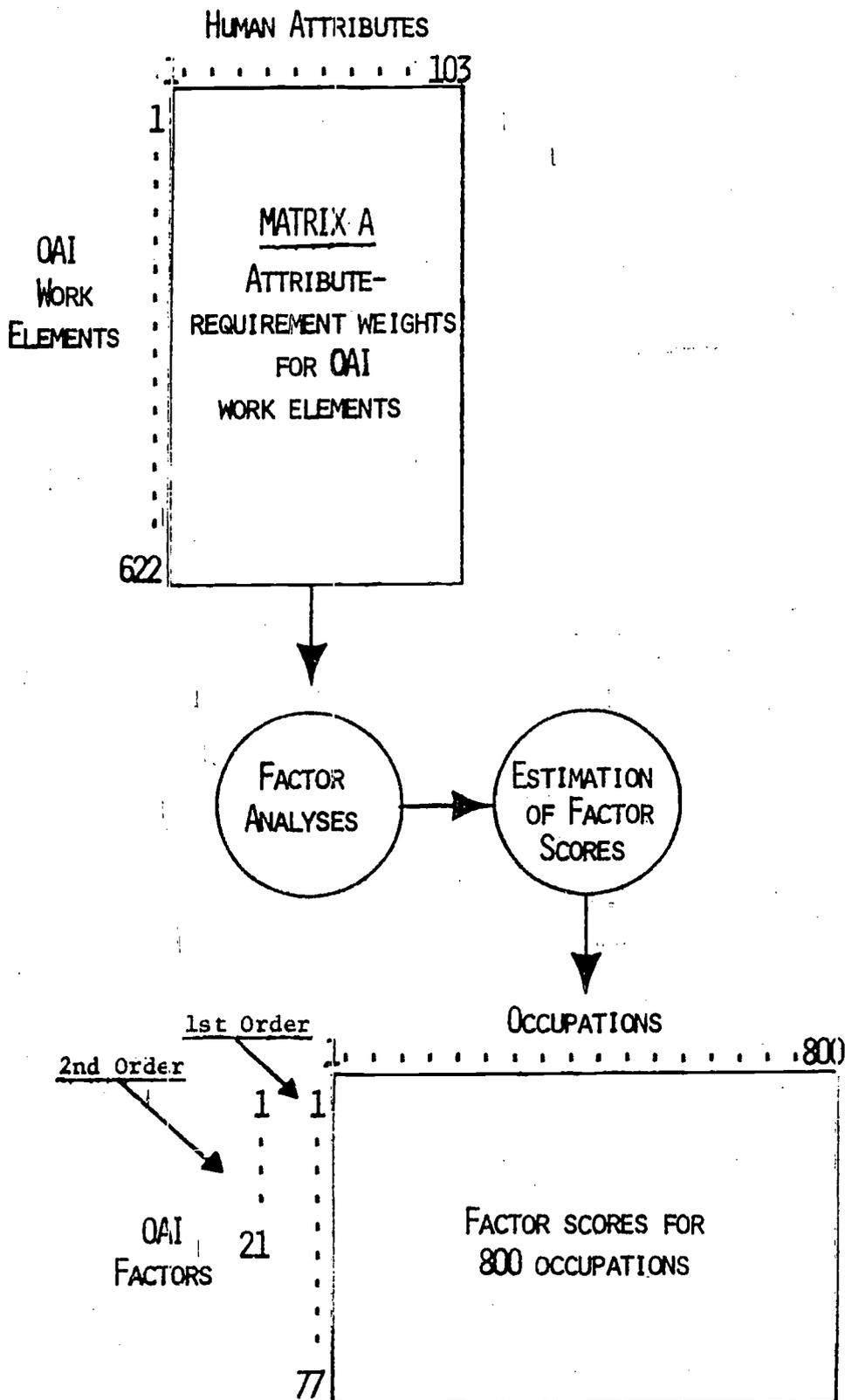


Figure 7.

Having accomplished this, we proceeded with an attempt to establish some degree of construct validity for our two sets of occupational descriptors. Our rationale was that if the OAI attribute requirements and factors are actually relevant to human behavior, then it should be possible to demonstrate significant relationships between these variables and the behavioral potentials measured by selected tests. For this purpose, we chose five test batteries and inventories measuring various abilities, interests, needs, and satisfactions (see Figure 8). Test data were either collected or located on incumbents or graduate trainees in different occupations, and these occupations were rated on the OAI. In our validation analyses, the OAI factor scores and attribute-requirement estimates for occupations served as the independent (or predictor) variables, and the test and inventory scores of persons in the occupations served as the dependent variables.

