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ABSTRACT

The Position Analysis Questionnaire (PAQ), a structured job analysis questionnaire that provides for the analysis for individual jobs in terms of 187 job elements, has been found in previous studies to be useful as the basis for predicting the mean test scores of incumbents on a sample of jobs in terms of the nine tests of the General Aptitude Test Battery (GATB) of the United States Training and Employment Service. The present study was directed toward use of the PAQ as the basis for predicting test-related data for various commercially available tests considered to measure the same constructs as those measured by the GATB tests. Data were obtained for a sample of 96 jobs, the data consisting of a PAQ analysis for each job and data for the incumbents on various commercially available tests. The data for the various jobs for which any given test had been used were grouped into categories for the constructs represented by the individual GATB tests. The available norms of the tests representing any given construct were converted to a set of standard scores with a mean of 10 and a standard deviation of 20. The PAQ job dimension scores were then used as predictors of whatever test-related criteria were available for any given construct. The PAQ-based predictions for the criteria of mean test scores and cutoff scores were all highly significant. However, the predictors for actual validity coefficients were understandably low. The prediction of whether or not specific tests would be "valid" were also significant. Although the predictions supported the utility of the PAQ-based job-component validity model, a number of problems probably resulted in overly conservative predictions. A later analysis will be carried out after the sample size is increased. (Author/JT)

# Job-Derived Selection:

## Preliminary Report

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The Position Analysis Questionnaire (PAQ) is a structured job analysis questionnaire that provides for the analysis for individual jobs in terms of 187 job elements. On the basis of such an analysis it is possible to derive 32 job dimension scores (technically principal component scores). In previous studies it has been found that regression equations consisting of these job dimension scores can be used as the basis for predicting (with very respectable correlations) the mean test scores (and other test-

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related data) of incumbents on a sample of jobs in terms of the nine tests of the General Aptitude Test Battery (GATB) of the United States Training and Employment Service.

Since the GATB tests are not available for general use, the present study was directed toward the use of the PAQ as the basis for predicting test-related data for various commercially-available tests which were considered to measure the same "constructs" as those measured by the GATB tests. Data were obtained for a sample of 96 jobs, the data consisting of a PAQ analysis for each job and data for the incumbents on various commercially available tests. Depending on the nature of the test data available for individual jobs, four types of criteria were used as indications of the "importance" of individual tests for each job in question. These criteria were: (1) the mean test score of incumbents on the job; (2) a "potential" cut-off score (which was the score which had actually been used as a "cut-off" for selection purposes by the organization which supplied the data); (3) a validity coefficient; and (4) an indication as to whether the test would be "valid" for the job. The data for the various jobs for which any given test had been used were grouped into categories for the "constructs" represented by the individual GATB tests. (Adequate data were available for only five of the nine constructs.) The available "norms" of the tests representing any given construct were converted to a set of standard scores with a mean of 100 and a standard deviation of 20 (that used with the GATB tests). The PAQ job dimension scores were then used as predictors of whatever test-related criteria were available for any given construct.

The PAQ-based predictions for the criteria of mean test scores and cut-off scores were all highly significant. However, the predictions for actual validity coefficients were understandably low. The prediction of whether or not specific tests would be "valid" were also significant (in 75 percent of the cases for which the PAQ predicted a test would be valid, the tests indeed proved to be valid predictors).

Although the predictions supported the utility of the PAQ-based job-component validity model, a number of problems probably resulted in overly conservative predictions. This particular report is of a preliminary nature, based on the data available at the time. A later analysis will be carried out within a few months after the sample size is increased.

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# INTRODUCTION

The conventional method for identifying personnel tests to be used in the selection of personnel for various jobs consists of validation of tests for each particular job in question. This procedure involves: (1) the administration of a sample of tests to incumbents who are already on the job in question or to applicants who are going to be placed on the job; (2) the obtaining of some criterion measure of job performance for the individuals who have taken the tests; and (3) the analysis of the statistical relationships between the test scores and the criterion of job performance. Those tests for which a significant relationship is found between test scores and job performance criterion values can then be used as a basis for the selection of individuals for the job in question. As is indicated in step 1 of the above procedure there are actually two variations of the general test validation methodology. One of these is a concurrent procedure, which involves the use of a sample of individuals actually on the job. The other method, which is referred to as predictive validity, consists of the administration of the tests to candidates for the job, and the later analysis of the relationship between test scores and the criterion of job performance after the individuals have had sufficient time to be able to demonstrate their job-performance abilities. (In the case of predictive validity, the test is not used in the actual selection of the job candidates used in the validation procedure.)

These procedures are time consuming, and in some instances are not feasible at all, as is the case, for example, if the sample of job candidates is too small for carrying out a conventional validity study. Thus, over the years, there have been certain efforts made to develop some type of "generalized" procedure that could be used in the development of test batteries, a procedure that would be essentially rooted in the systematic analysis of job characteristics.

The concept of a generalized approach to the establishment of test batteries for personnel selection using information about the job obtained through systematic job analysis procedures was initially referred to by Lawshe (1952) as synthetic validity, and was later described by Balma (1959, p. 359) as follows: "The inferring of validity in a specific situation from a logical analysis of jobs into their elements, a determination of test validity for those elements, and a combination of elemental validities into a whole." Since the term synthetic validity has been criticized as being not specifically appropriate to such procedure, McCormick (1974) has suggested the use of the term job component validity.

The development of a procedure for establishing the job component validity of predictors for jobs would consist of the following (McCormick, et al., 1972): (1) some method of identifying the constituent components of jobs (which are referred to as job elements by Balma); (2) a method for determining, for an experimental sample of

jobs, the human attribute(s) required for successful job performance when a given job component is common to several jobs; and (3) some method of combining the estimates of human attributes required for individual job components into an overall estimate of the human attribute requirements for an entire job. Such a procedure would make it possible to "build-up" the aptitude requirements for any given job by: (1) knowing what job components occur in the job in question; (2) knowing what aptitudes are required for each such component; and (3) knowing what aptitudes are required for each such component; and (4) having a procedure for summating the attribute requirements that are relevant to the individual job components.

## The Position Analysis Questionnaire (PAQ)

Various procedures have been used in the development of some type of job component or generalized validity procedure. One of these has involved the use of the Position Analysis Questionnaire (PAQ). The PAQ is a structured job analysis questionnaire that provides for the analysis of individual jobs in terms of 187 job elements. In the analysis of jobs with the PAQ job elements, various rating scales are used (the particular rating scale used for each job element being the one for which the concept of the scale seems particularly appropriate to the element). Most of the scales are six-point Likert-type scales, ranging from zero (does not apply) to five (the highest value). The various scales used include those dealing with importance, time, extent of use, and in some instances special scales. In certain instances a dichotomous scale is used. The dichotomous scale provides for indicating whether the job element in question does, or does not, apply to the job.

Principal components analyses of the PAQ. Data based on the PAQ have been subjected to various principal components analyses. Of particular relevance to our present interest are those carried out by Jeannert and McCormick (June 1969), and by Marquardt and McCormick (1974a). The first of these was based on a sample of 536 jobs, and resulted in the identification of 32 principal components which are referred to as job dimensions. 27 of these were based on the principal components analyses of the job elements within each of the six divisions of the PAQ, and the other five were based on the principal components analysis of most of the job elements of the PAQ pooled together. The study by Marquardt and McCormick was based on a sample of 3700 jobs, and resulted in the identification of 30 job dimensions resulting from the principal components analyses of the job elements in each of the six PAQ divisions, and 14 based on an overall or general principal components analysis using the pooled elements from all six of the PAQ division.

Use of the PAQ to establish job component validity. One of the primary uses of the PAQ has been in the framework of establishing the job component validity of tests for various jobs. This has consisted primarily of the analysis of samples of jobs for which test data for the job incumbents were available from the United States Training and Employment Service (USTES), and for which PAQ analyses were available. The USTES publishes test data for incumbents on several hundred jobs, the test data consisting of normative and validity data for the nine tests of the General Aptitude Test Battery (GATB). These tests are as follows:

G - Intelligence
V - Verbal Aptitude
N - Numerical Aptitude
S - Spatial Aptitude
P - Form Perception
Q - Clerical Perception
K - Motor Coordination
F - Finger Dexterity
M - Manual De[illegible]ity

As the primary approach to the use of PAQ-based data in the job component validity framework, samples of jobs were selected which "matched" the ones for which the USTES has published test normative and/or validity data. In these analyses, the primary criterion of the "importance" of a given test to any given job consisted of the mean GATB test scores of the incumbents on the individual jobs. This criterion was based on the assumption that individuals tend to "gravitate" into jobs which are commensurate with their own abilities. Thus, it would be assumed that jobs for which the incumbents have high mean test scores on a given test would require more of the quality measured by the test than jobs for which the incumbents have lower mean test scores. Using mean test scores as a criterion, the scores on the PAQ job dimensions were then used in a regression procedure for the prediction of the mean GATB test scores.

Two such studies have been carried out. The first of these, by Mecham and McCormick (1969), involved a sample of PAQ analyses for 179 positions which "matched" 90 jobs for which the USTES published test data. In this instance the PAQ job dimensions that were used as predictors were those developed by Jeanneret and McCormick (1969). In the second study PAQ analyses for 659 positions were matched with 141 jobs for which the USTES had published test data (Marquardt and McCormick (1974b). In the case of both of these studies the prediction of the mean test scores of the incumbents from PAQ job dimension scores was quite respectable. The ranges and medians of the multiple correlations across the nine GATB tests resulting from these studies are given below.

| | Mecham and McCormick | Marquardt and McCormick |
|---|---|---|
| Correlations | | |
| Range | .59 to .80 | .46 to .76 |
| Median | .71 | .73 |

In both of these studies the predictions of the cognitive tests were best, those of the perceptual tests were intermediate, and those of the psychomotor tests were the lowest. Although there were differences in the predictions for the various types of tests, the general level of prediction was viewed as demonstrating the potential utility of the use of such a procedure for the establishment of the job component validity of personnel selection tests.

## Objectives of the Present Study

The use of PAQ job dimension scores for the prediction of mean GATB test scores of "hypothetical" samples of job incumbents on various jobs clearly can give some indications of the aptitudes that presumably would be required for individual jobs. However, since the predictions are in terms of GATB test scores, and since the GATB tests are not available for use by private organizations, the operational use of such predictions would necessitate that the predictions in terms of the nine GATB tests would have to be "converted" into terms corresponding to those of commercially-available tests. Thus, it would be desirable to develop some procedure for use of the GATB test score predictions as the basis for the selection of corresponding commercially-available tests, and for the estimation of scores for such tests which correspond to those of the GATB tests. Thus one could use predictions of appropriate GATB test score cut-offs as the basis for deriving estimates of cut-ff scores on other (corresponding) tests which would be comparable to those of the GATB test in question. The basic objective of the present study has been that of developing some procedure for shifting from the prediction of GATB test scores to the prediction of scores on commercially-available tests that presumably correspond with those of the several GATB tests.