TESTS AND INVENTORIES

GENERAL VOCATIONAL CAPABILITY TESTS

GENERAL APTITUDE TEST BATTERY

OHIO VOCATIONAL INTEREST SURVEY

MINNESOTA IMPORTANCE QUESTIONNAIRE (NEEDS)

MINNESOTA SATISFACTION QUESTIONNAIRE

Figure 8. Tests and inventories used in validating the OAI

Here is a brief summary of our results (see Table 1). Using the OAI factors as independent variables, we found that clusters of occupations with similar factor-score profiles were significantly discriminable (by analysis of variance) in terms of the various test and inventory

Table 1. Validation of the Occupational Descriptors

Independent Variables	Dependent Variables (test scores)	Analyses	Results*
<u>Occupational Clusters</u> (based on 1st-order occup. rating factors)	Gen. Voc. Capability Tests Gen. Apt. Test Battery Ohio Voc. Interest Survey Minn. Impt. Questionnaire	ANOVA ANOVA ANOVA ANOVA	8 of 8 sig. 7 of 8 sig. 22 of 24 sig. 15 of 20 sig.
<u>OAI Factors</u> (2nd-order occup. rating factors)	Gen. Apt. Test Battery	Mult R	16 of 16 sig.; median cross- validated R=.59
<u>Attribute-Requirement Estimates</u>			
Aptitudes	Gen. Apt. Test Battery	\bar{r}	10 of 12 sig.; median \bar{r} =.62
Interests	Ohio Voc. Interest Survey	\bar{r}	16 of 24 sig.; median \bar{r} =.39
Gen. Voc. Capabilities	Gen. Voc. Capability Tests	ANOVA	7 of 8 sig.
Needs	Minn. Satis. Questionnaire	ANOVA	10 of 15 sig.

*p < .05

scores of persons in these occupations. For example, of the 60 analyses involving clusters based on first-order occupation-rating factors, 52 significant F values were obtained. In addition, we obtained significant cross-validated multiple correlations between the OAI factor scores for a sample of occupations and the average aptitude test scores of incumbents in these occupations. The median cross-validated multiple R for the second-order occupation-rating factors was .59.

In validating the OAI attribute-requirement estimates, we found significant correlations between the estimated requirements of occupations for various aptitudes and interests and the average scores of job incumbents on corresponding tests and inventory scales. The median correlation for aptitudes was .62 and, for interests, .39. We also established significant relationships (by analysis of variance) between the estimated requirements of occupations for eight general vocational capabilities and the general vocational capability test scores of persons trained for the occupations. In this instance, seven of the eight analyses yielded significant F values. Finally, we were able to demonstrate (again, by analysis of variance) some relationships between the OAI estimates for occupations on 15 different need dimensions and the scores of incumbents on corresponding satisfaction scales. Significant F values were obtained for 10 of the 15 need dimensions tested.

Conclusion

In conclusion, we feel that we have developed a meaningful and potentially useful set of occupational descriptors, and that we have provided some evidence for their validity.

Our immediate plans call for repeating the factor analyses of the OAI based on a cumulative sample of 1400 occupations. We will then use these factors as a basis for clustering the occupations.

It is our hope that the resulting factor and occupational cluster structures will prove useful in the areas of curriculum analysis and development, occupational guidance, and test development. For example, it might prove feasible to develop curricula corresponding to various occupational clusters. In this case, the curricular content would be derived from descriptions of tasks and conditions that occur in selected occupations in each cluster and that are relevant to the important dimensions in the cluster's work-factor profile. In the occupational guidance setting, the test-score profiles of individuals could be compared with the attribute-requirement estimates of various occupational clusters, and indices of profile congruence could be computed. Moreover, the factor-score profiles and task descriptions for the occupational clusters might be translated into information that the counselee could use in occupational exploration and decision-making. Finally, it would seem feasible to develop tests and inventories based on the systematically derived work factors and occupational clusters. Examples might include interest scales and general occupational capability tests based on the work factors (or dimensions), and occupational awareness (information) and proficiency tests based on the occupational clusters.

We are encouraged by our findings to date and are formulating long-range development plans in some of the areas just mentioned.

ERGOMETRIC RESEARCH AND DEVELOPMENT REPORTS
Center for Occupational Education
North Carolina State University, Raleigh

- Report No. 1 Cunningham, J. W., Editor. The Job-Cluster Concept and Its Curricular Implications: A Symposium. Center Monograph No. 4, 1969.
- Report No. 2 Cunningham, J. W. "Ergometrics": A Systematic Approach to Some Educational Problems. Center Monograph No. 7, 1971.
- Report No. 3 Cunningham, J. W., T. C. Tuttle, J. R. Floyd, and J. A. Bates. The Development of the Occupation Analysis Inventory: An "Ergometric" Approach to an Educational Problem. Center Research Monograph No. 6, 1971.
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