There are two possible general approaches to the "matching" of GATB and commercially-available tests that might serve as the basis for converting from one to another. The preferable approach would be one for which data are available for two tests that are based on the scores of the individuals in a "general population" who have taken both tests. The equivalence of two such tests would best be reflected by a high correlation between the two. In turn, corresponding norms for the two tests preferably should be available for the general population, in order to make it possible to "convert" scores from one test to equivalent scores on another test in terms of either standard deviation units from the mean, or in terms of percentile norms. The USTES has published data on certain commercial tests that have been administered to the same samples of individuals who have taken certain of the GATB tests. These data, however, were found not to be particularly useful for this study, since many of the tests for which such data were presented were those more typically used in educational circumstances rather than for personnel selection. Also many of the samples of individuals represented in the normative data consisted of students or of individuals on given occupations rather than of the "general

population." In most instances normative data were simply not available.

The second approach is one in which a judgment needs to be made about the equivalence of test content, or the equivalence of the "construct" that presumably is being measured by the two tests in question. This is admittedly a subjective evaluation, and therefore needs to be approached with caution. In the case of some pairs of tests there is no particular problem in making a reasonably valid judgment about their equivalence, but in the case of other tests the subjective judgment may not be entirely valid. In those instances where tests are considered to be equivalent, there is of course the further possible problem of conversion of norms from one test to those for the second test. Many of the norms presented in test manuals are for individuals on certain jobs or in various job groupings, without there being norms available for what might be viewed as a "general" population. (It might be added that the norms for the GATB test have been based on a sample of 4000 individuals whose jobs are reasonably representative of the major occupational groups of workers in the labor market. Therefore, the application of this approach preferably would require the availability of a reasonably comparable set of norms for any other test that would be considered as being essentially "equivalent" to one of the GATB tests.)

## METHOD

The primary focus of this study, then, was to develop some way of testing the utility of a job-component validity model, based on PAQ job dimensions, for use with commercially-available tests. To accomplish this it would be necessary to translate the predictions for the GATB tests made by combining the PAQ job dimension scores into terms relevant to commercially-available tests representing similar aptitude constructs. Therefore, this study was viewed as a test of the generalizability of the PAQ-based job-component validity model that has been heretofore tested only with GATB test data.

The basic approach used has been that of obtaining, from various organizations, data from any validity studies that they had carried out for jobs in their organizations, as well as obtaining PAQ analyses for any such jobs. Several approaches were used in an attempt to obtain such data, including the following:

1. Direct mailing of letters to several hundred organizations, explaining the goals of the project and asking them to submit any relevant test data they had available (validity information as well as normative data), and asking them to arrange for the analysis of jobs in question with the PAQ.

2. Establishing contacts with various test publishing firms, asking them if they had any validity or normative data on any of the tests which they published for incumbents on specific jobs.

3. Mailings to consulting firms which it was believed were involved in test validation studies.

4. Mailings to former graduate students of Purdue University.

5. Appeals made in certain publications which it was felt had the audiences that it might be useful to contact, asking if anyone had the kinds of data we were seeking. These appeals included articles in The Industrial Psychologist (TIP) (the newsletter of the Division of Industrial/Organizational Psychology of the American Psychological Association), and the Personnel Administrator, which is the official organ of the American Society for Personnel Administration.

Although the combination of all of these sources yielded test data for incumbents for a moderate number of jobs, there was still a problem in the case of certain jobs. In the case of certain jobs for which test data were available the organization or individual furnishing the test data were unable or unwilling to arrange for the analysis of those jobs with the PAQ. In order to include these jobs in our sample, it was decided to "match" these jobs with jobs which had already been analyzed with the PAQ and which were in the PAQ data bank (presently consisting of some 20,000 jobs). This matching was carried out on the basis of job code numbers from the Dictionary of Occupational Titles (D.O.T.), which, although admittedly imperfect, seemed to provide a reasonable basis for matching jobs. Even after augmenting the sample in this way, however, the total sample still consisted of only some 58 jobs. This was not seen as a large enough sample to allow for any meaningful analyses. Thus, other attemps to obtain relevant normative and/or validity data were made.

In an attempt to enlarge the sample of jobs, some archival data were used. Such data consisted mainly of validity or normative data for various tests for incumbents on different jobs as reported in sources such as the Validity Information Exchange of Personnel Psychology, The Handbook of Employee Selection (Dorcus and Jones, 1950), and the manuals for various tests commonly used in industry. The PAQ analyses for the jobs for which data were obtained through these sources had to be obtained by matching these jobs with jobs in the PAQ data bank. As before, this was done on the basis of D.O.T. code numbers. This archival data yielded data on an additional 38 jobs, bringing the total sample for this study to 96 jobs.[1]

[1] It should be noted that obtaining test data and PAQ analyses for jobs so they could be included in this study was the major difficulty encountered in the project. The present sample took almost 2 years to collect, and new approaches to data collection are currently going on. It was felt that a preliminary report should at least be prepared to describe this line of research, but it is hoped that present efforts will allow a more extensive analysis later with a much larger sample.

With this final sample of 96 jobs for which there were available test data from either an organization or various archival sources, as well as a PAQ analysis for each job, the following operations were carried out:

1. The commercially-available tests for which data were now available, had to be matched to individual GATB tests which were judged to measure the same "constructs."

2. A method had to be developed which would allow the equating of the norms for the commercially-available tests with the norms of the corresponding GATB tests.

3. Analyses would be carried out relating, for each job, the PAQ predicted GATB test data, to the data on the commercially-available test in question. This comparison would revolve around: (1) the mean test scores; (2) what were referred to as "cut-off"scores (which in most instances consisted of the test score one standard deviation below the mean of the scores of the incumbents on the job in question); (3) validity coefficients; and (4) the determination of whether or not the test would be a "valid" predictor of performance for the job in question.

Although the total sample consisted of 96 jobs, a small portion of the sample was based on data for jobs in each of seven clusters which had been formed by one organization. (These clusters had been used in a previous test validation study the organization had carried out.) PAQ analyses were available for certain of the jobs within each cluster, but not for all jobs. The test data for the incumbents of all of the jobs within each cluster were not differentiated by specific job. Thus, it was not possible to relate PAQ analyses for the individual jobs with the test data for the incumbents on those same identical jobs. In view of this a "composite" PAQ analyses were then used as the "predictors" of the test data for the incumbents on the jobs in the clusters.

In view of the special treatment of the data for the jobs in these seven clusters a complete set of analyses was also carried out for all of the jobs excluding these. This set of analyses then was based on a subsample of 89 jobs (96 minus the 7).

## Constructs Used in the Study

As was mentioned above, this study required relating data on a number of commercially-available tests to the GATB tests. This presented a bit of a problem in that the factorial composition of apparently "similar" tests is sometimes quite different, and thus two tests of, for example, verbal ability, may actually be testing somewhat different abilities or attributes. Recognizing this problem, it was nonetheless decided that the only feasible way that this study could be carried out would be to consider, as measures of the same "construct," all of the commercially-available tests that purport to measure the same construct as that represented by any given GATB test. Although the actual GATB tests were not available, there is information published concerning the general nature of each subtest. Thus, for example, a test of "verbal aptitude" that consisted primarily of reading comprehension items would not be included as a test of the "Verbal Aptitude" construct as measured by the verbal (V) GATB test used in this study to represent that construct.

Since the entire framework of this study revolved around the GATB, it was only natural that the constructs which would be of interest would be the nine measured by the subtests of the GATB, these being General Intelligence (G), Verbal Aptitude (V), Numerical Aptitude (N), Spatial Aptitude (S), Form Perception (P), Clerical Perception (Q), Motor Coordination (K), Finger Dexterity (F), and Manual Dexterity (M). The commercially-available tests used to measure each construct, and the number of jobs for which each such test was used are given in Appendix B.

## Development of Equivalent Norms

The determination of which commercially-available tests measured each of the constructs in question, although basically a judgemental question, did not pose any serious problems. Once the individual tests had been classified as measuring a specific construct, it was then necessary to develop a method of equating scores on each of the commercially-available tests used to measure the construct to test scores on the GATB subtests for that same construct. The optimal procedure for accomplishing this would have been to have available normative test data for a single, general population on all the tests within a particular construct. Such data were not available, however, and other methods had to be employed. These methods involved the combining and synthesizing of general norm groups, and eventually all test scores were expressed in the same standard score units, those units based on the standard score distribution reported for the GATB tests. The GATB standard scores are based on a mean of 100 and a standard deviation of 20. A more detailed explanation of the methods employed to develop these equivalent norms is given in Appendix C.

As a result, for any construct, it was possible to locate, for each job for which test data for a test measuring that construct were available, the position on the continuum of scores on the construct where the sample of incumbents on that job would fall. It was the scores of these incumbents on the different con-

structs that were used as criterion values in this study, such criterion values for various jobs being viewed as reflecting the relative "importance" to the jobs in question of the construct in question.

## Actual Criteria Used

Four different criteria as related to individual jobs were used in the study, these being considered as reflecting various indices of the "importance" to the individual jobs of each of the nine constructs as represented by the GATB tests. These criteria for each job and in each test, consisted of: (1) mean test score of the job incumbents on the individual job; (2) a potential cut-off score; (3) a coefficient validity; and (4) an indication of whether the test would be "valid" for the job. The first two of these were considered to be the primary criteria used in the study. Considereing for a moment the criterion of mean test scores of incumbents on the individual jobs, one could view a continuum for each of the nine constructs expressed in standard score form with the mean scores of incumbents on the various jobs falling in various positions along that continuum, from low to high. (As indicated earlier, the conversion of the norms of the commercially-available tests to the standard score forms of the GATB tests served as the common metric for relating the mean scores of incumbents on that continuum.) In the case of certain jobs the cut-off score criterion consisted of scores that were actually used as cut-off scores in selecting people for the jobs in question by the organizations which had provided the test data. In the case of most jobs, however, this was a "potential" cut-off score which was one standard deviation below the mean of the scores of incumbents on the job in question.

In the case of the criterion of validity coefficients it was of course not necessary to be concerned about the "normative" data that were used with the criteria of mean test scores and predicted cut-off scores. Rather, for any given construct, the coefficients of validity of the tests which were considered to represent that construct could be viewed as representing a continuum from low to high as expressed by the actual coefficient values themselves. In the case of certain analyses the fourth criterian was used, namely an indication as to whether individual tests would be "valid" predictors of performance. This criterion was based on the question as to whether the initial coefficient of validity for that test itself was one which was statistically significant or not.

## Development of Predicted Criterion Values

The predicted criterion values for the individual jobs were derived from a standard computer printout of data that are printed from the PAQ analysis of any given job. These computer printouts are based on previous analyses of PAQ-based data as related to the published USTES test data mentioned previously. Such data include, for the each of the sample jobs, and, for each GATB test, estimates of

the mean test score of job incumbents, the standard deviation of the distribution of test scores of incumbents on each job (to be used to establish a "cut-off" score), and the validity coefficient. The computer printout, based on regression analyses of PAQ job dimension scores as related to these three values, provides estimates, for any given job, of the first three criteria. In connection with the fourth criterion the computer program on which these computer printouts are based also includes provision for making a prediction about those tests (usually three) which would be valid predictors for performance on the job in question. This particular aspect of the program, in effect, is a "policy capturing" procedure that parallels the practice of the USTES in its approach to the identification of the three "best" or most "valid" tests for use in the selection of individuals for any given job, and in establishing cut-off scores for those three tests. The PAQ printout, in effect, provides estimates of the cut-off scores of those three tests. Thus, for any given job, the fourth criterion consists of the identification of three tests, which are predicted to be the most "valid" for use in selecting people for any given job, based on USTES practices in this area. Thus, in the case of the three tests identified by the computer program as being most "valid" for any given construct, a determination would be made as to whether that test in the actual validity setting, did in fact turn out to have a significant validity coefficient for the job in question.

Relating Predicted to Actual Criterion Values

As implied above, the predictions of the four different criteria used in the study were derived from the conventional PAQ computer printout for the individual jobs used in the case of the analysis of any given construct. In these predictions there was of course the initial "selection" of jobs for which relevant test data were available for the incumbents as related to any given construct. In addition, given those jobs for which test data for a given construct were available, there was a further selection, for individual analyses, of the types of test criterion data which were actually available. Thus, for any given construct, a job would be included in the analysis for any particular criterion, depending upon whether actual criteria data were available - such as mean test scores, cut-off scores, validity coefficients, or an indication as to whether a coefficient was or was not valid. Thus, the analyses consisted of a series of sub-analyses for the individual constructs, each sub-analysis consisting of data for jobs for which both predicted and actual criterion data were available.

In this process the actual (or obtained) test values for incumbents on any job, were converted to standard scores on the constructs involved. The predicted scores were all in terms of GATB tests, but, since the constructs were defined in terms of the GATB subtests, and since all scores were in a common metric, this provided no problem. The actual predicted scores themselves were

the result of combining the PAQ job dimension scores for any job, according to regression equations, developed in earlier research designed to predict GATB test scores from PAQ job dimension scores (Mecham and McCormick, 1969). These equations were designed to yield mean test scores, potential cut-off scores, validity coefficients, as well as make some prediction about which tests should be valid predictors of performance for a job. These predictions were then compared to the actual criterion data in these areas by means of a series of correlational analyses.

## RESULTS

For each of the nine aptitude constructs represented by the nine tests of the General Aptitude Test Battery (GATB), Pearson product-moment correlations were computed for each of the following sets of data, the analyses in each instance being based on those jobs for which relevant test data and criterion data were available.

(1) Predicted GATB mean test scores (as derived by procedures involving job analysis data from the PAQ) and actual mean test scores obtained for incumbents on each of the jobs in the sample,

(2) Predicted GATB cut-off scores (scores one standard deviation below the predicted mean test scores) and (in the case of a few organizations) actual cut-off scores which had been set for each of the jobs in the sample (the actual cut-off scores were not necessarily one standard deviation below the mean),

(3) Predicted validity coefficients (obtained from PAQ job analysis procedures).

In addition to the Pearson product-moment correlations, a phi coefficient was computed for each of the nine GATB aptitude constructs between the predicted validity of a particular test (valid=1, not valid =0) as derived from PAQ procedures, and the actual validity of the tests (valid=1, not valid=0) as obtained in actual validation procedures carried out by organizations providing data for the present study. The Pearson product-moment correlatins as well as the phi coefficients computed for each of the nine GATB aptitude constructs are presented in Table 1.

One should note that no test data were available for either the Form Perception or Motor Coordination constructs. In the case of Finger Dexterity and Manual Dexterity, data were available on only seven jobs, these being the seven job clusters mentioned earlier in this section. Data concerning these two ability areas probably should be considered as essentially meaningless, because of the small sample size.

The results reported in Table 1 would seem to indicate a substantial relationship between PAQ predictions concerning mean test scores and cut-off scores obtained for the jobs in the sample. When considering the relationship between predicted and actual mean test scores for those ability areas with sufficiently large sample sizes to warrant consideration, five of five correlations are significant at the .03 level or better. The correlations range from .30 (Spatial Ability) to .68 (Clerical Ability). The results concerning predicted and actual cut-off scores are similar. Again, when considering only those ability areas with adequate sample sizes, four of four correlations are significant at the .03 level or better. The correlations range from .28 (Intelligence) to .70 (Verbal Aptitude).

The relationship between predicted and actual validity coefficients is not as promising, however. Only one of the five correlations is significant at the .05 level, with it being in the opposite direction to what would be normally expected. The correlations range from -.36 (Verbal Aptitude) to .19 (Numerical Aptitude). The data relating to the predicted versus actual validity or non-validity of the particular tests show considerably stronger relationships than for the validity coefficients themselves. These coefficients ranged from -.15 (Intelligence) to .53 (Spatial Aptitude). It would thus seem that PAQ-based data were relatively successful in predicting whether or not particular tests would prove to be valid predictors of job performance.

One explanation of the relatively (moderately) low phi coefficients obtained in the present study is that PAQ-based data are conservative in their prediction of the validity or non-validity of tests. Predictions from PAQ data would thus have a tendency to predict as invalid a number of tests which might actually prove to be valid indicators of job performance. As a result, a frequency count was made of only those cases where the PAQ data predicted that a particular test would be valid. In Table 2 are given the number of correct valid predictions and the number of predictions which were incorrect, as well as the percent of predictions made which were correct. Note that considering all five ability areas where such data were available, 75 percent of the cases in which tests were predicted to be valid, they were indeed valid predictors of job performance. These results, taken together with the phi coefficient data, would seem to suggest that, if anything, predictions based upon PAQ data are conservative in nature, and are relatively accurate in their prediction of valid indicators of job performance.

TABLE 1

Correlations Between Predicted and Actual Mean Test Scores, Cutoff Scores, Validity Coefficients, and Phi Coefficients for Valid - Non Valid Tests

Pearson Product-Moment Correlations: Criterion of Mean Test Scores

| | Total Sample | | | Subsample N=89 | | |
|---|---|---|---|---|---|---|
| Test | r | significance | N | r | significance | N |
| G-Intelligance | .32 | .011 | 49 | .48 | .001 | 42 |
| V-Verbal Aptitude | .52 | .001 | 34 | .48 | .001 | 34 |
| N-Numerical Aptitude | .54 | .001 | 69 | .56 | .001 | 62 |
| S-Spatial Aptitude | .30 | .030 | 39 | .29 | .050 | 32 |
| P-Form Perception | * | * | * | * | * | * |
| Q-Clerical Perception | .68 | .001 | 31 | .68 | .001 | 31 |
| K-Motor Coordination | * | * | * | * | * | * |
| F-Finger Dexterity | -.02 | .480 | 7 | * | * | * |
| M-Manual Dexterity | -.67 | .050 | 7 | * | * | * |

Pearson Product-Moment Correlations: Criterion of Cutoff Scores

| | Total Sample | | | Subsample N=89 | | |
|---|---|---|---|---|---|---|
| Test | r | significance | N | r | significance | N |
| G-Intelligence | .28 | .028 | 47 | .39 | .006 | 40 |
| V-Verbal Aptitude | .70 | .001 | 34 | .70 | .001 | 34 |
| N-Numerical Aptitude | .61 | .001 | 45 | .64 | .001 | 38 |
| S-Spatial Aptitude | .53 | .024 | 14 | .53 | .110 | 7 |
| P-Form Perception | * | * | * | * | * | * |
| Q-Clerical Perception | * | * | * | * | * | * |
| K-Motor Coordination | * | * | * | * | * | * |
| F-Finger Dexterity | -.20 | .329 | 7 | * | * | * |
| M-Manual Dexterity | .23 | .305 | 7 | * | * | * |

*Insufficient number of cases for analysis

TABLE 1 (Con't.)

Pearson Product-Moment Correlations: Criterion of Validity Coefficients

| | Total Sample | | | Subsample N=89 | | |
|---|---|---|---|---|---|---|
| Test | r | significance | N | r | significance | N |
| G-Intelligence | -.26 | .191 | 13 | | | |
| V-Verbal Aptitude | -.36 | .022 | 31 | | | |
| N-Numerical Aptitude | .19 | .072 | 56 | | | |
| S-Spatial Aptitude | .15 | .204 | 29 | Same as for total sample | | |
| P-Form Perception | * | * | | | | |
| Q-Clerical Perception | .16 | .182 | 34 | | | |
| K-Motor Coordination | * | * | 00 | | | |
| F-Finger Dexterity | * | * | 00 | | | |
| M-Manual Dexterity | * | * | 00 | | | |

Phi Coefficients: Criterion of Valid vs Non-valid tests

| | Total Sample | | | Subsample N=89 | | |
|---|---|---|---|---|---|---|
| Test | r | significance | N | r | significance | N |
| G-Intelligence | -.15 | .303 | 13 | | | |
| V-Verbal Aptitude | .49 | .003 | 31 | | | |
| N-Numerical Aptitude | .30 | .011 | 56 | | | |
| S-Spatial Aptitude | .53 | .001 | 29 | Same as for total sample | | |
| P-Form Perception | * | * | | | | |
| Q-Clerical Perception | .01 | .485 | 34 | | | |
| K-Motor Coordination | * | * | | | | |
| F-Finger Dexterity | * | * | | | | |
| M-Manual Dexterity | * | * | | | | |

* Insufficient number of cases for analysis

TABLE 2

Frequency Count of Correct and Incorrect Predictions Only When PAQ-based Data Predict Tests to be Valid Indicators of Job Performance

| Test | No. Correct Predictions | No. Incorrect Predictions | Percent Correct Predictions/ Incorrect + Correct |
|---|---|---|---|
| G-Intelligence | 9 | 3 | 75 |
| V-Verbal Aptitude | 7 | 0 | 100 |
| N-Numerical Aptitude | 15 | 6 | 71 |
| S-Spatial Aptitude | 3 | 1 | 68 |
| P-Form Perception | * | * | * |
| Q-Clerical Perception | 13 | 6 | 68 |
| K-Motor Coordination | * | * | * |
| F-Finger Dexterity | * | * | * |
| M-Manual Dexterity | * | * | * |
| All Tests Together — | 47 | 16 | 75 |

*Insufficient number of cases for analysis

## DISCUSSION

It would seem, based on the results reported here, that PAQ-based data can indeed serve as the basis of a job component validity model as reflected by the fact that there is a reasonable relationship between test score data predicted by the PAQ, and actual test score data for job incumbents resulting from actual test validity studies. Although data were not available in all the areas tested by the GATB, for those areas for which adequate data were available, there were significant relationships between PAQ predicted and obtained mean test scores, and between predicted and obtained cut-off scores. Furthermore, for the tests which were predicted to be valid by the PAQ, in only 25 percent of the cases were the tests not actually reported to be valid. These results are clearly indicative of the utility of PAQ-based data in a job component validity model in and of themselves, and, when all the data are taken into consideration, the support is rather impressive, especially considering certain obvious shortcomings in the available data.

In considering these possible shortcomings for example, the regression equations used to predict test data were not based on commercially-available tests such as were used in this study, but were based on GATB data. Although the tests used in this study were matched with the corresponding GATB tests as well as possible, it is obvious that all tests classified as representing the same construct are not necessarily measuring the same "identical" construct. Thus, we have a regression equation derived to predict scores on one test of, say, verbal aptitude, and we are using that regression equation to preduct test data based on other tests of "verbal aptitude" which may at least be somewhat different in content. The magnitude of the obtained relationships becomes even more impressive in part because of the possible "slippage" from this possible disparity.

There are other problems as well. The process of equating the norms for the different tests may also have added some error variance into the prediction system, although this probably did not play a major role in reducing the predictability of test scores. A much more serious problem probably stems from the very nature of the various validity studies which provided the data which we were trying to predict. Of course, there was no control on the design of the validity studies which served as the sources of the criterion test data, and, not only did the quality of the studies seem to vary somewhat, but the criteria used in the different studies, and all studies had been carried out in the same fashion, it might have been easier to predict the outcome from the PAQ-based equations.

Unfortunately, these (and perhaps other) problems are typical of those which involve the collection of already existing research data from a variety of organizations. (The data obtained from rats in a laboratory certainly can be obtained under much more neatly "controlled" conditions than obtaining human data from the real

world of work.) The nature of this project required the collection of test validity and/or normative data from various organizations, and it would be inevitable that the adequacy of the various test validation studies used would have been variable, and that the criteria used in them would have varied. The collective effect of some of these problems and of their effects on the summarizing and analysis of the data would be expected to reduce the strength of the actual relationships between the predictors and the criterion values, thus representing a conservative estimate of the predictability of the PAQ-based data. In the light of these constraints, the results seem generally to give further support to the potential use of a structured job analysis procedure as the basis for establishing personnel specifications for jobs.

This particular report is presented as a preliminary report covering relevant data that were available. Efforts are being made to obtain, for additional jobs, relevant test data and PAQ analyses toward the end of building up a larger sample for a subsequent analysis within the next several months. In connection with the analysis it is expected that a more recently-developed set of PAQ job dimensions will be used, specifically a set that would be based on a larger and more representative sample of jobs. It is also hoped that data for an expanded sample of jobs would include test validity and/or normative data for a wider range of commercially-available tests, thus providing a basis for greater "generalization" of PAQ-based job data for the estimation of personnel requirements of jobs using the basic job component validity model.

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## APPENDIX A

### Jobs Included in the Sample

Jobs for which data were obtained directly from various organizations:

| Job Title | D.O.T. Number* |
|---|---|
| Feeder Catcher | 619.886 |
| General Factory Worker | 899.381 |
| Roll Catcher | 643.886 |
| Slotter | 651.782 |
| Utility | 922.883 |
| Stripper | 749.887 |
| Apprentice Steelworker | ** |
| Bundler Stacker | 221.388 |
| Oil Maintenance and Operator (trainee) | ** |
| Oil Assistant Operator | 542.280 |
| Business Forms Pressmen | ** |
| Special Officer (Dept. Store) | ** |
| Saleclerk | 290.478 |
| Pipefitter (trainee) | 862.381 |
| Oil Refinery Process Trainee | 452.280 |
| Computer Operator | 213.282 |
| General Clerk | 209.388 |
| Billing Checker | 209.688 |
| Requisition Handler | 221.388 |
| Order Filler | 922.887 |
| Stock Assistant | 223.387 |
| Typist | 112.800 |
| Shipping Packer | 227.587 |
| Shipping Checker | 209.688 |
| Sorter | 222.687 |
| Returned Goods Receiving Clerk | 222.387 |
| Material Handler | 929.887 |
| Induction Clerk | 161.688 |
| Bookkeeper | 210.388 |
| Keypunch Operator | 213.582 |
| Calculating Machine Operator | 216.488 |
| Record Clerk | 222.587 |
| Correspondence Clerk | 204.288 |
| Timekeeper | 219.388 |
| Buyer's Assistant | 223.368 |
| Receiver Checker | 222.687 |
| Secondary Receiver | 222.587 |
| Industrial Truck Driver | 905.883 |

There were also several clusters of jobs which have no particular title since they are actually composites of several jobs included in this sample. These clusters resulted from various research efforts on the part of the organizations, and were treated as individual jobs.

*Code number from the Dictionary of Occupational Titles

**The title as furnished by the company covers several related D.O.T. classifications.

Jobs for which data were obtained from journals, test manuals, etc.:

| Job Title | D.O.T. Number* |
|---|---|
| Electrician | 824.281 |
| Bank Clerk | 209.388 |
| Bookkeeping Machine Operator | 215.388 |
| Secretary | 201.368 |
| Meter Reader | 239.588 |
| Mail Clerk | 231.588 |
| Shipping Clerk | 222.587 |
| File Clerk | 206.388 |
| Gas Serviceman | 637.281 |
| Yard Clerk | 910.388 |
| Industrial Engineer | 012.188 |
| Electrical Technician | 003.181 |
| Packer | 920.887 |
| Machinist | 638.281 |
| Subscription Clerk | 209.488 |
| Telephone Service Representative | 249.368 |
| Aircraft Inspector | 619.381 |
| Truck Driver | 905.883 |
| Telephone Operator | 235.862 |
| Plant Worker | 355.878 |
| Assembler | 726.781 |
| Coding Clerks | 219.388 |
| Aircraft Manufacturing Foremen | 621.131 |
| Draftsman | 005.281 |
| Accountant | 160.188 |
| Insurance Sales Representative | 250.258 |
| Programmer | 007.187 |
| Claims Adjustor | 241.168 |
| Accounting Clerk | 219.488 |
| Computer Operator | 213.382 |
| Stenographer | 207.388 |
| Receptionist | 237.368 |
| Bank Teller | 212.368 |
| Reservations Clerk | 912.368 |
| Typist | 112.800 |
| Clerk | 105.000 |
| Keypunch Machine Operator | 213.582 |
| Policeman | 375.268 |

* Code number from the Dictionary of Occupational Titles

# APPENDIX B

## Tests Used to Measure The Various Constructs

### Intelligence

Wonderlic - 21 cases
Otis Test of Mental Ability - 3 cases
Test of Learning Ability - 6 cases
SRA Adaptability Test - 2 cases
Special (or in house) - 7 cases

### Verbal Aptitude

SRA-Verbal - 7 cases
PTI-Verbal - 7 cases
SET-Verhal - 2 cases
EAS-Verbal - 13 cases

### Numerical Aptitude

SRA-Numerical (or Arithmetic Form) - 3 cases
EAS-Numerical - 14 cases
SET-Numerical - 3 cases
PTI-Numerical - 7 cases
Arithmetic Fundamentals - 3 cases
Arithmetic Reasoning Test - 1 case
FIT-Arithmetic - 4 cases
Special (or in-house) - 31 cases

### Spatial Aptitude

Minnesota Paper Forms Board - 2 cases
EAS-Spatial - 5 cases
SRA-Assembly - 1 case
Special (or in-house) - 30 cases

### Clerical Perception

SET-Clerical - 3 cases
Special (or in-house) - 24 cases

## APPENDIX C

### Development of Norms

In order to carry out this study, it was necessary to have all test data in some common framework - that is, all test scores had to be expressed in terms of some common scale. In order to do this, it would have been desirable to have data on all the tests used in this study for the same population. This was clearly not possible. Therefore, some alternative strategy had to be formulated. Since the tests of the General Aptitude Tests Battery (GATB) of the United States Training and Employment Service were used as the criterion tests in other studies involving the PAQ in a job component validity model (Mecham and McCormick,1969; Marquardt and McCormick, 1973), it was decided that the norms for the GATB would be utilized as the basic framework. The GATB tests are reported in standard score form, with a mean of 100 and a standard deviation of 20, these values being derived from test data on over 20,000 people collected by the United States Training and Employment Service.

The major problem, however, was with the other tests that would be used in this study. Although it was not very difficult to assign any given test to an appropriate construct, since the "constructs" utilized in this study were of such a broad nature (for example, it seems obvious that the Short Employment Test of Verbal Ability should be classified as a "Verbal Aptitude" test), there is no body of data indicating the norms for these tests on a "general"population. Not only were the different tests used with different populations, but for most tests there was not a single population that could be considered as a "general working population" for which norms were supplied. Since that is basically what the GATB norms are based on, it seemed desirable to have all other norms based on the same kind of population.

The first problem, then, was to construct general norms for each of the different tests. The seriousness of this problem varied for the different tests. For example, for the Employee Aptitude Survey Tests, norms are provided for a general working population, and so these norms were used. For the Otis Test of Mental Ability, norms are provided for a general population, but these norms are given separately for males and females, and so they had to be consolidated into a single set of norms. For the various tests published by the Psychological Corporation (viz. The Short Employment Tests and the Personnel Tests for Industry), no general norms are provided. Rather, there are norms provided for separate occupational groups. In general, the number of occupational groups for which such norms were provided were too numerous to be reasonably consolidated, so these norms were sampled. That is, a number of groups which seemed to have "high" norms were combined with a number of groups which seemed to have "low" norms, yielding a single set of norms which it was

felt provided a fair representation of a norm for a "general" population.

Thus, for each test a single set of norms was constructed, recognizing that the populations deemed "general" were different for each test. Again, there was no way to avoid this lack of a single "general" population for whom scores were known on all tests used. The test scores which were obtained from either the organizations involved in the study, or any of the other methods discussed earlier, for each job, were then standardized on the general norms established for the corresponding GATB test. This resulted in a standard score for each test, for the incumbents on each job, reflecting where mean test for incumbents on that job fell on the particular construct relative to all other jobs.

The problem still remained of converting all these scores to some common metric. As was pointed out above, the GATB norms were to be used as the framework for this common metric. Since one set of standard scores is always directly convertible to any other set of standard scores, the scores for each job were then converted into standard scores with a mean of 100 and a standard deviation of 20. For example, if the mean score for a sample of plumbers happened to be 48 on the Revised Minnesota Paper Forms Board, and this was found to be equal to a standard score of .50 based on the general population norms constructed for that test, conversion to the GATB norms was simply a matter of multiplying the GATB standard deviation of 20 by .5, (10), and adding this to the GATB norm mean of 100 (since the standard score was positive), yielding a GATB standard score of 110. This process was repeated for each job and each test so that the final product was a continuum for each "construct," with the mean scores of incumbents on the various jobs being assigned positions on this continuum based on standard scores with a mean of 100 and a standard deviation of 20. It was these converted scores that were used as the criterion values of "mean test scores" used in this study. Thus, since the PAQ based predictions are in terms of the GATB tests, and the criterion tests scores for the various jobs were in GATB standard score terms, mean test score values for the two could be directly compared for any job. A somewhat similar procedure was used in deriving the predicted cut-off score criterion values, which were one standard deviation below the mean of the scores of incumbents on the individual jobs.

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